PREDATOR - PREY

G.H. BALAZS Groupers FILE

Mongoose Predation on Sea Turtle Eggs and Nests

The small Indian mongoose (*Herpestes auropunctatus*) was widely introduced onto islands of the Caribbean and Pacific in the late 19th century for rat control in sugarcane plantations (Espeut 1882). Although it is generally effective in reducing rat damage, the mongoose commonly had an adverse impact on some of the endemic fauna of these islands (Westermann 1953). At present, most of the endemic terrestrial species have either become extinct due to mongoose predation or have adapted to its presence.

We have been skeptical of local folklore which claims that mongooses regularly prey on sea turtle eggs and hatchlings. The mongoose is a strictly diurnal predator which hunts primarily by sight and secondarily by smell (Hinton and Dunn 1967). Although mongooses may scratch in leaf litter or soil to uncover invertebrates, they do not usually dig for prey. Most sea turtles come ashore at night and bury their eggs at depths to 50 cm, and their hatchlings usually emerge during hours of darkness. Thus, mongooses would not commonly discover open nests at either laying or hatching. There are few published reports of mongoose predation on sea turtles. Seaman and Randall (1962) reported evidence of mongooses preying on a green turtle (*Chelonia mydas*) nest. Ernst and Barbour (1972) report *Caretta caretta* predation by mongooses.

We have gathered evidence that mongooses are major predators on hawksbill (*Eretmochelys imbricata*) nests on all the U.S. Virgin Islands inhabited by mongooses (Table 1). Personal reports from other islands indicate that the problem is probably encountered wherever mongooses were introduced onto tropical oceanic islands. J. Ynterna (pers. comm.) has reported seeing mongoose tracks at leatherback (*Dermochelys coriacea*) nests, and a 1982 study of the Virgin Islands Division of Fish and Wildlife on St. Croix (unpublished) showed 5% of leatherback hatchlings were lost to mongooses. "Mongoose predation occurred when olfactory cues associated with an emergence of the previous evening enhanced their orientation to the nests. Limited excavation of the nests occurred and resident hatchlings near the surface were consumed."

Eyewitness accounts and physical evidence at disinterred hawksbill nests indicate that mongooses prey primarily

TABLE 1. *Records of sea turtle predation by mongooses.*

Date	Observer	Nest location	Age of nest	Evidence at scene
September 1979	M. Turbe	St. Thomas	2 days	Mongooses seen feeding on eggs.
July 1980	O. Martin	Buck Island	—	Mongoose with head in hole; shells scattered about. Nest was covered, but three hours later it was open again with new egg shells.
August 1980	R. Thomas	Buck Island	4 days	Tracks. After being covered, the nest was opened again the next day.
August 1980	V. Small	St. John	Previous night	Tooth marks on egg shells.
September 1980	M. Turbe	St. Thomas	Previous night	Mongooses seen with eggs. The nest was covered with plywood, but an hour later mongooses had burrowed under the plywood.
October 1980	V. Small	St. John	60 days	Tooth marks on egg shells; burrow into nest.
October 1980	V. Small	St. John	73 days	Tooth marks on egg shells; burrow into nest.
October 1980	V. Small	St. John	63 days	Tooth marks on egg shells; two burrows into nest after turtles emerged. Probably the mongoose ate the undeveloped eggs remaining in nest.
August 1981	J. LaPlace	St. Thomas	Previous night	Tooth marks on egg shells; tracks at nest.
August 1981	J. LaPlace	St. Thomas	Previous night	Tooth marks on egg shells; tracks at nest.
August 1981	V. Small	St. John	60 days	Tooth marks on egg shells. One dead decomposed hatchling was still in the nest.
August 1981	J. LaPlace	St. Thomas	57 days	Saw two mongooses at nest. Found three dead hatchling turtles with tooth marks.
August 1981	V. Small	St. John	1–2 days	Tooth marks on egg shells; burrow into nest.
September 1981	V. Small	St. John	55 days	Mongooses heard fighting. Three dead hatchlings found in surrounding vegetation; one was missing its head.

on nests with freshly deposited eggs or on nests just prior to emergence of hatchlings. The small, sharp teeth of mongooses leave marks on the egg shells easily distinguished from those of rats or dogs, the other potential predators in the ecosystem. We hypothesize that mongooses are attracted to new nests by the odors of the fluids emitted by the female at egg laying. The nests preyed upon just prior to emergence may be detected by the odors associated with hatching or the sounds produced by the concerted scrambling of the still buried hatchlings (Carr and Hirth 1961). A nest at Saltpond Bay, St. John visited early in the morning had been opened and mongooses were in the area. The nest contained 79 live hatchlings, 14 pipped eggs and 46 unhatched but developed eggs. Of the 79 hatchlings 12 still had the remains of a yolk sac, indicating they were not ready for emergence. Even if the hatchling emergence occurred at night, the open nest would attract mongooses to the late emergents and weak stragglers on their way to the sea in daylight.

Mongooses are persistent in their predatory activities when they discover a nest. Nests reburied after mongoose predation is interrupted are usually reentered by mongooses (Table 1). Mongooses burrowed through the openings of mesh wire with 15 cm squares buried over nests to inhibit dog predation. A local resident of St. Thomas attempted to use a sheet of plywood to protect a turtle nest being consumed by mongooses. The mongooses subsequently furrowed for over a meter diagonally beneath the plywood to regain access to the eggs.

The small Indian mongoose is considered to be a solitary predator, but a population density of up to five per hectare and a behavioral response common in mongooses called food envy (Ewer 1963) may combine to result in groups of mongooses present at large food sources. One of us (DWN) has repeatedly observed local populations of mongooses which have learned to utilize unusual but abundant food sources. Groups of mongooses may be seen feeding on the insects attracted to fallen fruit under a mango tree. A mongoose feeder with a recorder showed 15 visits per hour after a month's operation, and mongooses could always be seen in the vicinity. Group feeding seems to enhance the learning of predation on sea turtle nests to such an extent that all the 15 recorded nests on Neltjeberg and Penn beaches were destroyed, while 13 nests on the similar Jumbi and Windswept beaches were unmolested, presumably because the local mongoose population has not learned to feed on turtle eggs.

Removal of the mongoose population immediately adjacent to turtle nesting beaches may greatly increase the nest success of the turtles by eliminating mongooses which have learned to dig into turtle nests.

CARR, A. F., AND H. HIRTH. 1961. Social facilitation in green turtle siblings. Anim. Behav. 9: 68–70.
ERNST, C. H., AND R. W. BARBOUR. 1972. Turtles of the United States. Univ. Press of Kentucky, Lexington. 347 pp.
ESPEUT, W. B. 1882. On the acclimatization of the Indian Mongoose in Jamaica. Proc. Zool. Soc. London, pp. 712–714.
EWER, R. F. 1963. The behavior of the meerkat, *Suricata suricatta* (Schreber). Z. Tierpsychol. 20: 570–607.
HINTON, H. E., AND A. M. S. DUNN. 1967. Mongooses, their natural history and behaviour. Oliver and Boyd, London. 141 pp.
SEAMAN, G. A., AND J. E. RANDALL. 1962. The mongoose as a predator in the Virgin Islands. J. Mamm. 43: 544–546.
WESTERMANN, J. H. 1953. Nature preservation in the Caribbean. Pub. Found. Sci., Res. in Surinam and Netherlands Antilles. 9: 1–106.

David W. Nellis and Vonnie Small

Virgin Islands Division of Fish and Wildlife
St. Thomas, Virgin Islands and
National Park Service
St. John, Virgin Islands

That the acrosome reaction (and not capacitation) of guinea pig spermatozoa is itself pH-dependent and reversibly inhibited by low pH is supported by similar results from studies using sea urchin spermatozoa, which, unlike mammalian spermatozoa, do not require capacitation prior to the acrosome reaction.

Transfering spermatozoa from an acidic medium containing 2 mM Ca^{2+} to an alkaline medium containing 0 mM Ca^{2+} produced very few acrosome-reacted spermatozoa instead of a population consisting mainly of acrosome-reacted spermatozoa, as would have been expected if Ca^{2+} had penetrated readily into the cells while they were in the low pH medium. Increasing the Ca^{2+} concentration to 4-10 mM slightly counteracted inhibition of the acrosome reaction for sperm samples at pH values of 6.4 and 6.7. Sperm samples at pH 6.1 did not undergo acrosome reactions regardless of the concentration of extracellular Ca^{2+}, indicating that Ca^{2+} entry is severely limited or inhibited at this pH. Because an influx of extracellular Ca^{2+} into spermatozoa through the plasma membrane is an essential preliminary to the acrosome reaction, the failure of Ca^{2+} entry into spermatozoa is likely to be the primary cause of the failure of the acrosome reaction in the acidic medium.

This study was supported by grant HD-03402 from the National Institute of Child Health and Human Development.

* *

James Norris, Department of Zoology, University of Hawaii

FOOD HABITS OF PISCIVOROUS CORAL REEF FISHES FROM THE NORTHWEST HAWAIIAN ISLANDS

(Sponsor: Dr. James D. Parrish)

Food habits of piscivorous fishes resident on coral reefs were investigated to determine their trophic roles in the community. This study is part of a 4 year project by the Hawaii Cooperative Fishery Research Unit on the trophic structure of inshore reef fish communities in the Northwestern Hawaiian Islands. Reef study sites were established at Midway and French Frigate Shoals (FFS) lagoons. Fishes were collected throughout the year and at various locations. Analysis of gut contents was used to determine the degree of piscivory exhibited by each species. Of 112 species analyzed, 36 species representing 17 families showed some evidence of fish consumption, although only 14 species are considered to be primarily piscivorous. The total number of potential prey fishes and their relative proportions at the Midway and FFS study sites were estimated from visual censuses and various collections, including complete collections of isolated patch reef communities using rotenone. Of 29 families observed or collected, 24 occurred in the pooled guts of all the resident piscivores analyzed. Goatfishes (Mullidae) accounted for over 22% of the total volume of prey and more than 10% of the total number. Wrasses (Labridae), parrotfishes (Scaridae), gobies (Gobiidae), surgeonfishes (Acanthuridae), cardinalfishes (Apogonidae), and squirrelfishes (Holocentridae) each accounted for more than 10% of either the total number or volume of prey. Although butterflyfishes (Chaetodontidae) were totally lacking in the guts of piscivores, they accounted for more than 3% of the total weight and 2% of the total number of fishes from 4 complete community collections. Proportions of the various prey taxa in the community of potential prey fishes were compared with proportions encountered in the pooled guts of all the piscivores analyzed. Goatfishes (primarily Mulloides spp.), the dominant prey group, typically occurred on visual censuses as large transient schools passing over a reef or sheltering there briefly. They were not represented in large numbers in the various collecting efforts. Occurrence of other species of transient prey in the guts of piscivores suggests that resident piscivores rely on nonresident prey to some degree.

Data from gut analyses indicate that young recruits to a reef are preyed upon heavily by otherwise nonpiscivorous carnivores as well as by resident piscivores. Two sympatric lizardfishes (Synodus ulae and Saurida gracilis, the most highly piscivorous species observed, were analyzed for evidence of partitioning of food resources. These species were common on study sites and may account for a major portion of resident fish mortality. A low degree of dietary overlap of prey families was observed between these two species. Data and field observations suggest that these piscivores separate feeding niches spatially rather than temporally. Such partitioning patterns may serve to reduce competition if prey are a limiting resource.

This project received support from the University of Hawaii Sea Grant College Program, the Hawaii Ocean Management Office, and the Hawaii Cooperative Fishery Research Unit.

* *

Thomas Rayson, Cancer Research Center of Hawaii, University of Hawaii

EXPRESSION OF A SRC-HOMOLOGOUS GENE DURING EMBRYOGENESIS OF THE HAWAIIAN SEA URCHIN, TRIPNEUSTES GRATILLA

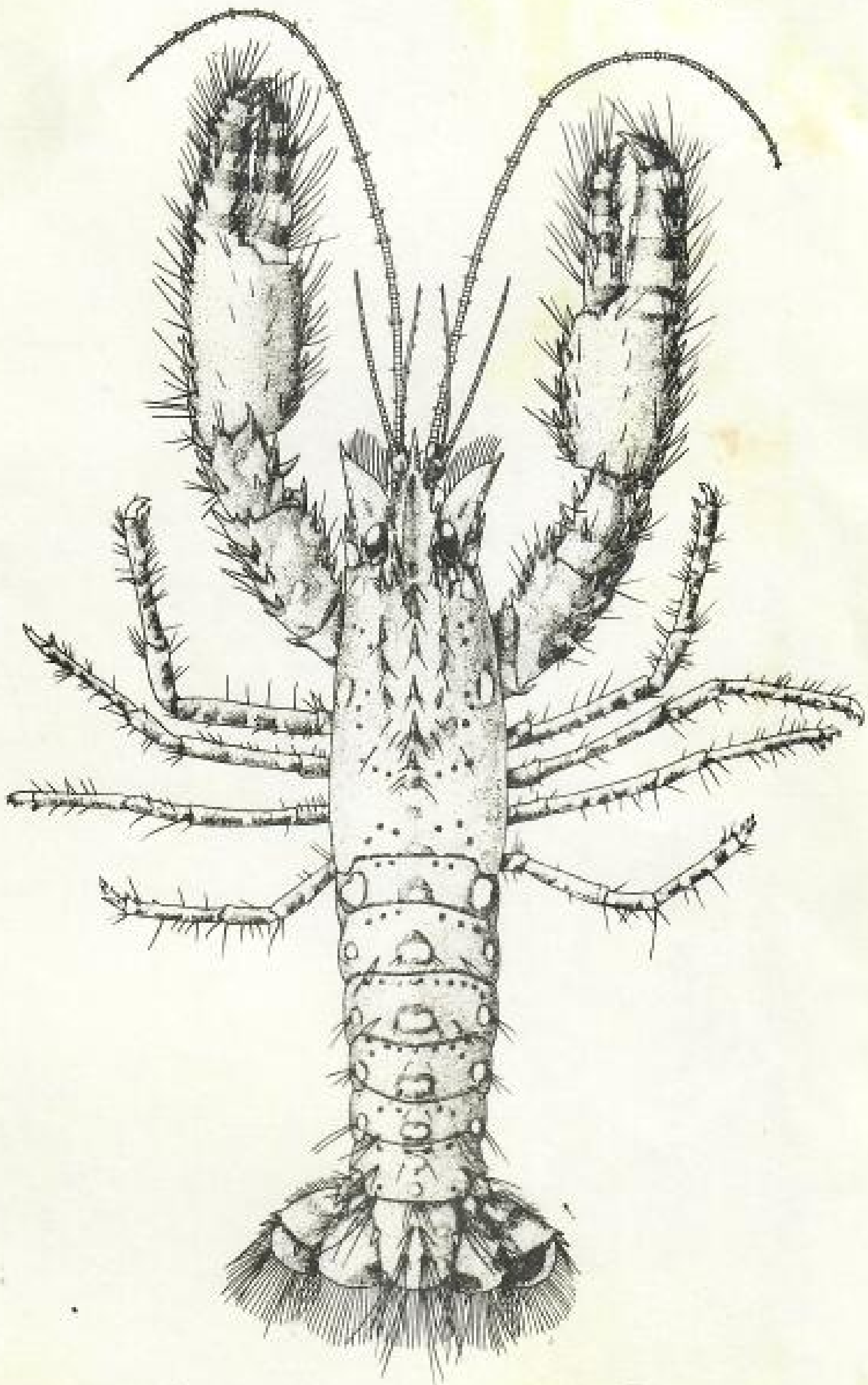
(Sponsor: Dr. Alan F. Lau)

Cellular proto-oncogenes, homologous to retroviral transforming genes have been detected in many vertebrates, but few invertebrates. Although the function of these proto-oncogenes in normal cells is not yet known, reports of the developmentally-regulated expression of some of these genes in vertebrates suggests that they may have a role in normal cellular development. This report describes studies of the expression of the putative c-src proto-oncogene in the developing sea urchin embryo model system. Cellular lysates of whole sea urchin embryos at various stages were examined by immunological and enzymatic assay for the protein product encoded by a src-homologous gene. Tumor bearing rabbit (TBR) sera reactive to the avian sarcoma virus $pp60^{v-src}$ protein was used in immunoprecipitations to identify the putative sea urchin c-src protein by its specific in vitro phosphorylation of the anti-src antibody using α-[^{32}P]-ATP as the phosphate donor.

[^{32}P]-labeled immunoglobulin heavy chain (Ig-H) from the anti-src serum was readily identified on SDS-polyacrylamide gels while control, non-immune serum showed no phosphorylation. High voltage electrophoresis on thin layer cellulose of acid-hydrolyzed, [^{32}P]-labeled Ig-H extracted from gel bands demonstrated that the phosphorylation occurred on a tyrosine residue characteristic of vertebrate c-src kinase activity. Expression of this tyrosine-specific protein kinase activity was developmentally-regulated. It was highest in eggs, decreased approximately 5-fold through blastula stage and then subsequently increased 3-fold to the 56 hour pluteus stage. Immunoprecipitation of a sea urchin protein by anti-src TBR serum was demonstrated directly using [^{35}S]-methionine-labelled cell lysates. A band of apparent molecular weight of 54,000 daltons was specifically precipitated by the immune serum. Since the mobility of this band was not affected by protease inhibitors present in the immunoprecipitation, the putative c-src protein from sea urchin appears to be smaller than the typical 60,000 dalton c-src protein isolated from vertebrates. Finally, immunoprecipitation of [^{32}P]-labelled sea urchin lysates with anti-src serum indicated that the 54,000 dalton protein was phosphorylated similar to vertebrate c-src proteins.

These results add to the short list of cellular proto-oncogenes, their protein products and activities which have been identified in invertebrate tissues. The observation of expression and developmental regulation of a cellular proto-oncogene during ninth annual

Albert Tester Memorial Symposium



presented by the Zoology Department

April 12–13, 1984

University of Hawaii

French Guiana

Brongersma (1968*b*: 441), Pritchard (1969*a*: 22; 1969*b*: 120), Schulz (1971*a*: 402): *Lepidochelys olivacea.*

Surinam

Kappler (1854*a*: 59; 1854*b*: 200): Varana.

Kappler (1881: 135; 1883: 233; 1885: 800; 1887: 122), Diemont (1941: 135): *Chelonia corticata.*

Kappler (1881: 166): *Caouana corticata.*

Brongersma (1961: 27, figs. 7*c*, 8*f*; 1968*a*: 34; 1968*b*: 125), Carr (1963*b*: fig. 2; 1967*c*, 1968: 154), Schulz (1964*a*: 8; 1967*a*: 6, 8; 1968*a*: 7, 9, 3rd plate, lower fig.; 1968*b*, 1969*a*: 3, 14, 64, figs.; 1969*b*: 20; 1971*b*: 26), Pritchard (1966*a*: 123; 1969*b*: 97; 1969*c*: 14), Janssen (1969: 23), Anonymus (1970: 32): *Lepidochelys olivacea.*

Janssen (1970: 23): *Lepidochelys olivacae.*

Schulz (1964*b*: 5, 9, 11, 20, 28, 35, figs.): *Caretta caretta.*

Schulz (1967: 2nd plate, lower fig.): Green Turtle.

References to the occurrence of *Caretta caretta* in Surinam by V[an] L[idth] d[e] J[eude] (1914: 202, *Thalassochelys caretta*), by Schulz (1964*a*: 5), and by Somberg-Honig (1967: ii), at least in part, are based upon Kappler's 'Warana', and hence upon *Lepidochelys olivacea.*

The press (Anonymus 1967*a, b, c*) also paid attention to the nesting on Surinam beaches of *Lepidochelys olivacea.*

Sea off Surinam and off Guyana

Carr (1963*b*: fig. 2), Pritchard (1966*a*: 123), Brongersma (1968*b*: 117), Caldwell, Rathjen & Hsu (1969: 4): *Lepidochelys olivacea.*

Guyana (formerly British Guiana)

Carr (1963*b*: fig. 2), Pritchard (1964: 27; 1966*a*: 123; 1966*b*: 652; 1967: 30; 1969*a*: 22; 1969*b*: 97; 1969*c*: 15; 1969*d*: 17), Anonymus (1966*c*: 59), Brongersma (1968*a*: 34; 1968*b*: 117): *Lepidochelys olivacea.*

Venezuela

Donoso-Barros (1964*a*: 21; 1964*b*: 26), Flores (1966: 11; 1969: 7): *Lepidochelys kempi.*

Brongersma (1968*a*: 34; 1968*b*: 117), Pritchard (1969*a*: 22, 162, fig. 24; 1969*b*: fig. 3; 1969*c*: 15): *Lepidochelys olivacea.*

Trinidad

Carr (1963*b*: fig. 2; 1967*c*, 1968: 152), Pritchard (1966*a*: 123; 1969*a*: 22, 163, fig. 24), Brongersma (1968*a*: 34; 1968*b*: 117), Bacon & Maliphant (1971: 11): *Lepidochelys olivacea.*

A hatchling of *Lepidochelys olivacea,* taken on the beach at Manzanilla Bay, Trinidad, by Mr. P. Morris on August 2nd, 1969, is present in the collections of the British Museum (Natural History); length of carapace 41.3 mm; width of carapace 32.5 mm; seven costals on each side; six vertebrals; four inframarginals on each side; inframarginal pores present.

Puerto Rico

Caldwell & Erdman (1969: 112), Caldwell, Rathjen & Hsu (1969: 4, 23), Pritchard (1969*a*: 22): *Lepidochelys olivacea.*

Cuba

Aguayo (1953: 211): *Lepidochelys olivacea kempii.*

Carr (1957: 46; 1963*b*: fig. 2; 1967*c*, 1968: 151), Pritchard (1966*a*: 123; 1969*a*: 22), Caldwell, Rathjen & Hsu (1969: 4): *Lepidochelys olivacea.*

Jamaica?

Dunn (1918*b*: 75) refers to a skull (condylobasal length 54 mm) of a turtle that in March or April was brought alive to Port Antonio, Jamaica, and he referred it to *Caretta kempi* (i.e., *Lepidochelys kempii*). Lewis (1940: 63-64) and Grant (in: Carr, 1952: 396, 398) are of the opinion that *L. kempii* is not to be found in Jamaica. Caldwell (1961: 277) states that *Lepidochelys* is unknown to the fishermen of Jamaica. Carr (1952: 398) refers to the remarks published by Garman (1888: 9) upon a 'bastard turtle' from Jamaica. One wonders whether the turtle brought to Port Antonio (Dunn, 1918*b*: 75) could not have been a fairly young stray *L. olivacea.* It would be of interest to re-examine the skull to try and identify it with the one or the other *Lepidochelys* species.

Appendix 3

Enemies of turtles

Sometimes one finds turtles in which one of the flippers is wholly or partly missing. Of one Leathery Turtle (De 94) the right hind flipper had been amputated; the wound had healed, leaving a scar. Of five Loggerheads a fore flipper or part of it, had been amputated; in Ca 17, Ca 32, and Ca 44 the right fore flipper is missing, Ca 18 had lost the left fore flipper, and in Ca 33 part of the left fore flipper is missing. Although there are statements in literature that a turtle, of which one or two (or even three) flippers are lost, may learn to set a straight course (Travis, 1959: 168), the loss of a flipper undoubtedly is a handicap. The Loggerhead, Ca 32, the right fore flipper of which is missing, when placed in an aquarium could only swim in circles. The question may be raised how turtles come to lose a flipper.

Moorhouse (1933: 6) remarks that some hatchlings are found to lack a flipper, or to have misformed flippers at birth. The two examples mentioned by him concern a hatchling found dead on the beach, and a hatchling taken from the nest. It is extremely doubtful whether any hatchlings with such a handicap will survive for any length of time, for it is well known that sharks and other predatory fish prey on hatchling turtles when these enter the sea (e.g., Hendrickson, 1958: 521-522; Baldwin & Lofton, in: Caldwell, 1959*a*: 344). Caldwell, Carr & Ogren (1959: 297) mention two juvenile Loggerheads, about twelve or thirteen days old, found in the stomach of a White-tipped Shark (*Carcharinus longimanus* (Poey)), and Baldwin & Lofton (in: Caldwell, 1959*a*: 346) mention a young Loggerhead found in the stomach of a Black Sea Bass (*Centropristes striatus* (L.)).

However, it seems unlikely that the turtles, which have been found in European Atlantic waters and of which a flipper is missing, were born lacking the flipper. It is assumed that the amputation of flippers in young, half-grown, and adult turtles is due to the attacks of sharks or of other predators. The fact that sharks do provide a real danger even to fully grown turtles is a subject that received more attention in ichthyological than in herpetological literature. Therefore, some data taken from the whole range of distribution of turtles (Atlantic, Indian, and Pacific Oceans) may be mentioned here.

Alexander (1837: 298), in dealing with the Green Turtles found on the island of Ascension, writes: "Sharks also contrive to get hold of the old ones. Thus an enormous shark fourteen feet long was caught from the taffrail of the *Thalia* in Clarence Bay, in which was found the head of a large turtle ...," and on p. 299: "One old female, called "Nelson," because one of her flippers had been carried off by a shark, was kept, out of respect, for two or three years in the ponds."

Garman (1884: 297) writes: "In the stomach of a shark, which the kindness of Lieut.-S. M. Ackley, U.S.N., enabled me to examine, a 10-pound Green Turtle was found. The shell was too hard for the shark's teeth, and was scored all over by the efforts of the "man-eater" to divide it. Discouraged in his attempts he had at last swallowed it entire."

Baird (1889: 44) includes turtles in the diet of the Tiger Shark (*Galeocerdo tigrinus* = *G. cuvier*).

Coles (1915: 91; 1919: 37) describes a White Shark (*Carcharodon carcharias* (L.)) attacking a large Loggerhead in the Bight of Cape Lookout, North Carolina. Such as Coles describes the event, the shark was starting an attack on Coles's skiff, when the Loggerhead came to the surface, just in the line of attack. The turtle was seized by the shark, and the two disappeared under water. The next day Coles harpooned a turtle, of which he assumes that it is the same specimen. The edge of the shell and the right hind flipper had been torn away; for a width of nearly thirty inches the carapace showed the marks of the shark's teeth (Coles, 1915: 91). In the second version Coles (1919: 37) mentions hearing the jaws crushing through the shell of the turtle. There are slight differences between the two versions. In the first account Coles places the event in 1905, the shark is stated to have been more than twenty feet long, and it started its attack on the skiff from a distance of several hundred yards. In the second account the event took place in 1903, the shark is said to have been eighteen feet long, and it started the attack from a distance of approximating a hundred yards.

Roosevelt (1917: 290-291) refers to the attacks of sharks on turtles in Florida waters. These remarks are based upon verbal communications by R. J. Coles and by local fishermen, who assured him that nearly half of the Loggerheads captured by them showed signs of having been attacked by sharks. "Usually this meant that one flipper was gone. In one case the turtle had lost two flippers, obviously at different times". On one occasion a very large shark was found with a huge Loggerhead in its mouth, "the turtle frantically waving all four legs while the shark shook its head in the effort to get its teeth through the shell."

Coles (1919: 40) mentions having found a freshly-eaten Loggerhead, approximately 100 lb. in weight, in the stomach of a Tiger Shark (*Galeocerdo tigrinus* = *G. cuvier* (Lesueur)) in North Carolina waters. The turtle had been bitten through both shells in three places; the pieces of shell were much crushed, but all parts of the turtle were present.

Larcher (1916: 251) remarks that sharks are present when the males of *Thalassochelys caretta* (= *Caretta caretta*) fight one another at mating time; the sharks profit from the weakness of the vanquished turtle, and devour it.

J. C. Bell & Nichols (1921: 18-19) also dealt with the food of the Tiger Shark (*Galeocerdo tigrinus* = *G. cuvier*) in Carolina waters. In the stomach of seven of these sharks remains of turtles were found: (1) parts of a sea turtle; (2) some pieces of turtle; (3) pieces of sea turtle; (4) a large amount of turtle shell and two jaws of a Loggerhead (p. 18); (5) partly digested turtle meat, and part of the shell of a sea turtle; (6) a Loggerhead intact; (7) parts of a Loggerhead (p. 19). These authors (1921: 19) also state that several Loggerheads, some badly mutilated, were caught in the same net as the sharks.

A freshly eaten Loggerhead of approximately 100 lb (appr. 50 kg) was found in the stomach of a Tiger Shark (Nichols, 1921: 274). The same author (p. 274) adds that thirty Tiger Sharks were examined by a Mr. Bell, who found that the prey consisted for 76 per cent of large creatures, i.a. of turtles; several Tiger Sharks had pieces of big turtles in their "innards" and one large female contained a Loggerhead intact. "Ordinarily loggerhead turtles and valuable food fish are probably consumed in quantity."

Hardenberg (1929: 145) when dealing with sharks from the Indo-Australian area states that fairly regularly remains of turtles were found in the stomach contents.

Deraniyagala (1930: 65), when dealing with the turtles of Ceylon, remarks that sharks not infrequently amputate a limb.

Moorhouse (1933: 6), in his report on the Green Turtle of Heron Island (Great Barrier Reef), writes: "Sharks appear to cause much damage, and animals have been seen with a large piece bitten out of the carapace and with flippers missing; probably the result of shark attacks. One female in particular had her flippers so badly mutilated that she could not clamber up the beach."

Banks (1937: 525) refers to "the loss of a flipper to a shark" as one of the marks by which certain female turtles can be recognized when they come ashore to lay various times.

Norman & Fraser (1937, 1948: 15; 1963: 35/36) quote the 1915 version of Coles's story of a Man-eater attacking a Loggerhead. These authors (1937, 1948: 42; 1963: 57) mention turtles among the items of the Tiger Shark's diet.

Beebe & Tee-Van (1941: 113) found a complete Green Turtle (*Chelone mydas* = *Chelonia mydas*), 760 mm long and full of eggs, in the stomach of a Tiger Shark (*Galeocerdo arcticus* = *G. cuvier*) from the eastern Pacific. The fact that the turtle was full of eggs, and hence fully adult, makes it likely that the length given is that of the carapace.

Sarangdhar (1943: 103-104) also mentions "a turtle (*Chelone mydas*), wholly intact" found in the stomach of a Tiger Shark (*Galeocerdo tigrinus* = *G. cuvier*) caught in Bombay waters.

Budker (1947: 96) mentions turtles as forming part of the diet of sharks; on p. 98 this author mentions large pieces of a turtle having been found in the stomach of a Tiger Shark (*Galeocerdo arcticus* = *G. cuvier*), and also that large pieces of a Loggerhead (*Thalassochelys caretta* = *Caretta caretta*) have been found in a Tiger Shark. No information is given as to the source from which Budker obtained these data.

Gudger (1948*a*: 230-231) does not add any new data. Gudger (1948*b*: 282) adds one new record: Max Nicholls (1947: 36) found a turtle in the stomach of a Tiger Shark (*Galeocerdo cuvier*) caught near Lord Howe Island.

Bigelow & Schroeder (1948: 68) state that turtles are a regular item in the diet of some sharks. With regard to the White Shark (*Carcharodon carcharias* (L.)) they state (p. 139): "Sea turtles are also described as a regular item in its diet in southern waters", and with regard to the Tiger Shark (*Galeocerdo cuvier*, p. 270): "a Tiger Shark has no difficulty in cutting through the shell of a sea turtle."

Gudger (1949) deals with the food of Tiger Sharks (*Galeocerdo tigrinus* = *G. cuvier*) at Key West, Florida. Turtle remains were found in the stomach of five turtles: (1) fragments of Green Turtle shell (p. 40); (2) some turtle scutes; (3) some plates of the shell of a Green Turtle; the upper and lower horny jaws of a turtle (p. 41); (4) several Green Turtle scutes; (5) Loggerhead and Green Turtle scutes, 13 turtle egg shells (p. 42).

Ingle & Smith (1949: 22) in dealing with the Green Turtle, write: "Reports from various sources indicate that sharks may mutilate adult turtles and even dispose of entire animals up to 50 lbs. .... Upon entering the water various fish, including sharks, feed upon the young turtles .....", and about the Hawksbill (p. 23): "Enemies are the predators which attack the young of Green Turtles."

Bigelow & Schroeder (1953: 38) remark that *Galeocerdo cuvier* preys upon the large sea turtles.

Sumarto (1955: 61, 62), in dealing with the stomach contents of *Galeocerdo rayneri* (= *G. cuvier*) in Indonesian waters, states that remains of turtles (*Chelonia* sp.) have been found.

Cadenat (1957*a*: 276) remarks that turtles (*Chelonia*, *Caretta*, and *Eretmochelys*), either entire or in pieces, are frequently found in the stomach of Tiger Sharks (*Galeocerdo arcticus* = *G. cuvier*) in West African waters.

Hendrickson (1958: 521-523, pls. 8*c*, 9*a*, *b*) dealt more extensively with the danger that sharks provide to turtles. Small sharks (40-60 cm in length) at night lie in wait for hatchlings in shallow water (15 cm deep). It is estimated that four per cent of the adult females examined on nesting beaches in Malaya and in Sarawak showed signs of assumed shark damage. Some specimens (carapace length of over 90 cm) showed fresh wounds, indicating that the sharks also attack fully adult females. Most damage was done to the hind flippers and to the pygal area. On plate 8*c*, Hendrickson shows a female Green Turtle of which the left hind flipper has been amputated, and of which the pygal area of the carapace is damaged. Two Tiger Sharks (*Galeocerdo* sp.) caught off the Talang Talang Islands, Sarawak, contained turtle remains. In plate 9*a*, *b* the stomach contents of one of these Tiger Sharks are shown, including remains of the Olive Ridley (*Lepidochelys olivacea*, head and jaws) and of the Green Turtle (*Chelonia mydas*, part of the head of one specimen, jaws of another, larger specimen), and also remains of fore and hind flippers of these turtles.

Villiers (1958: 53) states that Cadenat found four heads of *Eretmochelys imbricata* in the stomach of a Tiger Shark.

Caldwell (1959*a*: 344): "Some references indicate that sharks also destroy the adults" of Loggerheads.

Travis (1959: 168-169) comments on the large numbers of turtles he saw at Aldabra that were missing a flipper, usually one of the hind ones. He believes that these almost certainly have been bitten off by sharks, which are said to prefer turtle meat to all other.

Bonham (1960: 257) examined the stomach contents of a Tiger Shark (*Galeocerdo cuvier*) from Rongelap Atoll, Marshall Islands: "The beak, claw, and scute remains of a sea turtle fell from the everted stomach of the shark as it was hoisted by the tail."

Parsons (1962: 50-51) mentions the remarks by Travis (1959; see above); he also refers (1962: 62) to sharks and other fish preying on hatchling turtles in Sarawak. Furthermore, Parsons (1962: 80) refers to remarks made by Colnett (1798: 133), who attributed the absence of turtles at Cocos Island to the great numbers of sharks that infested its waters.

Randall (1963: 346) mentions turtles as forming part of the diet of *Galeocerdo cuvieri* (= *G. cuvier*) in the West Atlantic: "Its serrate teeth are efficiently used to cut pieces from large sea turtles."

Springer (1963: 109) mentions "pieces of large sea turtles" having been found in Tiger Sharks. Dealing with the Ridge-Back Sharks (*Carcharinus*) from the Florida-Caribbean area, Springer (1963: 112) remarks: "But the larger dusky sharks i.e., *Carcharinus obscurus*, weighing more than 400 pounds, frequently were found to have turtle remains ..... in their stomach."

Stead (1963: 59), referring to Australian seas, writes: "In the tropical waters they capture large numbers of even full-grown (edible) turtles, up to 2 feet 6 inches in diameter of shell. The total amount of destruction of these turtles by the Tiger Shark must be very great indeed. In many places where considerable numbers of this shark are taken — as in parts of Oceania and Indonesia — during the breeding season of the turtles almost every large shark contains one or more turtles!"

To these data from literature the following record may be added. From a female Tiger Shark, 316 cm long, caught north of the Maroni River

(Surinam, 3/4.xii.1969, Station 911 of R/V "Calamar" of U. N. Fish. Devel. Project, 8 fathoms, received from Ir. H. Lionarons, through the intermediary of Dr. J. P. Schulz), the skull of an Olive Ridley (*Lepidochelys olivacea* (Eschscholtz)) was taken. The greatest length of this skull (RMNH 16918) is 157.5 mm; the condylobasal length could not be ascertained, as the basioccipital) bone with the condyle was missing.

Besides Sharks, other marine predators may attack turtles. Palm (1947: 25) remarks that the teeth of the Killer Whale, *Orcinus orca* (L.), are so strong that they can crack the shell of the largest turtles. Slijper (1958: 226) also includes turtles in the diet of the Killer Whale, but as he informed me, he did not dispose of definite records. R. Barth (1962: 411-412, pl. figs. 3, 4, 5) describes an adult female of *Chelonia mydas* taken at the island of Trindade in the South Atlantic Ocean (20°30'S, 29°20'W) of which the right hind flipper had been amputated five centimetres below the knee joint, and of which part of the carapace (posterior marginals, part of the fifth vertebral and part of the left fourth costal scute) had been bitten off. The damaged posterior of the carapace shows a semicircular indentation and this points to the turtle having been attacked by a large predator with conical teeth. Barth mentions the Sperm Whale (*Physeter macrocephalus* L.) to be abundant in the area; the Killer Whale (*Orcinus orca* (L.)) he observed only once between Rio de Janeiro and the island of Trinidade. To me it seems more likely that a Killer Whale, which has strong teeth in the upper and lower jaws, has caused the damage than that a Sperm Whale with very small upper teeth (often covered by the gums) would be responsible. That indeed Killer Whales do attack turtles was recently shown by Caldwell & Caldwell (1969: 636) who recorded the finding of remains of a *Dermochelys coriacea* in the stomach of three Killer Whales captured off the leeward side of the island of St. Vincent in the Lesser Antilles.

3.3 Juvenile, sub-adult and adult phase

3.31 Longevity

Little is known about the life span of green turtles in nature. The fact that reproductive maturity may be reached after anywhere from four to 13 years; that some females have been recaptured several times, after two to three years'absence, on their nesting beach; together with observations that predation on adults is minimal (except for man), that epizootics are unknown, and that food is plentiful, all together suggest that adult turtles more than 20 years of age may be common (except in places where they are exploited by man).

Pope (1939) reported that a green turtle from the Pacific Ocean lived for 15 years in the New York Aquarium.

3.32 Hardiness: (see sections 3.13, 3.16, 3.4)

3.33 Competitors

The only known vertebrate competitors of any importance are dugongs, manatees and some herbivorous fish (see section 3.42).

3.34 Predators

Sharks prey upon large green turtles (Moorhouse, 1933; Tinker, 1941; Travis, 1959, 1967; Hendrickson, 1969; Hirth and Carr, 1970). About 4% of adult females observed on Malaysian nesting beaches showed evidences of "assumed" shark damage (Hendrickson, 1958). Groupers are capable of taking individuals up to 4.5 kg (Tinker, 1941). A 22.7 kg green turtle was found inside the stomach of a tiger shark caught near Clarion Island (Beebe, 1937).

Large terrestrial mammals such as feral dogs, tigers and jaguars may take a few adult females as they deposit their eggs on beaches, but such predation is probably minimal.

3.35 Parasites, diseases, injuries and abnormalities

Ingle and Smith (1949) provide a list of references pertaining to the parasites of marine turtles. Their list includes: Distomum constrictum, Ozobranchus branchiatus, Stomatolepas transversa, Rhytidodoides intestinalis, R. similis and Platylepas hexastylos. More recently, other investigators have reported on parasites. Carl (1955) recorded barnacles (Balanus crenatus) on the carapace of a sub-adult green turtle found on the coast of British Columbia. Hendrickson (1958) records barnacles (Chelonibia testudinaria, Stephanolepas muricata) and leeches (Ozobranchus branchiatus) on turtles in the South China Sea. He also observed mosquitoes biting the soft skin of the turtle's upper eyelid. Hundreds of barnacles (Platylepas hexastylos) encrusted the dorsum and plastron of a sub-adult female taken in Chincoteague Bay, Maryland (Schwartz, 1960). Gupta (1961) took five trematodes from the intestine of a green turtle from Trinidad (Cricocephalus albus, Pleurogonius mehrai, Neoctangium travassosi, Deuterobaris chelonei and Schizamphistomoides chelonei). Caballero y Caballero (1962) found the trematode, Orchidasma amphiorchis, in the intestine of a turtle and Simha and Chattopadhyaya (1969) record a new blood fluke from the heart of a green turtle.

Smith and Coates (1938) describe fibro-epithelial growths in the skin of mydas and they discuss the microscopic structure. The growths in wild turtles occur on the neck, eyelids, axillae and groin.

Nothing is known of epizootics among green turtles if, indeed, there are any.

Some individuals may get hopelessly wedged between rocks in their approach to nesting beaches and thereby perish (Carr and Hirth, 1962).

3.4 Nutrition and growth

3.41 Feeding and behaviour on the feeding pastures

Most adults, and to some extent sub-adults, feed chiefly on their grazing pastures (see section 3.42), although in some regions of the world turtles may feed en route between breeding and feeding sites. As far as is known, no feeding, or very little, takes place off the nesting grounds.

The feeding habits of juveniles are not well-known, although it is commonly believed that they are carnivorous for their first few months of life.

It is assumed that some time after the turtle passes one year of age or when it weighs between 1 and 4 kg, it becomes mainly herbivorous (see section 3.42). Whether this dietary shift is gradual or seasonal is unknown. This change in food preference is not uncommon, since it has been reported in other reptiles, especially fresh-water turtles and lizards.

Sizes of grazing males and females on the feeding pastures in the Gulf of Aden are given in Table IX. As is to be expected, the female feeding population includes smaller individuals than the nesting population.

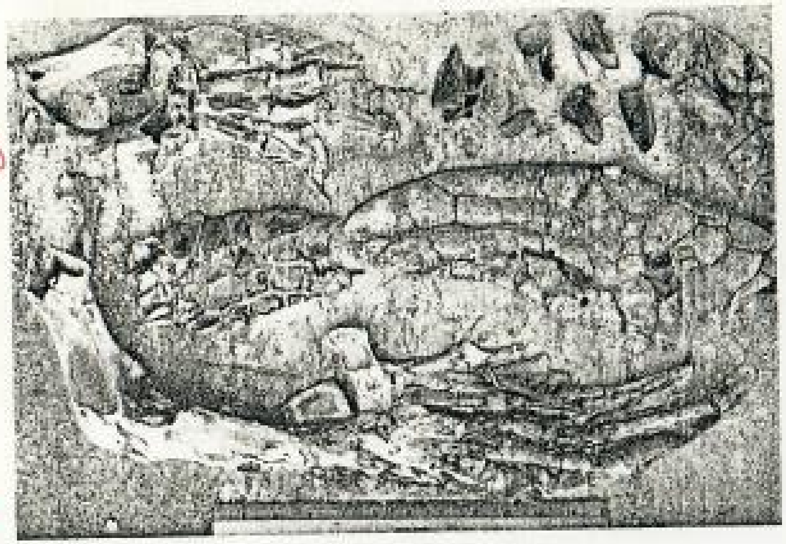
Carr and Carr (1970a) suggest that conditions on the feeding ground may affect the interval between reproductive cycles (see section 3.16).

Norman, J.R. & Fraser, F.C. 1948
Giant Fishes, whales and
dolphins. London: Putnam

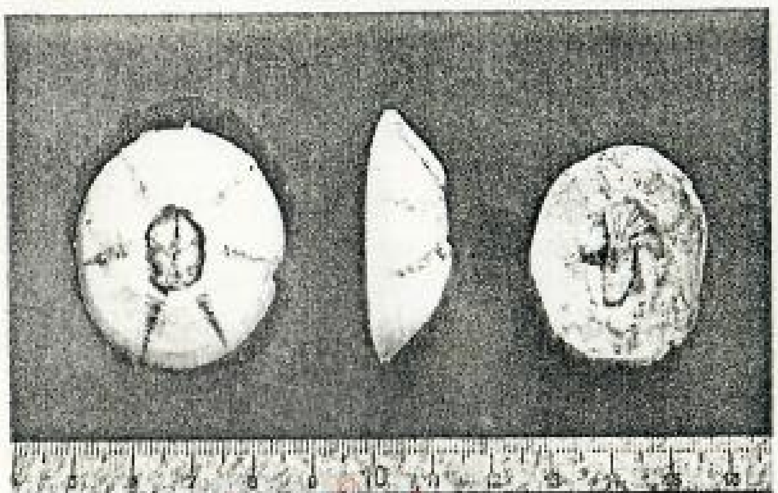
attack by
Carcharodon

a & b - photos of the stomach contents of a large tiger shark (Galeocerdo) caught off Talang Talang Besar Island, Sarawak. Plate a shows remnants of fore and hind flippers; Plate b shows fragments of heads of sea turtles as well as other food items.

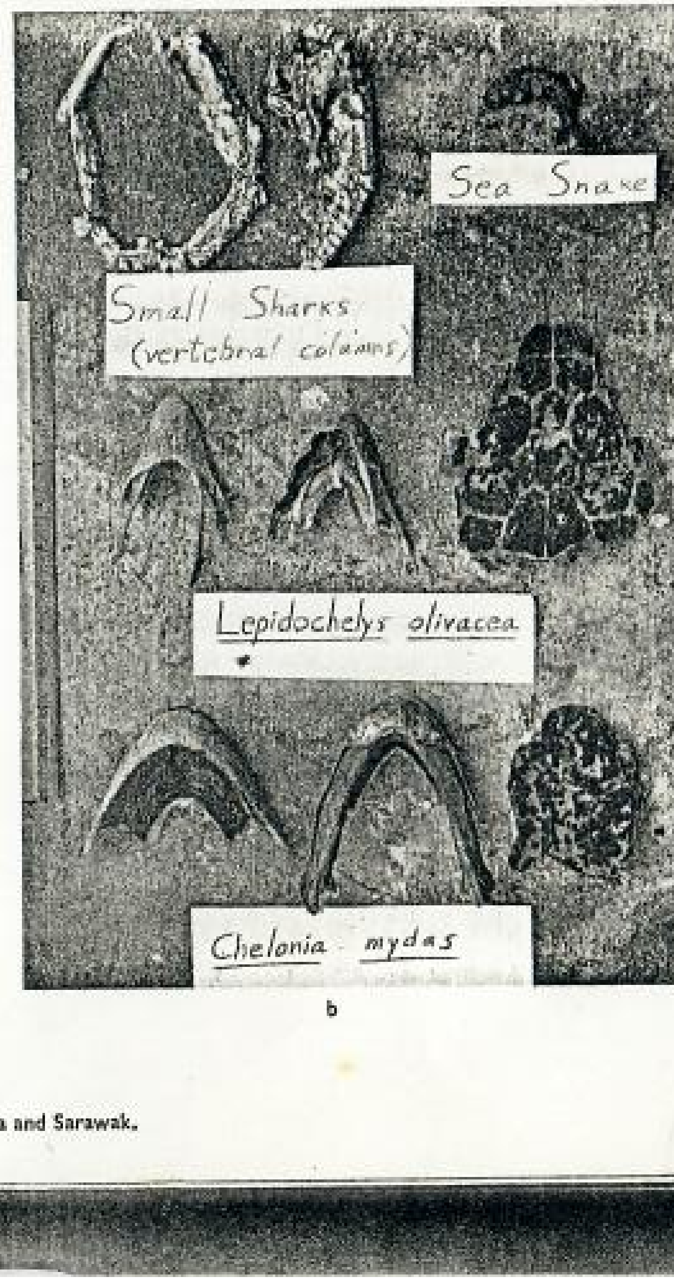
from - The Green Sea Turtle *Chelonia mydas* in Malaya and Sarawak by J.R. Hendrickson



a



from head
Chelonibia testudinaria



b

The Green Sea Turtle in Malaya and Sarawak.

nylon lines attached to fish hooks which were tied onto their plastra, frequent "bites" were felt and, occasionally, sharks were hooked and landed.

On Talang Talang Besar Island, when large numbers of baby turtles were released at the water's edge after dark, heavy splashing some yards out from shore indicated unusually concentrated feeding activity by large fish near the edge of the coral reef which fringed most of the beach. During the routine daytime release of large numbers of young turtles from a boat rowed well out past the reef edge, it was common to see attacks by fish on the concentrated group of baby turtles.

It seems reasonable to assume that predation pressure on *Chelonia mydas* is most extreme during the first few weeks of life in the water. After this original period has passed the young turtles have not only grown somewhat and become more vigorous and better coordinated swimmers, but they have lost the disadvantageous buoyancy which had originally prevented any effective diving, thereby severely limiting their escape activities.

With increased size and swimming power, the growing turtles find progressively increasing immunity from most of their smaller predators, but they never achieve immunity from the larger sharks. Moorhouse (1933) states that sharks appeared to have done considerable damage to some of the turtles he studied on the Barrier Reef in Australia. Norman and Fraser (1948) give an account of an attack by what was presumed to be a *Carcharodon* on a large Loggerhead Turtle. In the course of the study in Malaya and Sarawak, an estimated 4 per cent of the adult females examined on various beaches showed signs of assumed shark damage. In many cases, such damage was severe, involving amputation of limbs and loss of sizeable portions of the pygal area, including large pieces of shell. Plate 8 c is a photograph of a turned female which has suffered high amputation of a rear limb and some carapace damage. It seemed remarkable that some of the more extreme cases had survived such severe damage. Any preconceived notions the writer and his assistants may have had as to the ability of the shell of *Chelonia mydas* to resist the shearing action of the bite of a large shark were soon revised upon seeing the mutilated female turtles which came up on the beach to lay eggs. Most of the wounds were old and well healed, and it was impossible to be certain that the damage had not been suffered when the turtle was much smaller. However, some fresh and recently healed cases were also observed and there was no doubt that these wounds had been suffered by fully grown animals with carapace lengths in excess of 90 cm. Damage to the rear flippers and the pygal region was much more commonly observed than was damage to the fore flippers. This might conceivably have been due to the greater vulnerability of the posterior portions of the body to shark attacks. It was thought, however, that severe damage to the fore flippers would so hamper escape and later survival that the smaller number of anteriorly-mangled females on the beach was really an index to the greater mortality following attacks on that part of the body. Most of the animals sustaining complete or nearly-complete amputation of a limb experienced considerable difficulty in digging normal nests. Some of these turtles returned repeatedly to the beach but, so far as known, did not nest successfully.

On three occasions during 1952 and 1953 shark fishing rigs were set up in the waters near the Talang Talang Islands, Sarawak. Sharks caught were measured for length, weighed, and examined for stomach contents. Of the seven sharks caught, one was a Nurse Shark (*Ginglymostoma* sp.) measuring 2·6 metres and weighing 130 kilos and six were Tiger Sharks (*Galeocerdo* sp.) varying in length from 3 metres to 4·4 metres (193 kilos to more than 484 kilos). One of the six *Galeocerdo* had its entire abdomen ripped out by other sharks. Of the remaining five specimens, two had completely empty stomachs. One contained portions of another shark, including the complete head, about 30 cm. in breadth. Two contained identifiable turtle remains. Plate 9 a and b are photographs of the stomach contents of one of the turtle-eating Tiger Sharks.

The writer believes that *Galeocerdo* is the dominant large shark in the vicinity of the turtle islands. In the shallow seas of the Sunda Shelf, this fish is a common, fast-swimming predator of voracious habits. On several occasions when the observer attempted to swim far out from the reef edge at Talang Talang Besar Island to approach copulating turtles, fast-swimming sharks tentatively identified as *Galeocerdo* made repeated inspections of him. These inspections were sufficiently pointed that further attempts to observe turtles at sea by approaching them in the water were given up as unsafe.

Some of the islanders held the opinion that sharks are attracted to the vicinity of the islands by the concentrated "turtle smell" in the adjacent water. During the heavy nesting season up to 100 females lay each night and return to the water with mucus still exuding from their cloacae. Whatever the actual causes, the writer is inclined to agree that sharks do apparently congregate in large numbers around the turtle islands during the peak breeding season.

Large sharks appear to be the only important predators on adult turtles in the water. An early Indonesian reference (see Journal Straits Branch Royal Asiatic Society, 1885) describes extensive slaughter of adults on the breeding beaches by tigers and wild dogs (*Cuon javanicus*). The writer was told of tigers roaming the turtle beaches in Trengganu, Malaya. In one case an egg collector completely covered in a sarong and sleeping on the beach, was reported to have been seized by a shoulder and dragged for some distance by a tiger. It was concluded that the sleeping man was mistaken for a turtle, and that the tiger was almost as surprised as his victim when it discovered the error.

PARASITISM

It has been explained that, during the course of this study, it was not possible to sacrifice adult turtles for any purposes. Only external parasites were therefore recorded, since they could be collected without unduly harming the turtles.

Several times mosquitoes were observed biting nesting turtles on the beaches. Usually those were seen biting on the relatively soft skin of the upper eyelid.

The encrusting barnacle, *Chelonibia testudinaria* (Linnaeus, 1758) (Plate 9 c), occurred commonly on about one-third of the turtles seen during this study,

ECOLOGICAL ASPECTS OF
TIGER SHARK PREDATION ON THE
HAWAIIAN GREEN TURTLE

SOME ASPECTS OF THE PREDATOR PREY RELATIONSHIP OF TIGER SHARKS AND HAWAIIAN GREEN TURTLES

PREDATION BY TIGER SHARKS
ON THE HAWAIIAN GREEN TURTLE

Some ASPECTS OF TIGER SHARK PREDATION
ON THE HAWAIIAN GREEN TURTLE

PREDATOR-PREY RELATIONSHIPS OF
TIGER SHARKS AND HAWAIIAN
GREEN TURTLES

I. Introduction – Summarizing literature on sharks eating turtles. (should be nearly all Tigers, but possibly others, ie oceanic white tip Hughes); Documents the presence, but provides little if any info on numbers and size or other relevant ecological data.

Sharks and Survival edited by P.W. Gilbert
(Springer, 19 __) Large Sharks of the Florida-Caribbean Region in
(Randall, 19 __) Dangerous sharks of the Western Atlantic in

Hughes - like others - makes lots of notes on injuries on adults (by sharks?)

Hughes *Carcharhinus longimanus* (oceanic white tip)
107 km - 251.7 cm green

Hughes - Main Predators of sea turtles from juvenile through adulthood (2 species in study region found portions of larger sea turtles in their stomachs - 1) tigers 2) *Carcharhinus leucas* (Bass, 1972, Table 37) unpub thesis - "Sharks of east coast of Southern Africa"

PLAN

World overview —
TO
HAWAII situation ~~knowledge~~

Hawaii

[ACCESS TO STOMACH contents]

[Cory juv. turtle in shark]

1) Billy Weaver —
2) DLNR — FG
3) TESTER
4) old expeditions to Leeward Islands (turtles found in Tigers?) [MUNRO, BROOKS ?]
5) TIGERS I examined at FFS - datasheet
6) TIGER TAKEN BY USCG — whole turtle - size - [photos]
7) TAYLOR-NAFTEL (MMC Report; Oceans Article)
8) Grouper (as per Hirth) - TINKER; Per. comm. from kahuku (see newspaper article)
9) Photo to go w/ paper → WHITTOW's very important photo of decapitated turtle (WRITEUP)
10) I saw sharks by copulating turtles —

PARTITION via SITE AND TIME

G. Allen

LARGE SAFE FROM SHARKS - NO

Predation low ON BIG TURTLES!

Heading starting concepts short to hook.

other Areas - Turtles in sharks

1) Check Hirth, 1971; other Hughes Papers; Carr-Fisher MS; handbook
2.) Plate - in Perry's Sharks and Survival
3.) Hughes → 26 cm in Oceanic white-tip; other mention in Blue volumes?
4.) Hendrickson 1958
5.) Bustard (?) book!
6.) Grudges (photo of turtle head on hook?)
7.) Ellis
8.) Sarangdar - India
9.) others in shark file
10.) Brongersma
11. Travis - "shark chasing turtle"
12. Guam recent tigers - from Wayne
13. Carr's grad. student thesis
14. Go through books

OTHER POSTHATCHLING PREDATORS IN THE SEA → Killer whales (ORCA); Crocodiles; Groupers;

For J. Herp
or
Copeia

Needed →

→ Taylor - Not Rep Report, Oceans article;

→ Examine shark file, list appropriate references

→ check Hirth - List of predators

→ check Hughes, oceanic whitetip Bragersma - 1958 Hendrickson

→ Data working — turtles in tigers on length, turtles sizes, etc

→ Ann Meyerhof

→ Reexamination of Tester (Data Abstract)

→ Description of each part found - (Gray book)

— Stomachs examined, number

— stomach with turtle parts, number —

Hirth, H.F. 1971. Synopsis of biological data on the green turtle, Chelonia mydas (Linnaeus) 1758. FAO Fisheries Synopsis, No. 85, 1:1-8:19.

Key References for turtle parts taken from sharks -

Two Sources of references

Sea Turtle Biology —

Shark sampling —

After biting turtle once, why not return to ~~[illegible]~~ finish the job? (note my photo of male basking ashore with flipper freshly bitten off)

Need - ① Beebe and Tee-Van (1941)
② Whittney, 1940

Sarangdhar (1943) - "turtle intact in tigers"

Gudger (1949) "horny beak, scutes", found "event - regurgitation question discussed. "insoluble in HCL"

Ikehara (1961) ~15% of diet - turtles in tigers

Goodby (1959) How do sharks get rid of indigestible material?

Gudger (1948) Summarizes Beebe and Tee Van (1941) 28" turtle full of eggs (E. Pacific) and Whittney (1940) - vomited after one week (in captivity.
Also → photo of turtle head used for bait. Turtle scutes found in the majority of tigers

Bonham (1960) "beak, claw and scute remains from a 2,68 cm tiger shark - Rongelap.

Bell and Nichols (1921) Carolina shark - parts of sea turtle, whole loggerhead - vomit on deck mentioned

Anonymous (195) - Division of FG 3 of of 26 w/ turtles

Fujimoto (1971)

Tester (1969) -

Bass, D'Aubrey and Kistnasamy (1975) S. African Tigers

IN Hirth (1971)

Hirth and Carr (1970) vicinity of Aden - "Shark fishermen find fragments of turtles (only in Tigers)

Moorhouse (1933) ....

Tinker (1941) ....

Travis (1959, 1967) ....

Hendrickson (1969) ....

Beebe (1937) (look at) 22.7 kg green in Tiger by Clarion

Hughes (1976) - "Mortality rate much higher than previously thought - during NON-NESTING - 40-50% of loggerheads nest only once.

Brongersma (   )

Sharks of the East Coast of southern Africa
I. The Genus Carcharhinus (Carcharhinidae)

by A.J. Bass, J.D. D'Aubrey and N. Kistnasamy, Durban, SA
Aug 1973
South African Association for Marine Biological Research – Oceanographic Research Institute – Investigational Report No. 33

e bulk of them less than
mant females may make
iles caught in the estuary
they had been born not
restricted to immatures
cm in length. No adults
o 110cm is present.
he St. Lucia system. The
... significant that the only
119 and 127cm in length.
off central and southern
mpling has been sparse in

as are born in the estuary
sharks tend to move into
ment between the sea and
f 90 to 120cm seem to be
cm may be at least partly
redominantly longer than
month of the year. There
from July to November,
g in the St. Lucia system
the seasonal distribution
ore abundant during sum-
rks but data on these are

er and its tributaries may
Lake Nicaragua where
has recently proved that
ulation is not landlocked,
St. Lucia. Thorson (*pers.*
he Rio San Juan (which
out 50 to 80cm in length.
e common again.
the *C.leucas* population.
ws at St. Lucia there is a
ver 100cm) sharks caught
The association between
dom, P<0.01). The lake
females among the large
can be said about sexual
in the lake 67 males and
m an equal sex ratio but
<0.05) between sex and
ser to the sea. Nothing is
. Further south, the sex
males to 48 females) but
Size and sex distribution
marised in table 29.
d in Natal. *C.leucas* has
nal specimens range into

Cape waters during summer. It appears that mating and early pregnancy take place to the north rather than the south of Natal. Most of the adult females taken off the southern and central Natal coast are not pregnant although some of them may have dropped young a short time previously. The population off this section of the coast seems to consist mainly of strays from the main population, forming a fringe to the basic range of the species off the east coast of southern Africa.

FEEDING

The shallow habitat and the serrated, broad-cusped teeth in the upper jaw enable *C.leucas* to feed on a variety of prey which may include man at times. D'Aubrey (1971) noted that young specimens from Natal fed mainly on teleost fish with a higher proportion of elasmobranchs in the diet of larger specimens. This reflects not so much a change in food preference as a change in the availability of different types of food, as shown by examination of the stomach contents of sharks taken in the sea, and in rivers and lakes. The present sample of marine *C.leucas* consists mainly of large specimens (see fig. 15) which have a wide variety of prey available including a number of teleost and elasmobranch species of all sizes as well as various cetaceans and marine turtles. *C.leucas* from rivers and lakes in southern Africa are almost all immature sharks. The number of potential prey species is restricted in this environment as compared to the sea. The only elasmobranchs known to penetrate into rivers and lakes in southern Africa are *C.leucas* among the sharks and *Pristis pectinatus* and *Dasyatis uarnak* among the batoids. *Odontaspis taurus* and *Carcharhinus limbatus* may swim short distances up estuaries when seawater pushes in with an incoming tide. *C.limbatus* is supposed to have been recorded from St. Lucia lake but we have been unable to verify these reports. *Rhizoprionodon acutus* has been recorded (during the present study) from Richards Bay where it is apparently a rare visitor. The potential prey of *C.leucas* in the rivers and lake systems of Natal is thus restricted, as far as elasmobranchs are concerned, to a few relatively large species. The proportions of different prey species in *C.leucas* from the sea and from rivers and lakes in Natal are summarised in table 30. Sixty-nine percent (102 out of 148) taken in the sea had food in their stomachs as compared to 62% (99 out of 160) taken from rivers and lakes (mainly from the St. Lucia system). The latter sharks fed mainly on teleost fish while those in the sea ate relatively large amounts of elasmobranch and mammalian prey. The difference in diets becomes clearer when the prey species are considered in detail (table 31). *C.leucas* from St. Lucia fed to a large extent on mullet (Mugilidae) and grunter (*Pomadasys* spp.). These figures may be biased by the fact that many of these sharks were caught in gillnets after eating teleosts caught in the nets. Grunter and mullet were among the most common bony fish to be caught in these nets. Sharks taken in the sea had fed on a wide variety of teleost fish including benthic and pelagic species. In both areas *C.leucas* apparently scavenges to some extent. The high proportion of mammalian remains in sharks taken in the sea is partly due to scavenging rubbish thrown overboard from ships or washed into the sea by flooded rivers, and partly to their attacking whale carcasses brought into Durban by the land-based Union Whaling Company.

The large size, inshore habits and the ability to take relatively large prey make *C.leucas* one of the most dangerous sharks of our region. It has been blamed for a number of attacks, mainly as a result of the freshwater habitat in which several of the incidents took place. In only one case has there been direct evidence of the identity of the attacker. In a fatal attack on a bather at a Natal resort, tooth fragments left in the victim's leg were identified as belonging to *C.leucas* by Davies and D'Aubrey (1961). Re-examination of these tooth fragments in the light of knowledge gained since that date show that they might have come from some other local species, notably *C.amboinensis* and *C.obscurus*, and the identification of *C.leucas* as the perpetrator of this particular attack is no longer considered definite. The freshwater attacks which have been recorded from the Limpopo river, Kosi Bay and Richards Bay are attributable to *C.leucas* which is the only potentially dangerous shark regularly found in rivers and lakes in our area. Elsewhere in the world this shark has been blamed for at least three attacks in the ern fish (Myctophidae).

mens.

mens.

elengerii, Synodus indicus
ch are demersal species,

halaelurus punctatus.

cimens.

Month	Length of mother (cm)	No. of embryos			Length of embryos (cm)		Locality
		Male	Female	Total	Mean	Range	
January	262	12	8	20	61	53–63	Port Elizabeth
February	262	12	2	14	38	31–40	Durban
March	247	9	5	14	35	34–36	Port Elizabeth
April	292	4	12	16	41	40–43	Port Elizabeth
June	280	7	6	13	—	—	Southern Natal
June	288	5	14	19	48	—	Southern Natal

Table 12. *Carcharhinus brachyurus*. Details of six gravid females.

Type of food	No. of stomachs	%	
Teleost	27	82	Including several gurnards (Triglidae), *Solea* sp., *Merluccius capensis*, *Tachysurus feliceps*, a toby (Lagocephalidae), *Pterogymnus laniarius*, *Chrysoblephus cristiceps*, *Trachurus trachurus* (in 3 specimens) and *Mugil* sp. (in 5 specimens). All of these except *Mugil* are commonly taken in trawls in the Algoa Bay area.
Elasmobranch	7	21	Including *Torpedo* sp., *Squalus* sp. and *Pristis pectinatus*.
Mollusc	6	18	Including 1 cuttlefish (*Sepia* sp.), and at least 4 squid.

Table 13. *Carcharhinus brachyurus*. Summary of the stomach contents of 33 sharks.

Lower jaw \ Upper jaw	30	31	32	33	34	35	36
28	–	–	1	–	–	–	–
29	1	–	–	–	–	–	–
30	1	–	5	–	–	1	–
31	–	–	4	–	–	–	–
32	–	–	49	5	10	1	1
33	–	–	5	3	2	2	2
34	–	–	5	4	6	–	1
35	–	–	–	–	1	–	–

Table 14. *Carcharhinus brevipinna*. Variation in numbers of lateral teeth in 110 specimens.

ocality overed	No. of days of freedom
mouth	537
Creek	53
Creek	25
mouth	35
ary	2
Creek	1 575
mouth	7
main lake	190
mouth	4
Creek	23
mouth	3
ar mouth	36
(90km south)	41
mouth	54
mouth	50
outh	1
mouth	324
mouth	108
mouth	357
main lake	366
mouth	51
Creek	60
ary	26
mouth	124

ed in the St. Lucia system.
rk was not recovered.

es

Natal, mainly adolescent

Area	Size and sex distribution
St Lucia — narrows and estuary	Mainly juveniles (predominantly males) with a few adolescents (predominantly females) and, near the estuary mouth, occasional adult females.
St Lucia — main lakes	Mainly adolescents (a slight excess of males) with a few juveniles. No adults.
Natal coast	Mainly adolescents (equal numbers of males and females) with a fair proportion of adults (mainly female) and very few juveniles.

Table 29. *Carcharhinus leucas*. Summary of size and sex distribution in St. Lucia and along the Natal coast.

Type of food	% of stomachs containing each type of food Inland systems (99)	Sea (102)
Teleost	89	58
Elasmobranch	3	22
Mammalian	3	20
Crustacean	6	4
Molluscan	0	5
Reptilian	0	1
Other odd items	9	9

Table 30. *Carcharhinus leucas*. Comparison of the major components of the diet of specimens from inland lakes and rivers in Natal and those taken from the sea off the Natal coast.

Type of food	Number of records: Inland systems	Sea
Teleost		
Unidentified	54	39
Mugilidae	17	1
Pomadasys spp.	8	2
Eels (Apoda)	5	–
Rhabdosargus sarba	2	–
Acanthopagrus berda	2	–
Soles (Soleidae)	2	–
Johnius hololepidotus	2	1
Thrissocles malabaricus	1	1
Lutianus argentimaculatus	1	–
Sardinops ocellata (?bait)	2	1
Scomberomorus sp.	–	3
Chanos chanos	–	1
Platax pinnata	–	1
Rockcod (Serranidae)	–	1
Gonorhynchus gonorhynchus	–	1
Pomatomus saltator	–	1
Platycephalus sp.	–	2
Tylosurus leiurus	–	1
Sparodon durbanensis	–	1
Crustacean		
Penaeus sp.	5	–
Scylla serrata	1	–
Unidentified crabs	–	3
Hermit crab (Pagurid)	–	1
Molluscan		
Squid	–	1
Gastropod	–	1
Unidentified cephalopods	–	3
Elasmobranch		
Dasyatidae	2	4
Raja clavata	–	1
Rhinobatus spp.	–	1
Pteromylaeus bovinus	–	1
Gymnura natalensis	–	1
Aetobatis narinari	–	1
Unidentified shark	–	4
Carcharhinus obscurus	–	1
Sphyrna zygaena	–	1
Sphyrna lewini	–	1
Rhizoprionodon acutus	–	1
Squalus cubensis	–	1
Echinorhinus brucus	–	1
Mammalian		
Cetacean (unidentified)	–	11
Tursiops aduncus	–	1
Dog	–	1
Rat	–	[illegible]
Antelope (*Tragelaphus scriptus*)	1	–
Unidentified	2	[illegible]
Reptilian		
Marine turtle (species uncertain)	–	1
Other food (?) items		
Bird (? domestic fowl)	–	1
Plant material	–	1
Plastic bait packets	2	–
Pieces of shark nets	5	1
Cigarette (brand unidentified)	–	1
Unidentifiable matter	2	1

Table 31. *Carcharhinus leucas*. Comparison of the diet of 99 specimens taken from inland systems and [illegible] specimens taken in the sea.

		Upper jaw 24	25	26
Lower jaw	22	15	–	–
	23	3	–	–
	24	2	1	4
	25	–	–	1

Table 32. *Carcharhinus amboinensis*. Variation in numbers of lateral teeth in 26 specimens.

Month	Length of embryos	Source of data
February	18 to 21cm	Present study
February	20 to 22cm	Present study
August	37 to 39cm	Present study
August	42 to 47cm	Present study
September	Two "almost fully-developed litters"	Fourmanoir, 1961
October	57 to 61cm	Present study

Table 41. *Carcharhinus longimanus.* Litters recorded from the south-west Indian Ocean.

Type of food	No. of stomachs	%	
Molluscan	12	52	Various squid, plus, in one case, the small pelagic snail *Janthina* sp.
Teleost	8	35	Including an oarfish, *Regalecus glesne*, and some scombroid fishes.
Mammalian	2	9	Whale meat and blubber from whales shot off Durban.
Elasmobranch	1	4	A single tooth from a shark, probably a species of *Carcharhinus*.
Other	3	13	A bird feather; pieces of plastic; a young (carapace length 26cm) green turtle (*Chelonia mydas*).

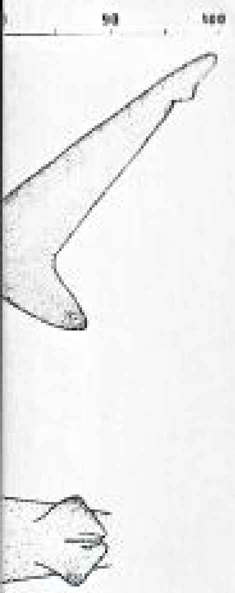
Table 42. *Carcharhinus longimanus.* Summary of the stomach contents of 23 sharks.

		Upper jaw 22	Upper jaw 23	Upper jaw 24
Lower jaw	22	1	1	6
	23	–	–	1
	24	–	–	1

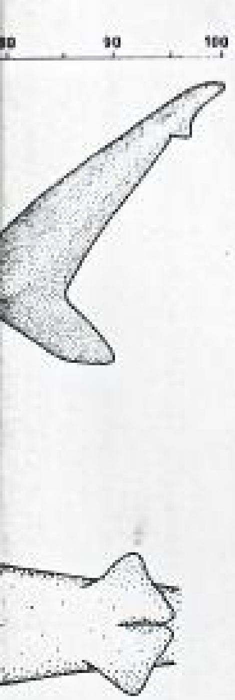
Table 43. *Carcharhinus melanopterus.* Variation in numbers of lateral teeth in 10 specimens.

	Precaudal range	Number	Total range	Number	Source of data
Europa Island	119 to 120	2	203 to 208	2	Present study
St. Brandon	111 to 117	9	197 to 204	7	Present study
Red Sea and Pacific	115 to 122	14	202 to 214	14	V. G. Springer and Garrick, 1964

Table 44. *Carcharhinus melanopterus.* Vertebral counts of specimens from different localities.



nbique.



s Shoal.

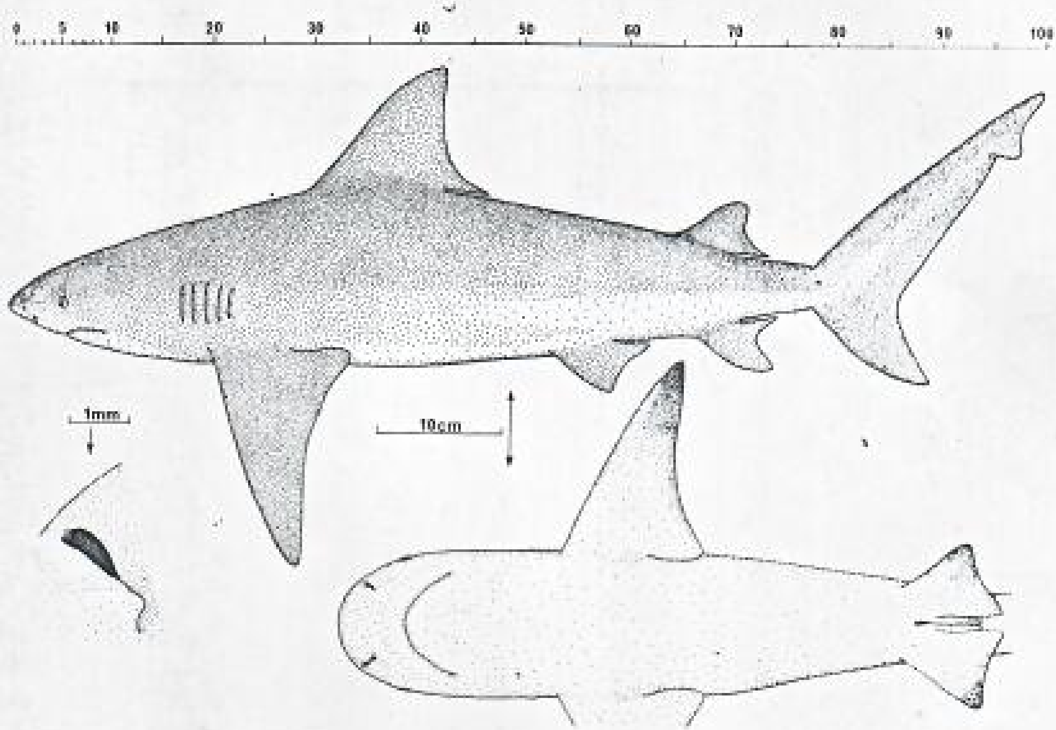


Fig. 13. *Carcharhinus leucas.* A 166cm male from the Natal coast.

— BULL SHARK

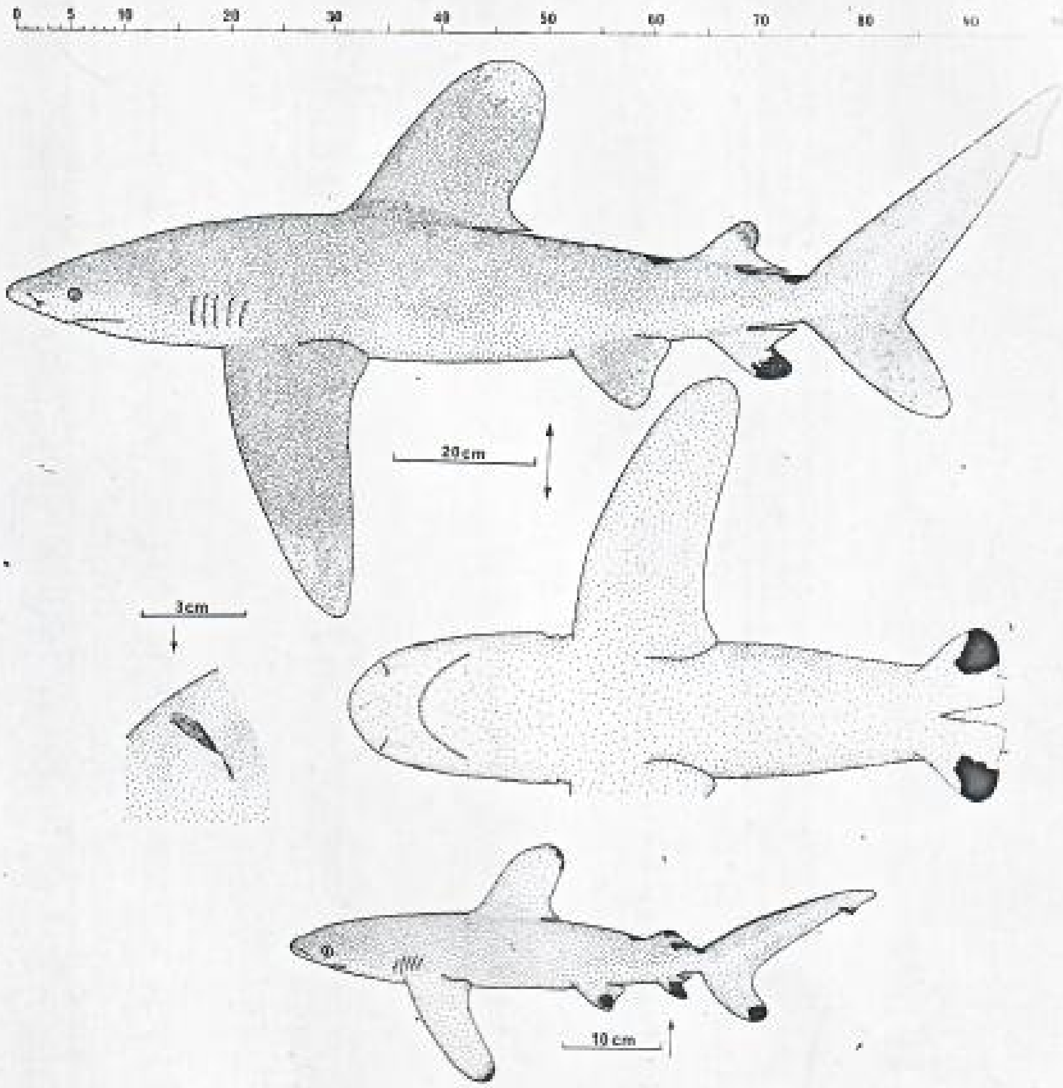


Fig. 19. *Carcharhinus longimanus.* A 150cm female (top and centre) and a 61cm male embryo (bottom, both from the Natal coast.

OCEANIC WHITE-TIP

Plate 8. *Carcharhinus amboinensis.* Teeth of a 223cm female from the Natal coast.

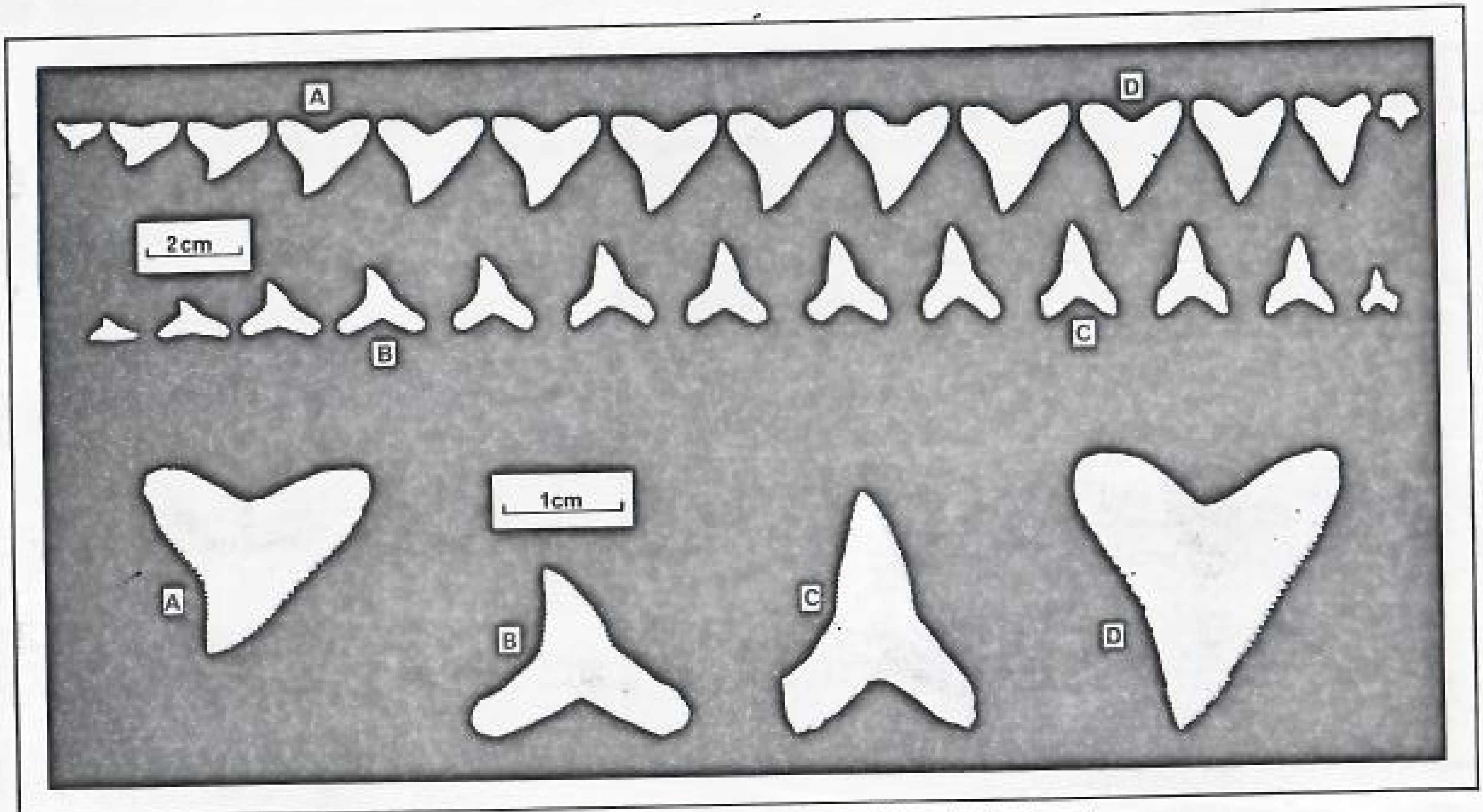


Plate 9. *Carcharhinus leucas.* Teeth of a 271cm male from the Natal coast.

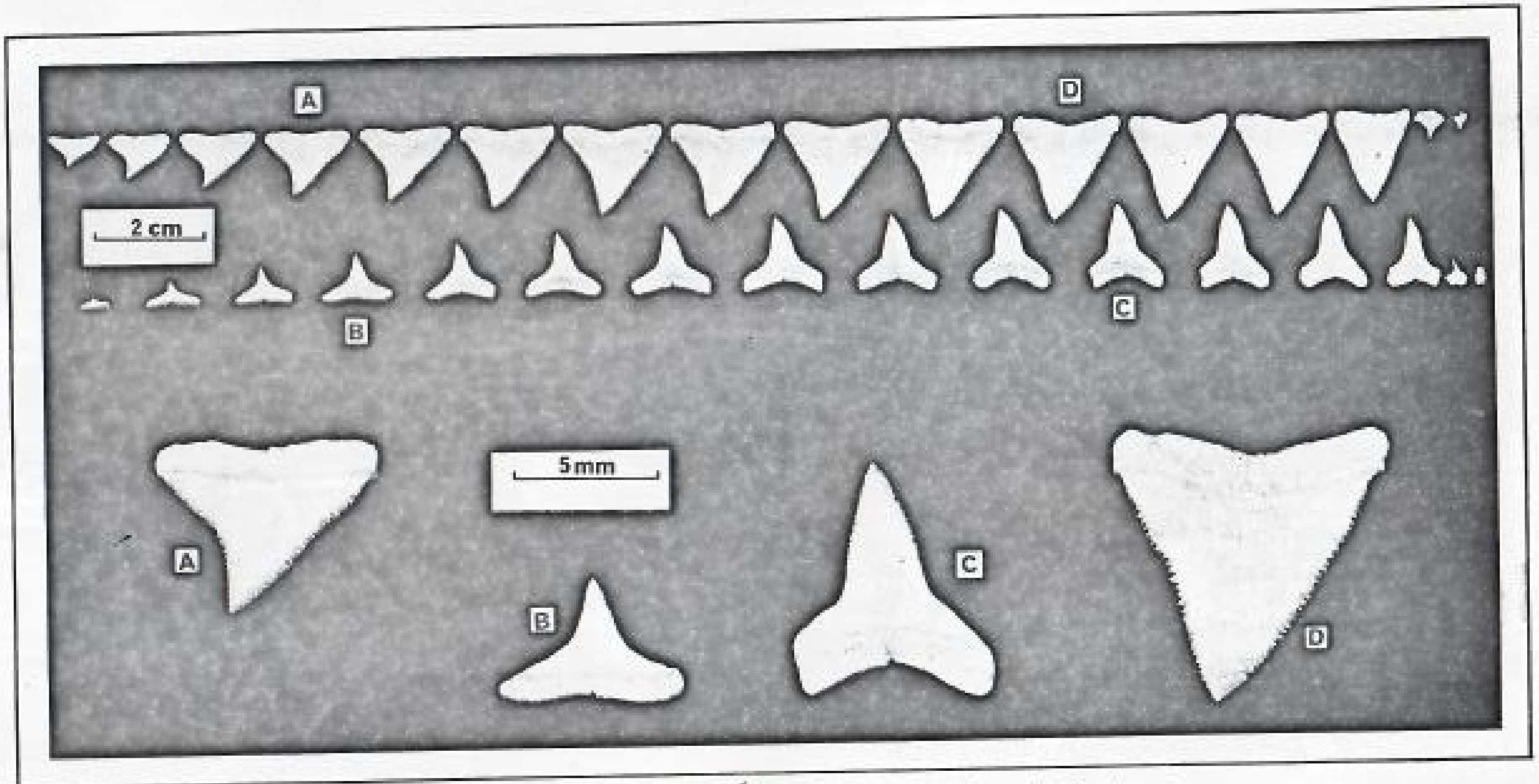


Plate 17. *Carcharhinus longimanus.* Teeth of a 238cm female from the Natal coast.

THE NATURAL HISTORY OF LISIANSKI ISLAND, NORTHWESTERN HAWAIIAN ISLANDS[1]

by Roger B. Clapp[2] and William O. Wirtz, II[3]

INTRODUCTION

Lisianski, a low sandy island in the Northwestern Hawaiian Islands (Figure 1), is located at 26°02' North and 174°00' West (Off. of Geog., 1956: 47), approximately 905 nautical miles northwest of Honolulu (Bryan, 1942: 190). The island is situated at the northern edge of a large reef bank which lies between 25°26' and 25°25' north latitude and between 173°52' and 174°01' west longitude.

Previous knowledge of the history and biota of the island is remarkably scant considering Lisianski's relatively close proximity to Honolulu. Most of what is now known about the island stems from work done by the Tanager Expedition in 1923. Publications resulting from that visit dealt primarily with vascular plants, fish, arthropods, and marine invertebrates. Information on the terrestrial biota gathered by the Tanager Expedition was necessarily slight, however, since the flora, and consequently, fauna, had been greatly reduced due to the destruction of vegetation by rabbits introduced earlier in the 20th Century.

Other primary sources of information on Lisianski prior to recent investigations are Munter's (1915) obscure and little known report of a visit made in March 1915 and Bryan's (1942) account--to date the best descriptive and historical summary of the island.

In 1963 the Smithsonian Institution's Pacific Ocean Biological Survey Program (hereafter POBSP), directed by Dr. Philip S. Humphrey, began a series of extensive surveys of Central Pacific islands. During the study period (1963-1969), Lisianski was visited thirteen times by POBSP personnel. On four of these visits POBSP personnel accompanied

---

[1]Paper Number 77, Pacific Ocean Biological Survey Program, Smithsonian Institution, Washington, D.C.

[2]Present address: Bird and Mammal Laboratories, Bureau of Sport Fisheries and Wildlife, National Museum of Natural History, Washington, D.C. 20560.

[3]Present address: Department of Zoology, Pomona College, Claremont, California 91711.

personnel from the Bureau of Sport Fisheries and Wildlife (hereafter BSFW), who, through 1969, had made eight visits to Lisianski (Table 1). From 1963 through 1969 about 27 days were spent on the island by both agencies. Data obtained on these visits form the primary basis of our recent knowledge of the island.

Also incorporated in this report is a considerable amount of unpublished data from earlier visits to Lisianski, most notably the information gathered on the birdlife in 1923 by Alexander Wetmore.

The purposes of this report are several. On the one hand, we wish to compile from diverse sources as complete and as accurate a summary of available information regarding the island as possible. On the other, we wish to report our recent studies, which have dealt primarily with the birdlife of Lisianski. We hope that this report, one of a series on the Northwestern Hawaiian Islands, will accomplish these aims as well as point out areas where our knowledge of the biota is still inadequate or incomplete.

The final draft was largely completed by late 1970 and few emendations or additions have been made since then. Data reported herein includes only that available through 1969.

DESCRIPTION

Lisianski (Fig. 2) is a low sand and coral island of approximately 450 acres (Freeman, 1951: 331). It is situated at the northern end of a large reef bank (Fig. 3) which is about 65 square miles or 41,322 acres in area. The island, somewhat resembling a parallelogram, is approximately 2,000 yards long, north to south, and 1,100 yards wide, being somewhat wider to the north. Its circumference is about 3.23 statute miles.

The eastern beach is dominated by an exposed ledge of reef rock, with small tidal pools, behind which a narrow, rocky beach rises for about ten feet to the vegetated interior (Fig. 4). South of the rock ledge a low curving beach extends to the southeastern corner (Fig. 5). This beach rises sharply for about three to five feet to the vegetated interior. At the edge of this beach, about 300 yards south of the rock ledge, is the cross-section of a log, probably a redwood, that is much used as a roosting site by Blue-faced Boobies (Fig. 6).

The beach widens (Fig. 7) as one moves toward the southeastern corner where a large unvegetated cut, about 225 feet across at its mouth, extends inland for a somewhat greater distance. Beginning just beyond this cut is a wide triangular sandy beach, the point of which is the southeasternmost part of the island. To the north of the cut the terrain above the beach is fairly level, while to the south the terrain is composed of rolling sand dunes densely covered with *Scaevola*. The large cut and a smaller one (Fig. 8) just to the southwest of the dense stand of *Scaevola* and the southeast and south beaches are the areas in which the densest concentrations of nesting Black-footed Albatrosses are found. There is a seven foot vertical drop from the vegetated interior to the with most turtles). The carapace bears three strong longitudinal keels in the hatchlings, and the plastron four; the inframarginal pores are already evident. The scutes are slightly imbricate at birth, but become juxtaposed with growth. An egg-tooth is present at hatching, and may persist for 40-50 days. Partial albinism (e.g. of the hind flippers and tail) is not unknown in hatchlings, but complete albinism is usually associated with lethal head deformities (especially absent eyes and an asymmetrical, deformed mouth).

Chávez *et al.* (1967) found that hatchlings of *L. kempi* emerge in the early morning hours; 1664 hatchlings observed all emerged between the hours of 5.17 and 7.00 A.M.; however in some cases some hatching had taken place in the night before the nests were inspected.

The mechanism of emergence appears to be similar to that of other sea turtle species. One to three days before a nest erupts, the sand immediately above the egg cavity drops, so as to form a shallow depression in the surface. Emergence is normally 'explosive'—a substantial proportion of the hatchlings within a nest emerging within a few minutes. Individual emergences, however, are also frequently observed.

To date, hatchlings of *L. kempi* have not been raised to maturity under captive conditions. However, this is mainly because hatchlings were unobtainable until recent years, and even now can only be obtained from one beach in the world at one time of the year. Half-grown and adult specimens adapt well to captivity, and have survived in public aquaria for many years.

NATURAL AND HUMAN WASTAGE OF EGGS, HATCHLINGS AND ADULTS

As mentioned previously, coyotes (*Canis latrans*) are major predators on the eggs of Kemp's ridley; single nests are almost always destroyed by coyotes within 24 hours unless they are transfered to a protected hatchery, and a proportion of those nests laid during *arribadas* are also destroyed by this predator. The ghose crab *Ocypode albicans* is a serious predator on both the eggs and emerged hatchlings. Until recent years man was a massive-scale predator on ridley eggs at Rancho Nuevo, but now this activity is illegal and has become sporadic. Hatchling turtles on their way to the sea are molested by black vultures or 'zopilotes' (*Coragyps atratus*); according to Chávez *et al.* these birds are absent from the nesting area until mid-May and June, when the first turtles start to hatch out. Hildebrand (1963) recorded two species of fish (*Caranx hippos* and *Sciaenops ocellata*) as definitely known to eat baby Kemp's ridleys, and Chávez *et al.* (1967) were informed by local villagers that one specimen of *Sciaenops* caught at Boca San Vicente had eleven newly-hatched ridleys in its stomach.

Organized at-sea capture of ridleys is concentrated at two places: Cedar Key, Florida, where the catch is made up almost entirely of immature turtles, and Campeche, Mexico, where adult turtles are taken, along with larger numbers of immature loggerheads (*Caretta caretta*). However, the capture in these two places is probably not as serious a drain on Kemp's ridley populations as accidental capture in trawls and shrimp nets. These nets are usually pulled up at such infrequent intervals that the turtle has drowned by the time it reaches the surface; and if it has not, it is usually dispatched without delay by the crews of the fishing boats, since a sea turtle can do considerable damage to a net. Some turtles are killed when they come ashore to nest in Tamaulipas, but this is no longer legal, and only a few are killed this way each year. Natural predation on adult Kemp's ridleys at sea has not been investigated, but judging by the proportion of mutilated and amputee individuals which come ashore to nest in Tamaulipas, it is probable that many others are killed by the same predators (presumably large sharks).

MIGRATIONS

Two tagging programmes (those of Chávez, 1968, and of Pritchard, hitherto unpublished) have demonstrated essentially the same fact: that ridleys, after nesting at Rancho Nuevo, remain within the Gulf of Mexico, but move in comparable numbers north (mostly to Louisiana) and south (mostly to Campeche). Chávez recorded recoveries of 17 out of the 285 nesting females tagged by him at Rancho Nuevo in 1966. Of these, one was taken at Key West, Florida, 5 were caught off the Louisiana coast, 3 off the Texas coast, one near Alvarado, Veracruz, one near Dos Bocas, Tabasco, and 6 from the coast of Campeche. Eleven of these 17 specimens were caught in shrimp trawls, and four in shark nets. Pritchard found that, of 80 nesting females tagged in May 1970, four were caught off the Louisiana coast, one near the mouth of the Panuco River, Tamaulipas, and one north of Ciudad del Carmen, Campeche. All recoveries were made within a few miles of the shore, and it appears probable that the normal migrations of this species do not involve any open-sea crossing. Chávez calculated that the minimum average speeds of the two turtles which moved the greatest distance in the shortest time were 24.0 and 29.5 km per day.

Mature Kemp's ridleys have only been found within the Gulf of Mexico, but it seems possible that newly-hatched ridleys embark on a several-year-long trip that takes them well outside the limits of the Gulf. On the eastern coast of the Gulf of Mexico, mature ridleys are rarely caught, but moderate (though currently diminishing) numbers of ridleys a few inches short of mature dimensions are found there (Carr and Caldwell 1958). Ridleys are unknown from the Bahamas. The species is known from the Dry Tortugas and Key West (Carr 1942: 10), and on the Atlantic coast of Florida from Fernandina Beach, St. Augustine, Cape Canaveral and Melbourne (Carr, 1955). Records are unaccountably very scarce on the Atlantic coast south of Melbourne, but there is a sight record for Salerno (Carr 1942: 11).

From the coast of Georgia, ridleys have been recorded from Sapelo Island (Martof 1963: 71), from 1½ miles off St. Simon's Island (AMNH 46781), and from 'S.E. Georgia' (De Sola and Abrams 1933: 11). There are no records from South Carolina, but from North Carolina the species is known from Cape Hatteras (Hay 1908: 184) and from Beaufort (Coker 1906: 57). From Virginia there are records from Reedville (USNM 86814); from 3 miles south of Great Wicomico Lighthouse (USNM 137573); and from Gloucester Point (Hardy 1962: 219). From Maryland there are records from Parker's Creek (Hardy 1962: 217, 218); from Camp Bay Breeze, near Lushy, Calvert Co. (Hardy 1962: 218); and from the mouth of Jones Falls, Baltimore Harbour (Hardy 1962: 218). The species is known from Atlantic City, New Jersey (Hay 1908: 184), and from the following localities in New York: New York Harbour (AMNH 28863); Oyster Beach, Nassau County, Long Island (AMNH 44867); Short Beach, Jones Inlet, Jones Beach State Park, Nassau County, Long Island (AMNH 69604); West Meadow Beach of Long Island Sound, near Setauket, Suffolk Co. (AMNH 88344); Long Island Sound (Babcock 1938: 46); Staten Island (AMNH 9723); Lower New York Bay (De Sola 1931: 135).

There is no diminution in records as we proceed further north. Dodge (1944) lists seven records from the coast of Massachusetts, while Carr (1957) men-

PRELIMINARY RESULTS OF TOP CARNIVORE TROPHIC ECOLOGY
NI/R4

prepared by

Mark A. De Crosta (Graduate Assistant)

TABLE 1. NUMBER OF FISH CAUGHT (WITH IDENTIFIABLE GUT CONTENTS) IN NWHI AS OF 11/16/78

	Carangoides ajax	Carcharhinus amblyrhynchos	Carcharhinus galapagensis	Galeocerdo cuvier
Nihoa	0	4 (1)	4 (1)	5 (2)
Necker	0	4 (2)	3 (1)	2 (1)
FFS	5 (3)	3 (1)	3 (1)	26 (17)
Maro Reef	51 (26)	7 (4)	18 (7)	4 (3)
Lisianski	10 (6)	0	0	0
Pearl and Hermes Reef	0	0	0	15 (10)
TOTAL	66 (35)	18 (8)	26 (10)	52 (33)

TABLE 2. PERCENT OCCURRENCE OF FOOD ITEMS IN STOMACHS WITH IDENTIFIABLE CONTENTS (ALL ISLANDS POOLED)

Carangoides ajax

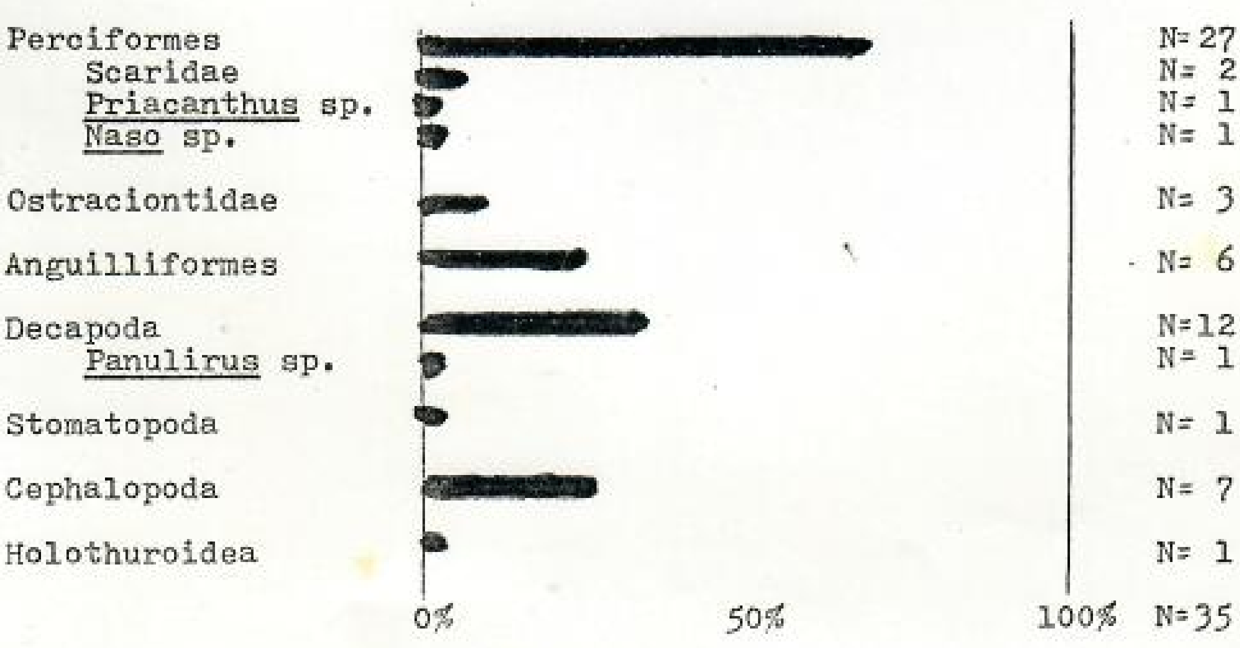
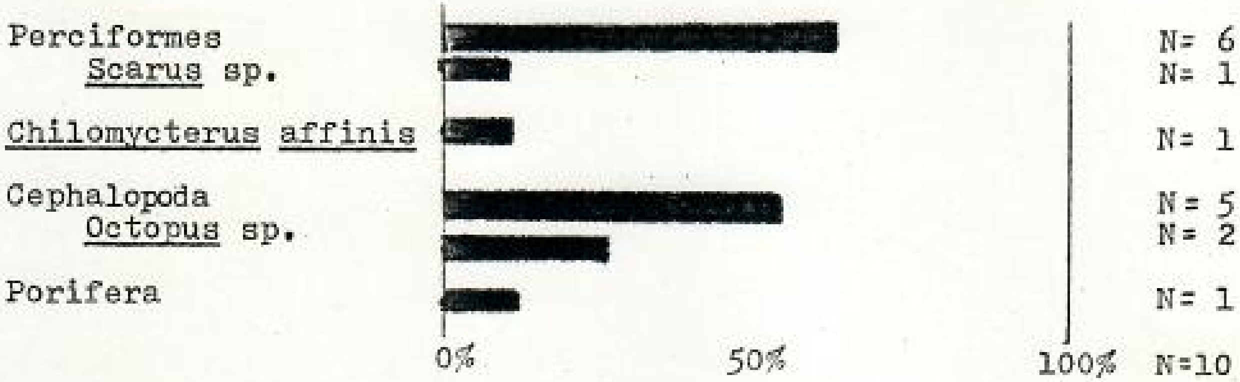
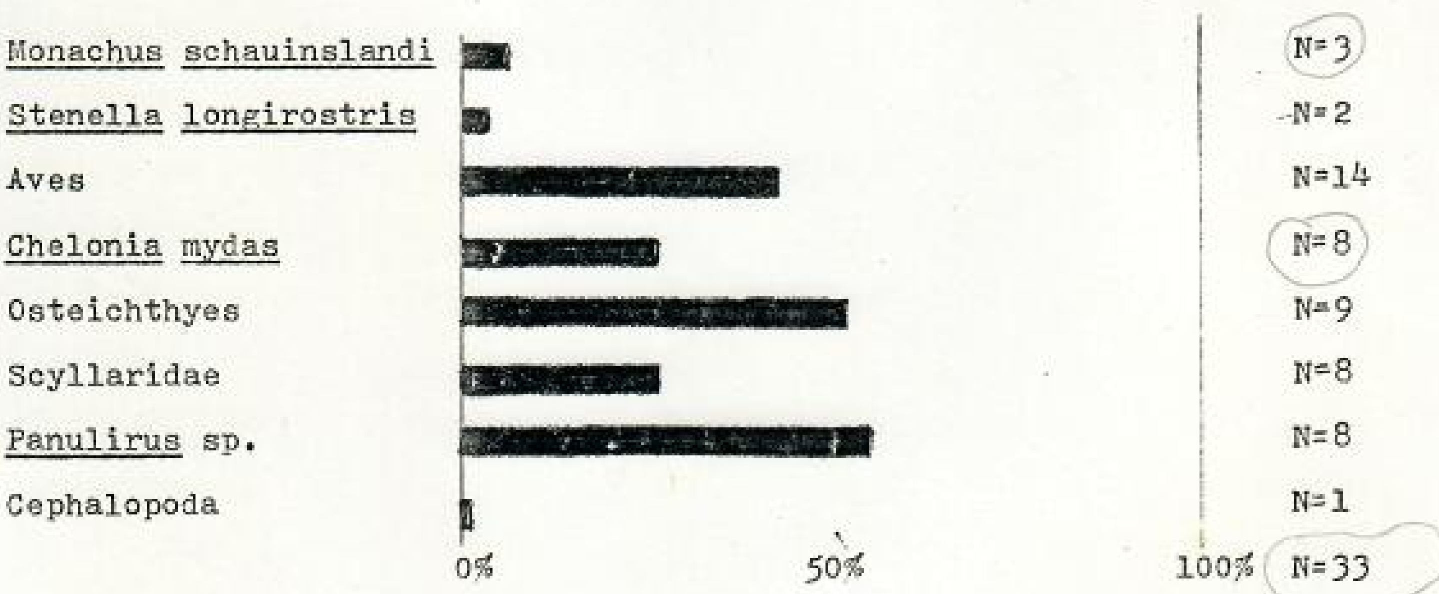


TABLE 2. (CONTINUED)

Carcharhinus galapagensis



Galeocerdo cuvier



CONTROL NO. ____
1-2

NATIONAL MARINE FISHERIES SERVICE
SOUTHWEST FISHERIES CENTER HONOLULU LABORATORY

FISH GUT ANALYSIS LOG

Vessel (3-5) ________ Cruise No. (6-9) ______ Date (10-15) ______ Time (16-19) ______ Oct. (20) ____ Lat. (21-24) ________ Long. (25-28) ________ Sta. No. (29-31) ____

Island/Bank (32-36) ________ Depth (37-39) ______ Substrate (40) ______ Gear Type (41-42) ______ Gear ID. (43-44) ______ Sample No. (45-49) ________

Species (50-59) ________ Lt.(mm) (60-65) ______ Wt.(g) (66-75) ________ Sex (76) ______ Maturity (77) ____ Investigator (78-79) ________

CONTROL NO. (1-4) ____ SAMPLE NO. (3-7) ________

Line No.	Species	No.	Volume (ml)	Weight (g)	Wet/Dry	Length	Body Part	Length	Body Part	Length	Body Part	Loc. in Gut	State of dig.	Age	Ecology of prey
8-11	12-21	22-25	26-31	32-41	42	43-48	49 50	51-56	57 58	59-64	65 66	67	68	69-70	71-76

Fishes from the Tropical Eastern Pacific
Part 2. Sharks.

References: Carcharias longurio, Jordan, D. S., & Gilbert, C. H., *Proc. U. S. Nat. Mus.*, 5, 1882: 106 (original description, color; type locality: Mazatlan, Mexico; types, Nos. 28,306, 28,330, 28,331, 29,451, 29,551, U. S. National Museum).

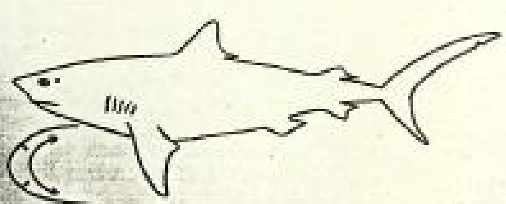
Carcharhinus longurio, Jordan, D. S., *Proc. U. S. Nat. Mus.*, 8, 1885 (1886): 363 (check-list).

Scoliodon longurio, Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish. Comm.*, 2, 1882: 105 (Mazatlan, Mexico). Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 130 (references; Guaymas, Mexico). Jordan, D. S., Fishes of Sinaloa, 1895: 382 (common at Mazatlan). Jordan, D. S., & Evermann, B. W., Fishes North and Middle America, 1, 1896: 42 (description). Jordan, D. S., & Evermann, B. W., Fishes North and Middle America, 3, 1898: 2748 (note on teeth and size of first dorsal). Gilbert, C. H., & Starks, E. C., Fishes of Panama Bay, 1904: 12 (6 specimens from Panama; note on porportions and teeth), 207 (range; Panama and Gulf of California). Garman, S., The Plagiostomia, 1913: 114 (short synonymy, description, color; range). Meek, S. E., & Hildebrand, S. F., Marine Fishes of Panama, 1, 1923: 52, Plate 2, fig. 1 (short synonymy, description, color, figure, comparison with types, claspers; Panama fish market, 525 and 700 mm. males). Breder, C. M., Jr., *Bull. Bingham Oceanogr. Coll.*, 2 (1), 1928: 3 (specimen from unknown locality). Seale, A., *Allan Hancock Pacific Expeditions*, 9 (1), 1940: 1 (490 mm. specimen, Tangola-Tangola, Mexico).

Galeocerdo Müller & Henle, 1838.

Galeocerdo arcticus (Faber).

Tiger Shark.



Text-figure 23.

Range: Tropical and temperate seas, north rarely to 70°. In the eastern coastal Pacific north to San Diego. (Mexico: Gulf of California, Santa Inez Bay, Concepcion Bay, Guaymas, Mazatlan, Tangola-Tangola; Guatemala: San Jose de Guatemala; Costa Rica: Golfito; Panama: Panama Bay and Pearl Islands; Clarion Island; Clipperton Island; Cocos Island; Galápagos Islands: Narborough, Albemarle and Guy Fawkes Island.)

Field Characters: A large, heavy shark with blunt head; caudal fin large with very long upper lobe, and well-developed lateral keels at base; teeth alike in both jaws, semicircular, with a deep notch and coarsely serrated edges, the tips turned obliquely outward. (Illustration after Norman, 1937.)

Color: Dark gray above, white below; numerous black, rectangular spots on body and fins, usually forming vertical bars, becoming rounded on upper caudal lobe. This pattern is lost on older individuals. Iris greenish-brown.

Size: Reaches a length of at least 20 feet (Record of 30 feet unconfirmed).

Weight: A shark of 1,625 mm. (5 feet, 4 inches) weighed 137 pounds; 1, 3,073 mm. (10 feet, 1 inch) 366 pounds (liver 97 lbs. 26% of whole); 1, 3,200 mm. (10 feet, 6 inches) 505 pounds; 1, 3,886 mm. (12 feet, 9 inches) 780 pounds (liver 188 lbs., 24% of whole).

Local Distribution: Well offshore and in bays of only four fathoms depth.

Abundance: Tiger sharks are fairly common throughout the area under consideration.

Food: Almost any invertebrate or vertebrate of sufficient size may find a place in the diet of this shark. Our list is as follows: garbage (3 stomachs), octopus (400 mm.), *Heterodontus quoyi* (375 mm.), sting rays (7 in 3 stomachs, four of them *Urobatis halleri*), *Gymnosarda alletterata* (400 mm.), *Mycteroperca jordani* (600 mm.), *Diodon holacanthus* (200 mm.), *Ogcocephalus* sp. (150 mm.), *Iguana iguana* (1,371 mm.), *Chelone mydas*, full of eggs (760 mm.), feathers (3 stomachs), 2 Clarion shearwaters, *Puffinus auricularis;* and Galápagos sea-lion pup, *Otaria jubata*.

Parasites: Two copepods taken from near the gills, *Pandarus satyra* Dana and *Rocinela aries*.

Study Material: Definite notes were made on 11 tiger sharks, and several other individuals were seen. All were hooked from the deck of vessels. Mexico: Santa Inez Bay, 1 (24,894), 1,625 mm., April 9, 1936; Santa Inez Bay, 1, 1,422 mm., April 9, 1936; Concepcion Bay, 1, 1,625 mm., April 16, 1936; Clarion Island, 1, *ca.* 1,400 mm., May 11, 1936; Clarion Island, 1 (25,655), 3,886 mm., May 13, 1936; Tangola-Tangola Bay, 1 (26,051), 3,073 mm., Dec. 10, 1937; Costa Rica: Golfito, 1 (26,184), 3,200 mm., March 8, 1938; Panama: Pearl Islands, 1, 1,882 mm., June 27, 1933; Galápagos Islands: Tagus Cove, Albermarle Island, 1 (6159), 2,133 mm., June 7, 1925; Guy Fawkes Islands, 1, "18 or 20 feet," March 31, 1923, "seen to kill and devour a sea-lion pup"; Cocos Island: 1, "15 to 18 feet," May 17, 1925.

References: Squalus arcticus, Faber, F., Fische Islands, 1829: 17 (Iceland and neighboring seas).

Galeocerdo tigrinus, Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882 (1883): 112 (San Jose de Guatemala). Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882 (1883): 105 (Mazatlan, Mexico). Pellegrin, J., *Bull. Mus. Hist. Nat., Paris*, 7, 1901: 161, 166 (Gulf of California, danger to man). Snodgrass, R. E., & Heller, E., *Proc. Wash. Acad.*, 6, 1905: 342 (Albemarle and Narborough Islands, Galápagos

Zoologica. Scientific Contributions; N.Y. Zool. Soc. V26 Pt 2 1941

Islands). Fowler, H. W., *Proc. Acad. Nat. Sci. Phila.*, 60, 1908: 61 (jaws from Guaymas, Mexico). Beebe, W., "Galapagos: World's End," New York, 1924: 201, 434 (Guy Fawkes Islands, Galápagos; eating sea-lion pup).

Galeocerdo maculatus, Jordan, D. S., & Bollman, C. H., *Proc. U. S. Nat. Mus.*, 12, 1890: 179 (Panama).

Galeocerdo arcticus, Meek, S. E., & Hildebrand, S. F., Marine Fishes of Panama, 1, 1923: 56 (once taken on the Pacific Coast by the *Albatross*). Beebe, W., "The Arcturus Adventure," New York, 1926: 247, 435 (Cocos Island). Breder, C. M., Jr., *Bull. Bingham Oceano. Coll.*, 2 (1), 1928: 3 (specimen from unknown locality). Schmitt, W. L., Annotated List of Fishes, Presidential Cruise, 1938, privately printed, 1938: v (Weights; Cocos, Clipperton, and Galápagos Islands).

Galeorhinus Blainville, 1816.

We have no material referable to this genus. It is evident from the confused literature that careful study should be made of the relationships of the northern *Galeorhinus zyopterus* and of the specimens reported from Peru and Chile as *zyopterus*,[19] *galeus*,[20] *molinae*,[21] and *chilensis*.[22] Fowler[23] places all of these records under the name *galeus*.

Apparently there are no records of the genus from the tropical eastern Pacific, beyond those from Cedros Island and Peru, the northern and southern boundaries respectively, of our region.

Family Sphyrnidae.

Sphyrna Rafinesque, 1810.

Hammerhead and Shovelhead Sharks.

Key to tropical eastern Pacific species.[24]

1a. Second dorsal fin with a long posterior lobe, which when lifted upward, will reach about twice as high as the fin; anterior margin of the head three-lobed. . . . . *zygaena*

1b. Second dorsal fin with a short posterior lobe, which when lifted upward, will reach about as high as the fin.

2a. Front margin of the head between the nasal apertures lobed, the front margin not forming a continuous curve.

3a. Head hammer-shaped; oculo-narial expanse irregularly quadrangular, almost exactly transverse in old adults; teeth heavy, serrate. . . . . *tudes*

3b. Head not definitely hammer-shaped; oculo-narial space irregularly oval; teeth slender, not serrate. . . . . *corona*

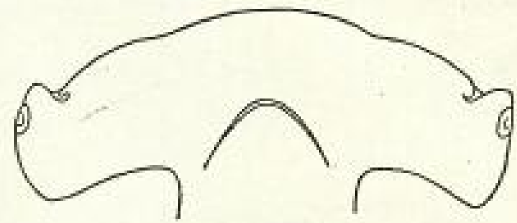
2b. Front margin of the head between the nasal apertures not lobed, the front margin forming a continuous curve.

4a. Teeth with low cusps, the cusps progressively smaller towards the angles of the jaws, entirely absent on one or two rows in the upper jaw and on four or five rows in the lower jaw; head broadly spade-shaped; length of snout to mouth 1.5 to 1.75 in the internasal distance. . . . . *vespertina*

4b. All teeth with cusps; oculo-narial space broadly oval; length of snout to mouth 2.2 in internasal distance. . . . . . . *media*

Sphyrna zygaena (Linnaeus).

Cruz, Pez Martillo.



Text-figure 24.

Range: Tropical and temperate seas; known in the eastern tropical Pacific from southern California, Mexico, Panama, Peru and the Galápagos Islands. (Mexico: San Lucas Bay, Mazatlan, Guaymas; Panama: Panama; Peru: Lobos de Tierra, Callao; Galápagos Islands).

Field Characters: A large shark with head expanded laterally, hammer-shaped; anterior edge of head between nostrils three-lobed; a line connecting the centers of the eyes passes through the mouth; diameter of eye greater than anterior extension of head immediately in front of eye; posterior lobe of second dorsal fin, when lifted upward, reaches twice as high as the fin. (Illustration from specimen 25,549; 1,030 mm.)

Size: Grows to 17 to 20 feet and a weight of 1,500 pounds.

Study Material: 1 specimen. Mexico: San Lucas Bay, Lower California, 1 (25,549), 1,030 mm., May 5, 1936, harpooned.

References: Squalus zygaena, Linnaeus, Syst. Nat., ed. X, 1758: 234 (original description; Europe, America).

Sphyrna zygaena, Jordan, D. S. & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 105 (Mazatlan). Jordan, D. S., & Gilbert, C. H., *Bull. U. S. Fish Comm.*, 2, 1882: 109 (Panama). Evermann, B. W., & Jenkins, O. P., *Proc. U. S. Nat. Mus.*, 14, 1891 (1892): 131 (2½ foot specimen from Guaymas, Mexico). Jordan, D. S., Fishes of

---

[19] Evermann & Radcliffe, *U. S. Nat. Mus., Bull.* 95: 1917: 10.

[20] Fowler, *Proc. 4th Pac. Sci. Congr.* Java 1929, 3, 1930: 490.

[21] Philippi, *Ann. Univers. Chile*, 71, 1887: 543, Plate 4, fig. 2.

[22] Perez, Estudios sobre algunos escualos de la costa de Chile, 1886: 3.

[23] Fowler, l. c., 490.

[24] Adapted with slight modifications from Springer (1940). *Sphyrna peruana* Philippi from Chile and Peru has not been considered here. The amount of material in our collection of *zygaena* and *tudes* is so small that we have made no attempt to determine whether the eastern Pacific species should be considered as local races, as seems to be indicated in many of the littoral tropical eastern Pacific sharks.

(Predator-prey relationships of tiger sharks
and Hawaiian green turtles)

[Ecological aspects of
Tiger shark predation on the Hawaiian green
turtle]

Some aspects of tiger shark predation on the Hawaiian
green turtle

Hirth

→ Predator-prey relationships of tiger sharks
and Hawaiian green turtles

The list of known predators of (other than man)
post-hatchling size turtles in the ocean habitat
sharks, groupers, crocodiles, large bass(?)
killer whales,

see green book

away from inshore of hatching beach

reefs from inshore waters of hatching beach

Predation while terrestrial
vs — while marine

Relatively little information

Predation on sea turtles

Elephant Seals in the
Northwestern Hawaiian Islands

EDITED BY C. BOYD PFEIFFER

Anglers Get Bigger Piece of Action

☐ Sport fishermen stand to win a considerable victory if the latest proposed king mackerel allocations are approved. These recommendations give recreational fishermen 25 million pounds of the proposed 37-million-pound annual king-mackerel catch. According to South Carolina biologist Charles J. Moore, these recommendations would apply to the entire Gulf and south Atlantic area.

"Once that limit is reached, no more kings could be caught for the rest of that season," Moore said.

The recommendations were proposed jointly by the Gulf and south Atlantic fishery management councils after determining that king mackerel are a high priority species because they are sought by both sport and commercial fishermen.

Other proposed regulations for king mackerel include a restriction on selling fish less than 25 inches in length and various restrictions on commercial fishing gear.

Will Import Ban Save Totuava?

☐ The Totuava, long esteemed for its eating qualities, no longer can be brought into the United States from Mexico. The National Marine Fisheries Service (NMFS) recently imposed the import ban to protect the Totuava's dwindling numbers. The fish was once abundant in the middle and upper regions of the Sea of Cortez.

The Totuava can weigh up to 200 pounds and is the largest member of the drum family. The Mexican government began protecting the species in 1975, but this failed to halt illegal imports into the U.S. The fish recently cost more per pound than filet mignon.

Biologists note that the Totuava's spring spawning run into the Colorado River last year was virtually nonexistent, prompting some to fear for their survival. "They're in tough shape," noted Dr. William Aron, conservation director for NMFS.—*Barry M. Fitzpatrick.*

NEWS NEWS NEWS NEWS NEWS NEWS NEWS NEWS NEWS NEWS NEWS NEWS

DIGGERS BLOCK BLOOD AND SAND WORM CONSERVATION

■ The Marine Worm Conservation Committee, which offered the only viable solution to the dwindling supplies of blood worms and sandworms, has been destroyed by the opposition of 30 licensed worm diggers. The result is that coastal fishermen may be faced with limited worm supplies and higher prices this season.

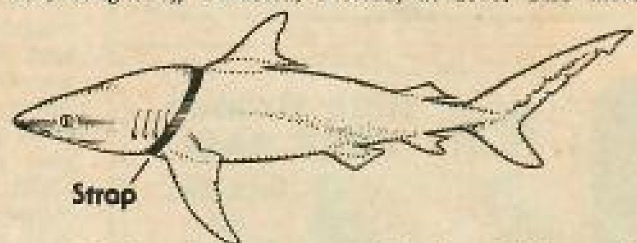
The Marine Worm Conservation Committee and the Maine Department of Marine Resources proposed conservation efforts aimed at providing for long-term gains for the worm diggers as well as for the fishermen using these popular baits. The conservation efforts considered would have eliminated Sunday digging and established a size limit on worms, if the decline in worms continued.

But the conservation measures, because they may have created short-term hardships, were opposed by a highly vocal minority of 30 out of 1,200 licensed diggers in Maine. It was this opposition that brought about the demise of the committee. Ninety percent of all blood worms and sandworms come from Maine. The supply there has been dropping at an alarming rate since 1973.

Ocean Littering And Shark Attacks: *Carelessly discarded packaging straps in our oceans could force some sharks to attack humans for food, suggest biologists at Mote Marine Labs in Sarasota, Florida.*

The sharks are getting snared by the circular straps used to bind boxes of fish commercially. Discarded at sea, these brightly colored, non-biodegradable straps attract feeding sharks. The sharks come in head first to investigate, then get noosed by the glass-fiber straps (see drawing).

Three "snared" sharks (a Bull, Tiger, and a Dusky) were caught off Sarasota, Florida, in 1975. Two more snared Dusky sharks were recently taken off Pensacola.



Once caught, a shark quickly grows into its strap, which leads to fin damage, thus restricting its ability to swim, maneuver, and hunt for food. A shark handicapped in this manner must alter its feeding habits to survive. All snared specimens examined showed signs of malnutrition. A shark in this condition, say biologists, may be less inhibited about attacking a swimming man for food.—Laurent E. Beaucage. *(A 200-pound broadbill swordfish, caught recently 80 miles off Charleston, South Carolina, had a plastic ring from a six-pack container nearly imbedded around the base of its bill. The plastic ring showed no signs of wear, but judging from the damaged tissue around the three-foot bill, it had been on the fish for months, perhaps years. Six-pack rings have already been found around the necks of ducks, geese, sea gulls and around bodies of trout.*—Ed.)

Commercial Fishermen Make "Hotspot" Map

☐ It's not often that a commercial fishing project promises something of value to sportfishermen. That's the case, though, in Louisiana.

The aim of a project there is to pinpoint places along the coast where commercial fishermen have lost or damaged nets due to underwater obstructions.

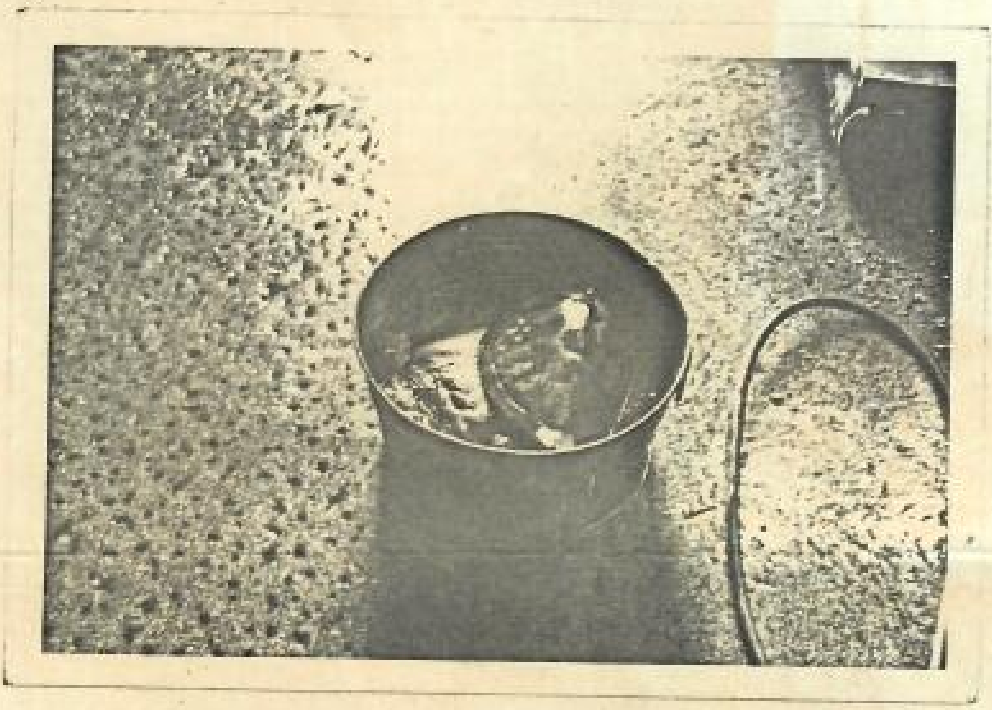
Maps produced by the project will help commercial fishermen avoid hanging up their nets. And since underwater obstructions provide food and cover for small fish that attract large gamefish, the maps will also show sport anglers new places to fish. For details write Louisiana Fisheries Federation, 999 North 9th Street, Suite 425, Baton Rouge, LA 70802.

Aussie Marlin: Black And Blue Fighters

☐ Australia's Great Barrier Reef is renowned for huge black marlin. Hundreds of blacks in the 1,000-pound class have been caught by visiting anglers. Now, local charter captains are trying to develop a blue-marlin fishery. Statistics compiled by the Japanese long-lining fleet reveal that blue marlin may be more plentiful than blacks along the Reef. Several blues weighing from 300 to 600 pounds have already been boated, but larger fish have been sighted, prompting some observers to conclude that blue-marlin fishing may one day rival the black-marlin angling. The world-record black marlin stands at 1,560 pounds, and the largest blue ever recorded

on rod and reel weighed 1,805 pounds.

Interestingly, the season for blacks runs from August through November. Blues are abundant from February through May.—*Barry M. Fitzpatrick.*



Seabirds – their biology and ecology 1979
A&W Publishers NY

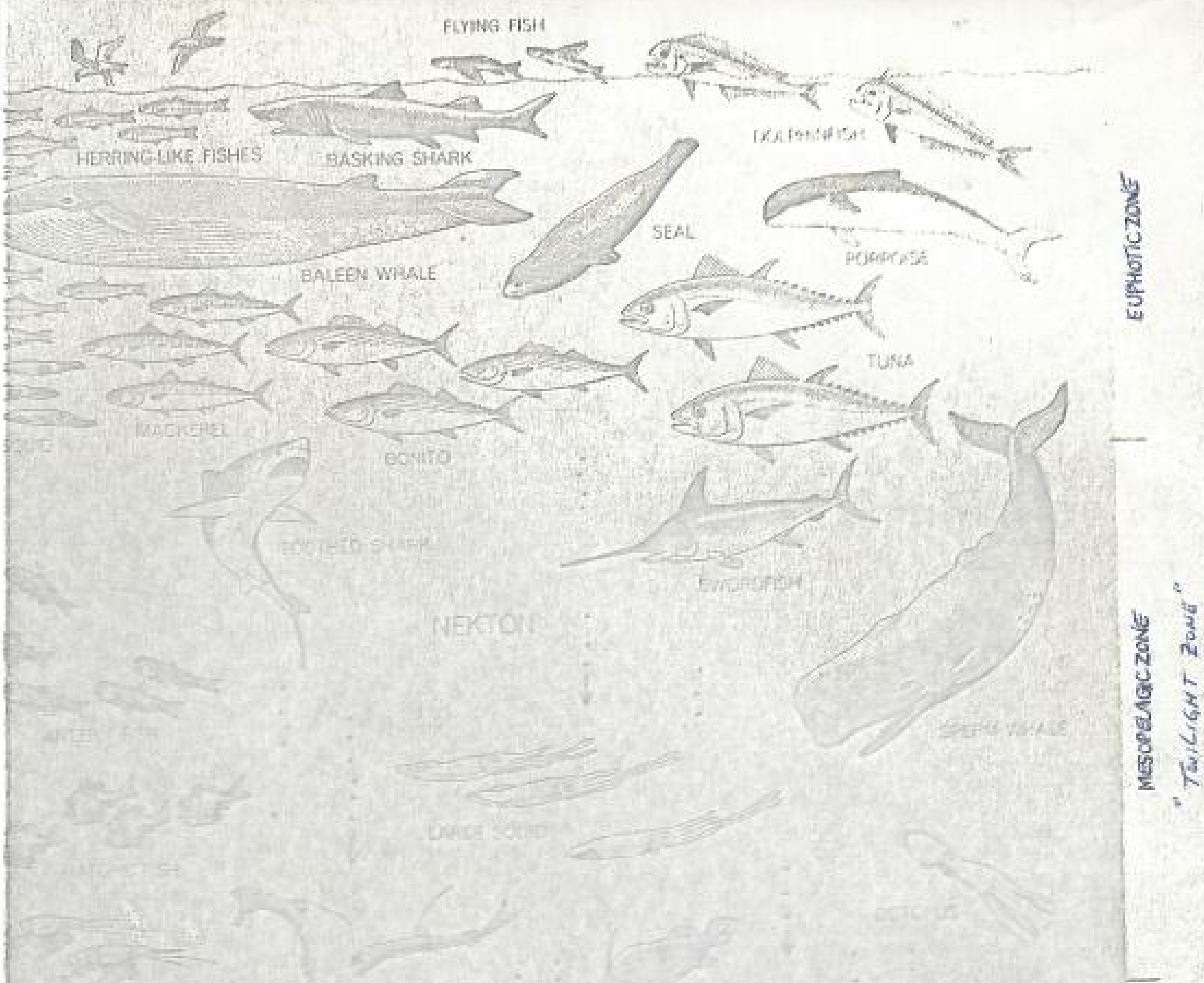
forms and the Emperor Penguin), puffinosis (sometimes kills large numbers of shearwaters and is found in Shags), botulism (which killed 2000 Herring Gulls in northeast Britain in June 1975), influenza (the virus has been discovered in the Wedge-tailed Shearwater and anti-bodies in Lesser Noddies), Newcastle disease (Gannet and Shag), aspergillosis (African Gannet), salmonellosis, etc. Infestation with various internal and external parasites is common. Seabirds harbour nematodes, tapeworms, acanthocephalid worms, flukes, mites, ticks, lice, fleas and flat flies. Debilitated Shags are subject to heavy infestation with mites beneath the skin. But all of these are probably unimportant in well-fed birds, as in animals in general. A porcupine, fit and fat, was found to have 20 per cent of its weight made up of tapeworms!

Man is undoubtedly the main disaster so far as many seabirds are concerned. His activities are food for another chapter, but it may be mentioned here that his waste oil is a major hazard, especially for auks, whilst his nets take an estimated 20000 auks in Galway Bay (Ireland) alone, each year, and the annual toll of Brunnich's Guillemots taken by drift nets off Greenland is around 0.5 million, many of which have dependent young; altogether, an estimated 1.5 million guillemots die at man's hand each year. This is more than the population can withstand. Shooting or trapping can be an important cause of death in some seabirds. Ten per cent of Farne Island Shags recovered, had been shot; most of the Black-browed and Grey-headed Albatrosses recovered had been captured or killed by fishing boats, 21 per cent of Caspian Terns recovered in the Great Lakes area had been shot, whilst of recoveries made beyond the southern United States 57 per cent had been shot!

Even within a species, the causes of mortality differ according to area. Razorbills, for example, tend to be shot in Scandinavia, Biscay and the Mediterranean but not in British waters; south coast birds tend to get oiled but this is not an important cause of death in Scandinavia, Biscay or the Mediterranean, and so on. Inexperience is linked with mortality not only through starvation but through shooting; first year birds of most, if not all, species are more vulnerable.

Natural predation accounts for only a small fraction of total deaths. Skuas are formidable predators and, together with Giant Petrels, take their toll of Antarctic seabirds. The nests of skuas on Bird Island (South Georgia) were littered with remains of Antarctic Prions and diving-petrels and these predators were estimated to account for 10000 prions each year. They are caught on the ground, where they are vulnerable. The big gulls will take auks, shearwaters, etc. Sea-eagles could have been significant predators, locally, when they were more numerous. Of 1044 prey items taken by sea-eagles in Norway, 62 were adult Shags. Peregrines take Craveri's Murrelets in the Gulf of California, some Sooty Terns on the Dry Tortugas, some Kittiwakes and auks off British cliffs.

Large fish take seabirds, but it is impossible to judge how many. Cod and angler fish take a few Shags and Cormorants and sharks may be significant predators in tropical waters. One 5 metre Grey Shark had thirteen juvenile Laysan Albatrosses in its stomach plus feathers belonging to many more. Among mammals, sea-lions take a few Guanays and a whale stranded near the Farne Islands had seven Shags in its stomach. Grey Seals may take a few birds, but there is no northern hemisphere equivalent of the Leopard Seal. These are serious predators of penguins against which they have evolved several behavioural ploys. Bernard Stonehouse gives a memorable description of King and Gentoo Penguins' reactions to seals. After winding in a crocodile through the tussock grass, the birds form a jostling mob at a favoured place of entry into the sea, 'the leading birds standing with toes in the water, the rest surging gently from behind'. The sudden appearance of a dark head in the surf sends them scuttling back up the beach. They may wander back and forth for an hour. Often, after the birds have entered the water, they panic, and leap ashore again. The sound of clapping, like a flipper smacking the water, is a signal to which they respond like magic. Nevertheless, despite the inbuilt fear responses, one worker, at least, concludes that Leopard Seals have a negligible effect on penguins. Introduced animals are much more serious enemies of seabirds than 'natural' mammalian predators, of which there are very few. Occasionally they are disastrous pests on islands unfortunate enough to become infested. So, directly and indirectly, man's influence on seabirds is largely baleful and exceeded, in magnitude, only by the long, slow changes in climate and oceanography that have shaped seabirds throughout evolutionary time.



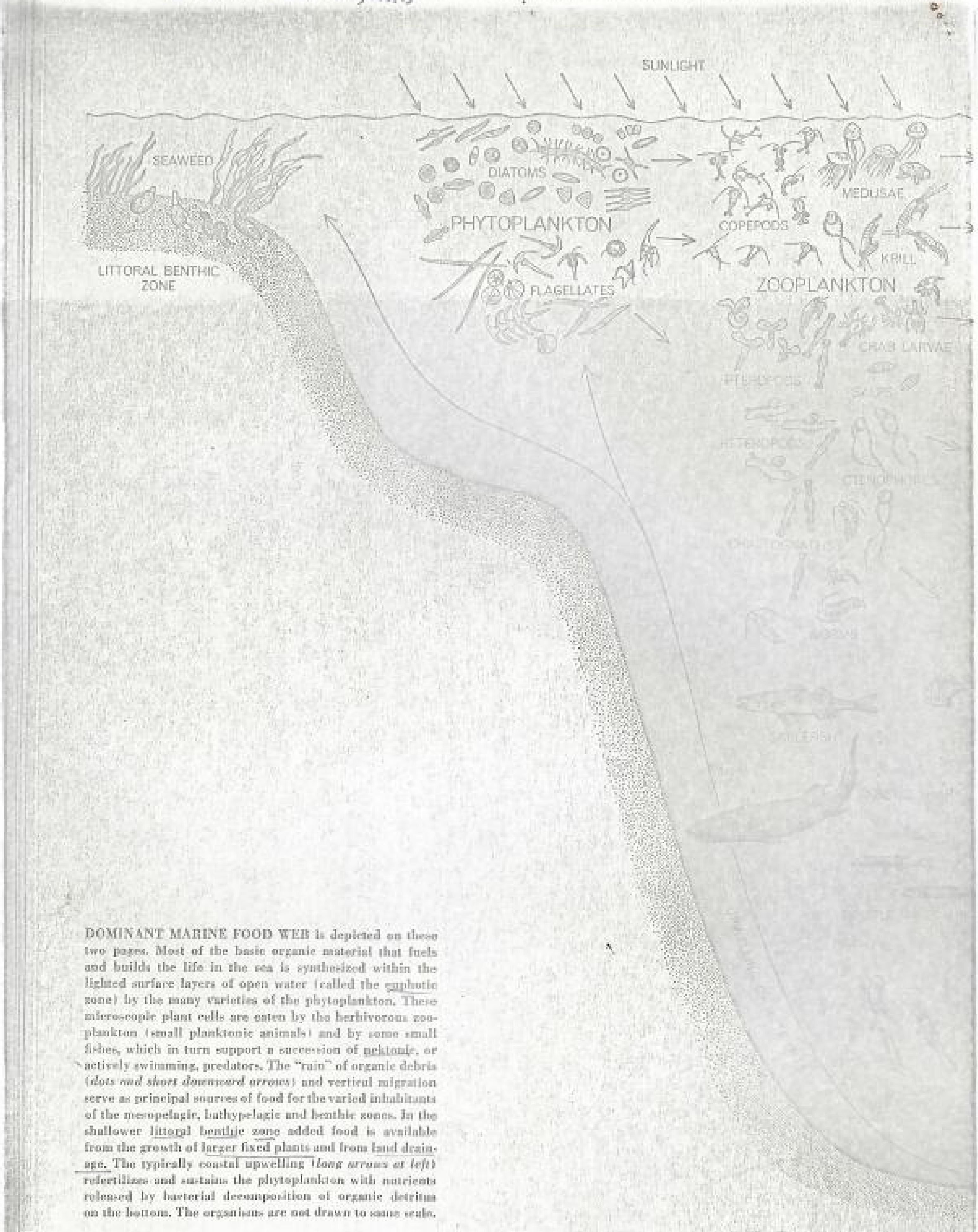
Krill = euphausid
Euphausiacea
Chaetognatha - small phylum

pteropods =
Ctenophora = phylum
SALPA = "Salps" = tunicates

pelagic: open sea as distinguished from coastal waters

The Nature of Oceanic Life
by John D. Isaacs
p 147-162 v221, No. 3

SCIENTIFIC AMERICAN
September 1969



DOMINANT MARINE FOOD WEB is depicted on these two pages. Most of the basic organic material that fuels and builds the life in the sea is synthesized within the lighted surface layers of open water (called the euphotic zone) by the many varieties of the phytoplankton. These microscopic plant cells are eaten by the herbivorous zooplankton (small planktonic animals) and by some small fishes, which in turn support a succession of nektonic, or actively swimming, predators. The "rain" of organic debris (*dots and short downward arrows*) and vertical migration serve as principal sources of food for the varied inhabitants of the mesopelagic, bathypelagic and benthic zones. In the shallower littoral benthic zone added food is available from the growth of larger fixed plants and from land drainage. The typically coastal upwelling (*long arrows at left*) refertilizes and sustains the phytoplankton with nutrients released by bacterial decomposition of organic detritus on the bottom. The organisms are not drawn to same scale.

31 p.

FISHES OF HAWAII, JOHNSTON ISLAND, AND WAKE ISLAND

BY

HENRY W. FOWLER

AND

STANLEY C. BALL

BERNICE P. BISHOP MUSEUM
BULLETIN 26

TANAGER EXPEDITION PUBLICATION No. 2

HONOLULU, HAWAII
PUBLISHED BY THE MUSEUM
1925

Fishes of Hawaii, Johnston Island, and Wake Island

By

Henry W. Fowler

And

Stanley C. Ball

The collections reported in this paper were taken during the spring and summer of 1923 at the islands of the Hawaiian group west of Kauai embracing Nihoa, Necker, French Frigate Shoals, Gardner, Laysan, Lisiansky, Pearl and Hermes Reef, Midway and Ocean islands, and at Johnston and Wake islands to the southwest. They were obtained by Mr. Ball and Major Chapman Grant with the aid of other members of the party.[1]

More time was spent at Laysan than elsewhere, and there an attempt was made to obtain a complete set of fishes. Of the species seen in a month's effort four-fifths are represented in the collections. In four days at Lisiansky, the next island westward, a few were seen which had not been noted at Laysan. Having then the services of John Baker, a Hawaiian fisherman, two parrot fishes seen but not obtained at Laysan were added to the collection. The only species seen at Lisiansky but not caught, was a yellow one with oblique dark bands. The observer, Major Chapman Grant, believes it to have been *Cheilodactylus vittatus* Garrett.

Laysan is but poorly protected, the fringing reef being frequently interrupted so as to allow the heavy swells to pound the reef and shore whenever the wind is fresh. No doubt this accounts for the paucity of small reef species. The water glass failed to reveal these forms swimming about the coral heads, and even breaking up the coral yielded almost nothing but crustaceans and worms.

At Lisiansky, a reef two or three miles off shore protects a large area between it and the sandy island. The island has few of the sandstone ledges along shore, such as were found at Laysan. Its sandy margins and bays supported myriads of a relatively small number of species. Whereas at Laysan not over fifty mullet were seen and fewer Neomyxus, one small

[1] Gregory, H. E., Report of the Director for 1923: B. P. Bishop Mus. Bull. 10, pp. 19-24, 1924.

school of Polydactylus and a few thousand Kuhlia, these species were represented at Lisiansky by millions. Shoals of Mugil and Polydactylus several square rods in extent were often seen. Of these the specimens listed here are preserved in the Bishop Museum, and a set of the duplicates has been sent to the Academy of Natural Sciences of Philadelphia. The color notes, unless otherwise stated are from the specimens in alcohol.

The greater number of species listed constitute new locality records, while four are new species and two are new genera. We have previously described one new genus as the type of a new family, also a new species of a genus new to Oceania. Equally important is the rediscovery of the little known *Bleekeria gillii.*[2]

EULAMIIDAE

Galeocerdo arcticus (Faber).

Tooth picked up on beach of east shore of Laysan Island, May 5, entire jaw from specimen caught at Nihoa, May 24. About six in two months caught at Laysan and Nihoa, probably others by sailors at night. Several also caught at Lisiansky and Gardner islands. Not previously recorded from these islands.

Eulamia commersonii (Blainville).

Common at all islands west of Kauai. One from Laysan 1015 mm. long, where always found outside reef. Eight young were taken from a female 2440 mm. long at Nihoa, May 24. Of these one examined measured 487 mm. Pieces of jaws and teeth from an example taken at Gardner Island probably this species. One from Wake Island, 495 mm.

GALEORHINIDAE

Triaenodon obesus (Rüppell).

Two from Laysan 1035 and 1488 mm. long, taken in April. Common at Laysan, Lisiansky, and Wake, many always in pools and channels of the shore reef. Not met with at Gardner or Nihoa which lack reef. An interesting addition to the Hawaiian ichthyfauna. Easily known by its obtuse snout and white-tipped dorsals and caudal. In the hundred or more specimens seen, the size was remarkably uniform. The variation was not more than 20 cm. Not a single young one was seen. A striking associa-

[2] Fowler, H. W., and Ball, S. C., Descriptions of new fishes obtained by the Tanager Expedition of 1923 in the Pacific Islands west of Hawaii; Acad. Nat. Sci. Phila., Proc. vol. 76, pp. 269-274, 1924.

Predator FILE

WHITE SHARK PREDATION ON PINNIPEDS IN CALIFORNIA COASTAL WATERS

White sharks, *Carcharodon carcharias*, prey on various fishes, sea turtles, whales, dolphins, and on several species of pinnipeds (Allen 1880; Elliot 1881; McCormick and Allen 1963; Davies 1964; Nishiwaki 1972; Ellis 1976; Ainley et al. 1981; McCosker 1981). Data on pinnipeds preyed upon by sharks in California waters are meager and many aspects of the predator-prey relationship are unknown.

Four types of evidence indicate that sharks prey on pinnipeds: 1) Pinniped remains in the stomachs of dead sharks, 2) observation of seals with injuries inflicted by large sharks, 3) observation of shark attacks on seals, and 4) the presence of sharks near seal rookeries at a time when seals are present. We report evidence of the first two kinds regarding shark predation on northern elephant seals, *Mirounga angustirostris*, and harbor seals, *Phoca vitulina*.

Methods

Five white sharks caught in southern California waters in 1975 and 1976 and two white sharks that washed ashore in central California in 1977 and 1978 were examined. The fresh dead sharks were weighed, measured, and their sex determined. Stomachs were dissected out and contents identified, and in some cases, weighed and measured (Table 1).

From 1968 to 1980, shark-bitten elephant seals on Año Nuevo Island and the adjacent Año Nuevo Mainland in central California were counted, photographed, and identified individually, and their behavior was monitored. This was accomplished during daily censuses conducted each breeding season from December to mid-March and during weekly censuses conducted during the remainder of the year. Only seals with fresh wounds judged by their pink or bloody appearance to be less than a few days old were included in the sample. This gives us confidence that our subjects were injured near the study area. We did not census animals with old scars or healed injuries, whose origins were difficult to ascertain. Shark injuries were differentiated from other wounds, caused by boat propellers or intraspecific fighting, by their oval shape and the jagged serrations caused by the predator's sharp teeth. Both slight and serious wounds were included. Slight wounds consisted of superficial tooth punctures or scrapes across the skin; serious wounds involved deep bites and tears. Seriously wounded seals had large flaps of flesh exposed or chunks of flesh missing. The dimension of bites was measured on a few dead seals.

We marked and followed 11 females who sustained moderate to severe shark wounds when pregnant just before arriving on the island to give birth. Their pups were marked at birth and the pair was observed until the filial relationship ended. Northern elephant seal females give birth within a week after arriving on the rookery. A female nurses her pup daily for about 4 wk before weaning it and returning to sea (Le Boeuf et al. 1972).

A similar search for shark-bitten harbor seals, which breed at Año Nuevo Island and numerous

TABLE 1.—Stomach contents of white sharks collected off the California coast from 1975 to 1978. Specimens 1-5 were collected by Sea World of San Diego, no. 6 by K. Skaug and M. Riedman, and no. 7 by an anonymous fisherman.

Specimen number	Date of collection	Location	Sex	Total length (m)	Weight of shark (kg)	Stomach contents
1	24 June 1975	8 km northeast of Santa Catalina Island	F	3.9	623.7	Anterior portion of stomach contained harbor seal remains (18.2 kg). Posterior stomach held unidentified pinniped.
2	1 Aug. 1975	110 m west of Laguna Beach	F	2.4	138.8	A 4-in patch of pinniped pelage.
3	6 Sept. 1975	Near Anacapa Island	F	4.9	1,428.8	Harbor seal, well digested.
4	7 Sept. 1975	11.3 km southeast of Anacapa Island	F	5.0	1,560.4	Skull and posterior portion of a juvenile elephant seal, plus large amounts of fur and digested material.
5	13 June 1976	West end of Catalina Island	F	5.5	1,882.4	Nearly digested. Bulk suggested a large animal, probably a marine mammal.
6	3 Feb. 1977	Año Nuevo Bay	F	4.7	?	Approximately one-third of a recently eaten 4-yr-old male elephant seal.
7	25 Sept. 1978	1.6 km offshore near Aptos	M	3.9	540	The head of a harbor seal.

other locations along the California coast, was not conducted.

Results

Table 1 summarizes data obtained from the stomachs of seven great white sharks examined shortly after they washed ashore dead or were captured at sea. Four points are worth noting:

1) Six stomachs contained seal remains, three of harbor seals and two of northern elephant seals.
2) Large prey was consumed. On the basis of tooth annuli and head and proboscis size, we estimate that specimen no. 6 (Fig. 1) contained the remains of a male elephant seal, 4 to 5 yr old. Intact, this seal would have measured approximately 3 m in length and weighed 450 to 680 kg.
3) The dimensions of the barely digested material in four of the shark stomachs indicate that the prey had been consumed in large pieces. For example, the stomach of one specimen contained the entire head, unmarred and severed cleanly at the neck. Both hind-flippers and the tail were covered with hair and still attached to a segment of the sacrum. Also included were both foreflippers, one attached to a large piece of flesh containing the shoulder, a large portion of the midsection including six vertebrae, and several pieces of flesh and fur in various stages of decomposition. The elephant seal material weighed about 225 kg.
4) Six of the seven sharks were females.

The majority of the shark-injured elephant seals were observed during the winter breeding season. Only two recently bitten animals were observed on Año Nuevo Island in spring, despite the larger number of animals present at this time compared with the breeding season (Le Boeuf and Bonnell 1980).

Fewer than three victims per breeding season were observed from 1968 to 1976. From 1976 to

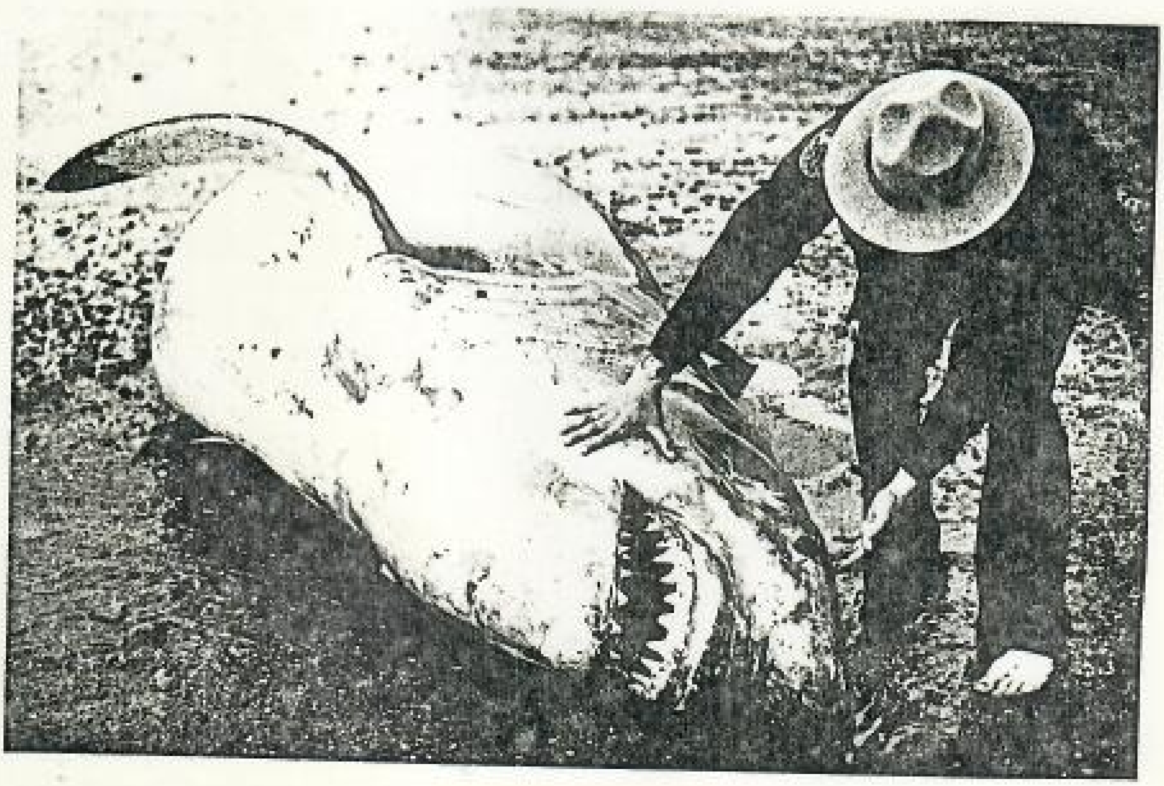


FIGURE 1.—A moribund great white shark (Specimen No. 6 in Table 1) that washed ashore near Año Nuevo Point shortly after having consumed approximately one-third of a young male northern elephant seal.

1980, 44 elephant seals with shark-inflicted injuries were observed (Table 2). Most of the elephant seals bearing recent shark wounds were adults. Males incurred the highest injury rate. Even the largest adult bulls, measuring more than 4.9 m and weighing between 1,800 and 2,700 kg were observed with shark bites (see Figure 2a). This may be due to the male habit of spending more time in the water near the rookery during the breeding season than females.

TABLE 2.—Shark-bitten northern elephant seals observed on Año Nuevo Island and the Año Nuevo Mainland.

Year	Adult males	Adult females	Juveniles	Pups	Total
1976		3			3
1977	3	4		1	8
1978	1	7	1		9
1979	5	1	1		7
1980	16	1			17
Total	25	16	2	1	44

Shark bites were located on diverse areas of the body but rarely on the head (Fig. 2). Possibly, frontal attacks were less successful or head bitten seals simply did not survive the encounter. In many cases, large pieces of blubber were missing or hung loosely from the animal. Some seals lost a foreflipper or hindflipper and in one case most of the proboscis. Some animals were bitten several times.

The majority of injured seals survived and recuperated rapidly. Infected wounds were rarely observed. Only three elephant seals died on the island or on the mainland following shark injury. In September 1976, an 8½-mo-old female was found dead with numerous deep lacerations and teeth marks covering her body. In December 1977, a 1-wk-old pup washed up with its entire sacral region amputated just below the umbilicus. In February 1978, a large 7-yr-old male died on the island's main breeding beach from massive shark wounds incurred within the previous 24 h. The most serious wounds consisted of two large oval chunks of flesh missing from the left side of the thoracic region (Fig. 2e). The bites measured 61 and 69 cm wide, 61 cm high, and 30 cm deep. No bite penetrated the body cavity although some muscle was removed and a rib was partly exposed.

Most female elephant seals bitten by sharks shortly before giving birth failed to wean their pups successfully. One female gave birth to a stillborn and returned to sea immediately. Seven females either abandoned their pups shortly after parturition or they were unable to care for them adequately. Four of these pups died; the eventual status of the other three pups could not be determined. The three females who were successful in weaning their pups appeared to have sustained the least serious injuries. All injured females remained in the harem for a much shorter period than normal. No injured female was observed to copulate, as uninjured females do, just before returning to sea. Thus, most injured females not only failed to produce a pup during the year of injury, but if they failed to copulate, they did not reproduce in the subsequent year as well.

Discussion

The data on stomach contents of white sharks presented in this paper is conclusive evidence that this shark preys on elephant seals and harbor seals in southern and central California waters.

We hypothesize that shark-inflicted injuries to northern elephant seals at Año Nuevo were caused primarily by white sharks. This hypothesis is supported by:

1) Data from a white shark that washed ashore at Año Nuevo Bay whose stomach contained the remains of an elephant seal (Table 2).
2) Observation of white sharks in the area. Twice during the summer of 1970 seal researchers saw white sharks measuring about 4.5 m from a dinghy 100 m south of the island. Party boat operators and fishermen reported seeing white sharks in this area several times during the last decade. Anglers report that white sharks occasionally attack large lingcod, *Ophidon elongatus*, when they are caught on hook and line; the sharks surface and circle boats, especially when fishing stops (Miller and Collier 1980).
3) An observed white shark attack of a northern elephant seal near Año Nuevo Island. This occurred on 1 February 1981.
4) The large size of shark bites. This indicates that they were caused by large sharks. White sharks may also be responsible for injuries to elephant seals on other rookeries in California (Ainley et al. 1981) and in Mexico (Townsend 1885; B. Le Boeuf, pers. obs.).

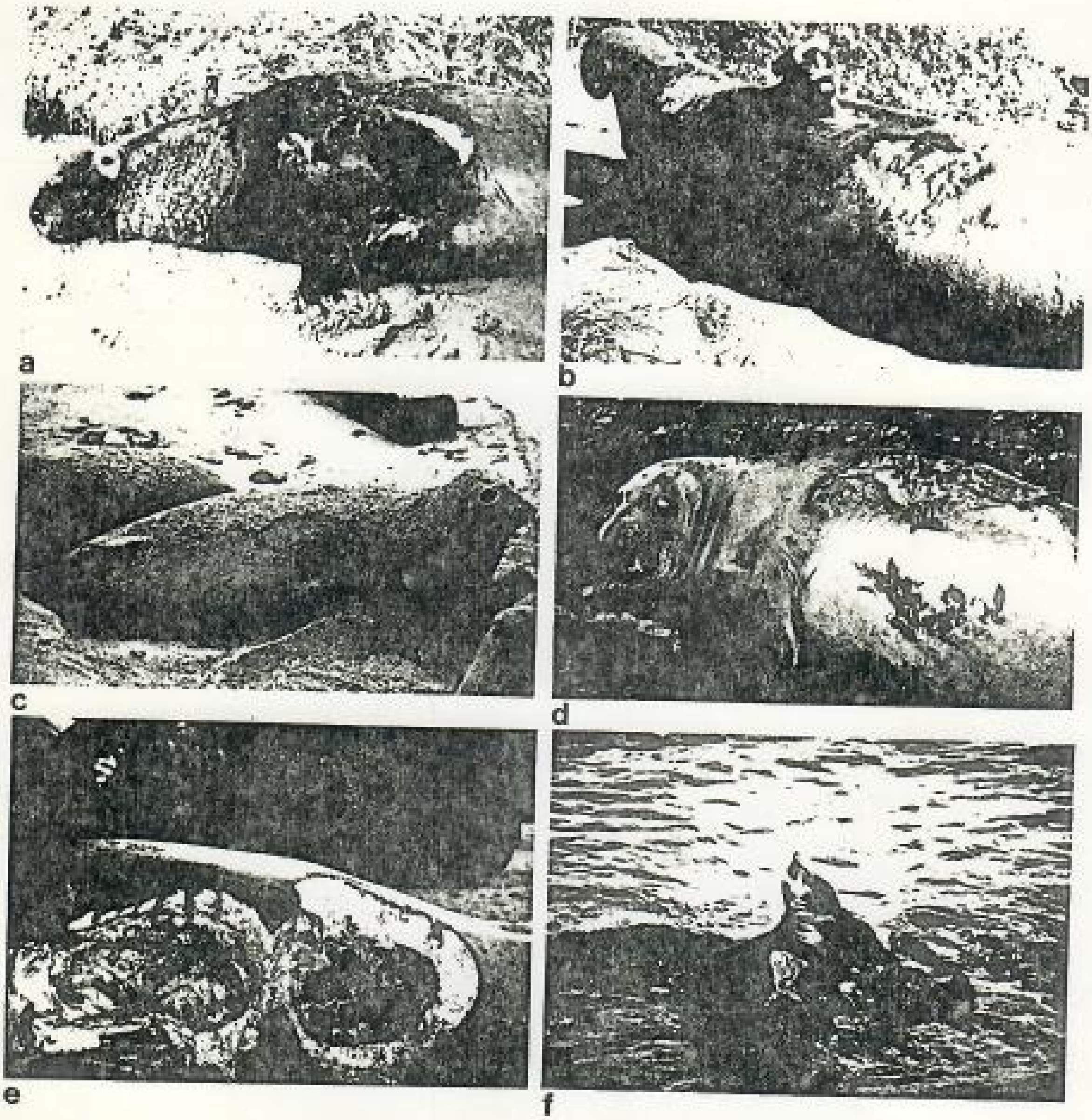


FIGURE 2.—A variety of shark-inflicted wounds observed on elephant seals and sea lions at Año Nuevo. A crescent shaped wound (a) and toothprints (b) on adult male elephant seals. A crescent bite on the dorsal posterior of an adult female elephant seal (c) and a large imprint of both jaws on an adult female with a blind left eye (d). Two large chunks of flesh bitten off the left side of an adult male elephant seal who subsequently died from his wounds (e). A California sea lion bearing a recently inflicted shark injury (f).

The results of this study support and augment those of Ainley et al. (1981) on South Farallon Island near San Francisco, Calif. They found that white sharks were responsible for most of the shark attacks observed on pinnipeds in the waters surrounding the island during the period September 1970 to February 1979. Northern elephant seals were attacked more frequently than harbor seals and sea lions, and shark-bitten female elephant seals exhibited low reproductive success.

Shark attacks on elephant seals of Año Nuevo Island and South Farallon Island (Ainley et al. 1981) appear to be increasing, but more data based on continued monitoring is necessary to confirm this point. Periodic increases in shark attacks of the magnitude found in these two studies may be related to several possible factors: The well-documented increase in elephant seals (Le Boeuf and Bonnell 1980), an increase in abundance of sharks, or to one or a few relatively inept predators at work.

Acknowledgments

We thank Sea World of San Diego for permitting us to use data from their shark collecting expeditions; Walter Ward for bringing the beached shark to our attention and for providing measurements; Keith Skaug, C. Leo Ortiz, Robert Gisiner, and Anne Hoover in acquiring and examining shark stomach contents; and Jack Ames, Ellen Chu, Daniel Miller, and Breck Tyler for comments on the manuscript. This study was supported in part by the National Science Foundation grant BNS 74-01363 402 to B. J. Le Boeuf.

Literature Cited

AINLEY, D. G., C. S. STRONG, H. P. HUBER, T. J. LEWIS, AND S. H. MORRELL.
1981. Predation by sharks on pinnipeds at the Farallon Islands. Fish. Bull., U.S. 78:941-945.

ALLEN, J. A.
1980. History of North American pinnipeds: A monograph of the walruses, sea-lions, sea-bears and seals of North America. Gov. Print. Off., Wash., D.C., 785 p.

DAVIES, D. H.
1964. About sharks and shark attack. Brown, Davis, and Platt Ltd., Durban, 237 p.

ELLIOTT, H. W.
1881. The seal-islands of Alaska. Gov. Print. Off., Wash., D.C., 176 p.

ELLIS, R.
1976. The book of sharks. Grossett and Dunlap, N.Y., 320 p.

LE BOEUF, B. J., AND M. BONNELL.
1980. Pinnipeds of the California islands: abundance and distribution. *In* D. Power (editor), The California Islands: Proceedings of a Multidisciplinary Symposium. Santa Barbara Museum of Natural History, Santa Barbara, Calif.

LE BOEUF, B. J., R. J. WHITING, AND R. F. GANTT.
1972. Perinatal behavior of northern elephant seal females and their young. Behaviour 43:121-156.

MCCORMICK, H., AND T. ALLEN.
1963. Shadows in the sea. Chilton Books, Phila., 415 p.

MCCOSKER, J. E.
1981. Great white shark. Science 81 2(6):42-51.

MILLER, D. J., AND R. S. COLLIER.
1980. Shark attacks in California and Oregon, 1926-1979. Calif. Fish Game 67(2):76-104.

NISHIWAKI, M.
1972. General biology. *In* S. H. Ridgway (editor), Mammals of the sea: Biology and medicine, p. 3-204. Charles C. Thomas, Springfield, Ill.

TOWNSEND, C. H.
1885. An account of recent captures of the California sea-elephant, and statistics relating to the present abundance of the species. Proc. U.S. Natl. Mus. 8:90-93.

BURNEY J. LE BOEUF

Center for Coastal Marine Studies and Crown College
University of California, Santa Cruz
Santa Cruz, CA 95064

MARIANNE RIEDMAN

Center for Coastal Marine Studies
University of California, Santa Cruz
Santa Cruz, CA 95064

RAYMOND S. KEYES

Sea World
1720 South Shores Road
San Diego, CA 92109

VERTICAL STRATIFICATION OF THREE NEARSHORE SOUTHERN CALIFORNIA LARVAL FISHES (*ENGRAULIS MORDAX, GENYONEMUS LINEATUS,* AND *SERIPHUS POLITUS*)

Length measurements of larval fish are most frequently used in describing life stages (Moser and Ahlstrom 1974), and the subsequent development of population estimates (Kumar and Adams 1977). Field and laboratory observations are used to construct growth models of larval fishes, which are useful in predicting rates of growth under various environmental conditions (Hunter 1976). When combined with observations of larval abundance and distribution, length measurements can be indicators of both larval and adult ecology. Larval length-frequency data provide information about adult distribution and abundance, spawning periodicity, food preferences, and behavioral transitions that occur during development (Gjøsaetor and Saetre 1974; Tanaka 1974).

Larval length-frequency distributions of three species of fish were determined in conjunction with a study of the effects of a power plant offshore cooling water intake on local nekton populations. The three species chosen [northern an-

* *

Anthony Sudekum, Department of Zoology and Hawaii Cooperative Fishery Unit, University of Hawaii

NOTES ON THE BIOLOGY AND FEEDING HABITS OF CARANX IGNOBILIS AND C. MELAMPYGUS IN THE NORTHWESTERN HAWAIIAN ISLANDS

(Major Professor: Dr. James D. Parrish)

A preliminary analysis was made of catch data, gut contents, and feeding relationships of two carangid fishes, Caranx ignobilis and Caranx melampygus, which were collected in the Northwestern Hawaiian Islands. Both species were found to be top level carnivores, feeding principally on reef fish, though there were significant differences in the relative importance of various prey items. Sex ratios, spawning periods and the effect of transient predators on shallow water coral reef communities are discussed.

* *

TESTER Symposium April 15-16, 1982

PIM MARCH 1984

nor Ariyoshi and descendants of Hawaiian *Alii*. They all participated in festivities culminating in the blessing of a royal coat of arms plaque on the Iolani Palace gate used exclusively by the royal family in the days of the monarchy. The original plaque was torn out when the last Hawaiian monarch, Queen Liliuokalani, was overthrown in 1893. — *Caroline Yacoe in Honolulu.*

Bullet-proof? Just watch this!

Friends of Fiji, and of the United States Embassy in Suva, will be relieved to hear that the massive crack in the bullet-proof glass protecting the ground floor receptionist from terrorist attack, and which threatened to become one of the lesser wonders of the Suva scene, is now no longer on view. The panel has been replaced.

It should be noted, of course, that terrorists continue to be absent from the Suva environs and that it was not a bullet that cracked the panel. It was, so we are rather reliably informed, the head of a large messenger who, not noticing the glass, bobbed forward the better to hear the receptionist's voice.

If this report is true Fiji may unknowingly be in possession of a singularly effective home-grown weapon.

Of Outrigger and Reef

Hardly an Australian, and not a few from the Pacific Islands, can pass through Honolulu without calling at one of the Outrigger chain of hotels. It's an association which goes back many years, to the days when the father of the present owner, Dr Richard Kelley, was running the Edgewater Hotel.

As Dr Kelley said recently: "Our hotels have always been popular with visitors from Down Under, and we want to keep it that way."

The Kelley organisation has therefore appointed a special executive representative for Australia and New Zealand. He is Matt Lurie, one of the best known of Australian names in the international travel industry.

Mr Lurie was the first British Commonwealth Pacific Airlines manager resident in Fiji when that historic airline ran its DC-6 services right across the Pacific linking Australia, New Zealand and North America before the days of Qantas.

From Fiji he went to Honolulu and then to the U.S. mainland, becoming, in succession, a vice-president of the Matson Shipping Company, a senior executive with the Travelodge hotel group, and general manager of Avis before retiring and returning to Australia several years ago.

In Sydney he operates a specialised travel consultancy and maintains close contact with the Pacific Area Travel Association of which he was international president in 1966 and 1967.

The Outrigger organisation is made up of seven major hotels, the Waikiki Outrigger Hotel, the Outrigger Surf, the Outrigger East, the Outrigger West, the Waikiki Surf, Waikiki Village and, the most recent acquisition and Dr Kelley's "flagship", the Outrigger Prince Kuhio. Together they have 3500 rooms.

The Reef Group, also part of the Kelley organisation, comprises the Reef Hotel, Reef Towers, Waikiki Tower of the Reef, the Reef Lanais and the Edgewater Hotel, foundation of the chain and still very well known.

PNG Highlands Oz bow-wave?

The following exchange recently took place in "Column 8", a gossip-type feature appearing regularly on the front page of *The Sydney Morning Herald*.

Gangway Papua New Guinea! Under the Australian Research Grant Scheme, $57,000 has been given to Dr A. Stolz of NSW for the investigation of crustal movement. Information about this project says: "Although the concept of continental drift was unpopular only a few decades ago, most geophysicists today would agree that the continental plates are moving at a few centimetres a year — or about as fast as your toenails grow. Australia is moving steadily north at 10 centimetres a year and is also being squeezed from each side".

And, the next day:

"Dear Column 8, re your leading story in today's Herald, Gangway Papua New Guinea: Fancy your not knowing that New Guinea, in nature's grand scheme of things, is part of Australia. Torres Strait is a mere transient puddle and was dry land as recently as 7000 years ago. New Guinea is Australia's leading edge, and its mountains are our geological bow-wave. Gangway Japan? Yours sincerely, Dr J. M. B. Smith, senior lecturer, Department of Geography, University of New England".

One that didn't get away . . . Labasa, Fiji, fisherman Mohammed Saizad hooked this 117 kg rock cod while line-fishing in Bua Passage in late January. He and his two fishing companions towed the fish to shallow water at Lekutu before hauling it in. The picture shows National Marketing Authority fisheries expert, Tadashi Ishikawa, with the fish. Photographer: William Copeland in *The Sunday Times*, Fiji.

18 August 1976 — from G. C. Whittow —

TRIG

11. 45. – 11. 55 am. Watched 15 ft shark close in shore. Dead turtle in wash - no head or flippers. South shore

12. 45 pm Seal swam by turtle but could not see shark

1. 46 pm Shark had 2 white spots on dorsal fin and tail looked :

Reprinted From: Journal of the Herpetological Association of Africa 29, 1983 : 15-17

OCTOPUS PREDATION ON THE HAWKSBILL TURTLE, *ERETMOCHELYS IMBRICATA* (CRYPTODIRA: CHELONIIDAE)

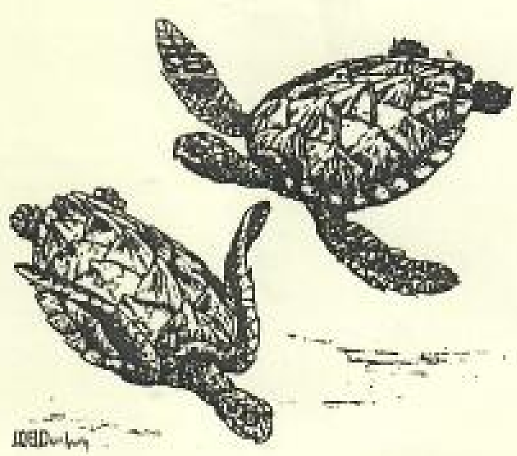
Whilst SCUBA diving during a routine fish transect in the mooring gulley at Storm's River Mouth (grid 3423BB) in the Tsitsikama Coastal National Park, one of us (CB) observed a medium-sized Hawksbill Turtle (Eretmochelys imbricata) apparently lodged under a rock overhang. Closer observation revealed that the turtle was restrained by a large octopus that was feeding on the left hind flipper. The incident occurred at 4 p.m. on 28 April 1983. Underwater visibility was good and the water temperature 18°C. The mooring gulley is formed by east-west running sandstone ridges that break the force of wave action. Water depth was 4m.

When disturbed the octopus released the turtle. The turtle was still alive although moribund. Damage to the left hind flipper was extensive, only 30% of the flesh remaining. Due to its condition the turtle was euthanased and the carapace (which has a mid-line length of 360mm) retained in the display collection of the Tsitsikama Coastal National Park.

The octopus was probably Octopus vulgaris. It is common along the southern Cape coast, and may attain a total length of 1m and body mass of 3kg (Smale and Buchan, 1981).

Sea turtles are relatively uncommon along the Cape coast, although most of the major estuaries of the Eastern Cape (i.e. those with permanently open mouths) have small resident populations of green turtles (Chelonia mydas). Juvenile hawksbill turtles (carapace length <40cm) occasionally strand in the region, but adults and hatchlings are absent. Hughes (n.d.) notes that the hawksbill in south-east Africa feeds mainly on sponges in the upper sub-tidal zone. Non-active sea turtles in the main fish tank of the Port Elizabeth Oceanarium lodge themselves under overhangs in the artificial reefs, particularly at night. At such times they would be vulnerable to attack from octopii, which are believed to hunt actively at night (Smale and Buchan, 1981). The extent of the damage to the Tsitsikama turtle's hind limb suggests that feeding had occurred for some time, and that the turtle may well have been captured during the previous night. It's moribund condition may thus have been due as much to lack of oxygen as to tissue damage.

Flipper injuries in sea turtles are not uncommon. Hughes (1974) noted that of 204 adult loggerhead females nesting on the Tongaland beaches during the 1965-66 season, 21% had notable injuries, of



which 67,5% were on the flippers. Similarly flipper damage accounted for nearly half (48,6%) of the injuries noted for green turtles form Europa Island. Sharks, particularly tiger sharks (Galeocerdo cuvieri), are probably responsible for most of these injuries. However, some could be due to octopus attacks. The proportion remains unknown, but may not be as rare as this unique observation suggests.

REFERENCES

Hughes, G.R. 1974. The Sea Turtles of South-East Africa. II. The biology of the Tongaland loggerhead turtle Caretta caretta L. with comments on the Leatherback Turtle Dermochelys coriacea L. and the green Turtle Chelonia mydas L. in the study region. Invest. Rep. oceanogr. Res. Inst. No. 36: 1-96.

Hughes, G.R. (n.d.) Sea Turtles: A Guide. Natal Parks Board publication. 24pp.

Smale, M.J. and Buchan, P.R. 1981. Biology of Octopus vulgaris off the east coast of South Africa. Marine Biol. 65: 1-12.

C.D. BUXTON and
W.R. BRANCH

Port Elizabeth Museum,
P.O. Box 13147,
Humewood 6013.

WORLD CONGRESS OF HERPETOLOGY

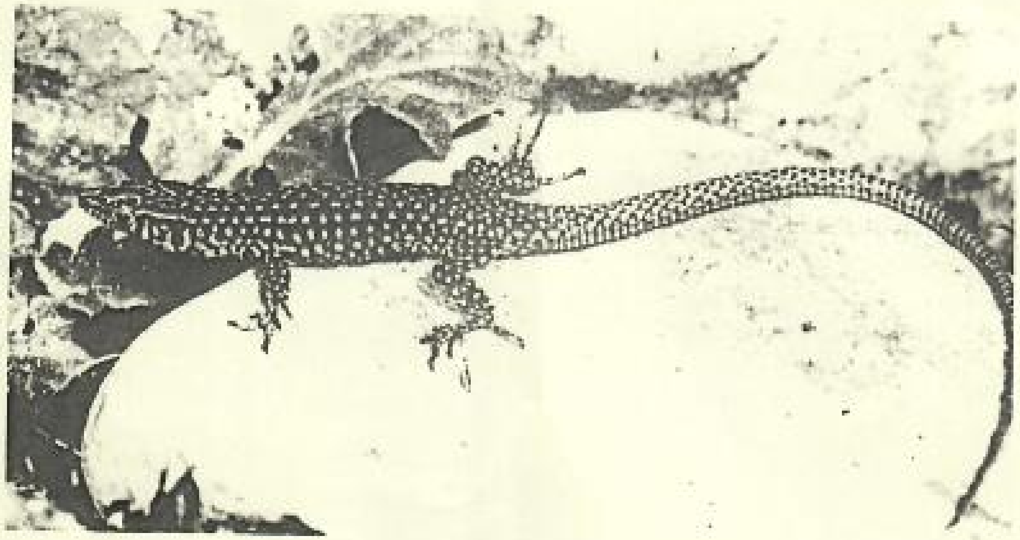
By recent action of the officers and official representatives of the major national and international herpetological societies, an international committee has been established to plan the first World Congress of Herpetology. The congress will be held in 3-5 years at a site yet to be selected. The Planning Committee consists of:

Donald G. Broadley (Zimbabwe)
Harold G. Cogger (Australia)
J. C. Daniel (India)
Ilya S. Darevsky (U.S.S.R.)
Marinus S. Hoogmoed (Netherlands)
Toshijiro Kawamura (Japan)
Michael R. K. Lambert (U.K.)
Hubert Saint Girons (France)
P. E. Vanzolini (Brazil)
David B. Wake (U.S.A.)
Kraig Adler (U.S.A.), *Secretary-General*

The congress will be organized to include a wide range of topics, to appeal to all persons interested in the scientific study of amphibians and reptiles. The committee currently is setting guidelines for operation, including the establishment of a larger and broadly representative International Herpetological Committee to provide a self-perpetuating mechanism for future congresses.

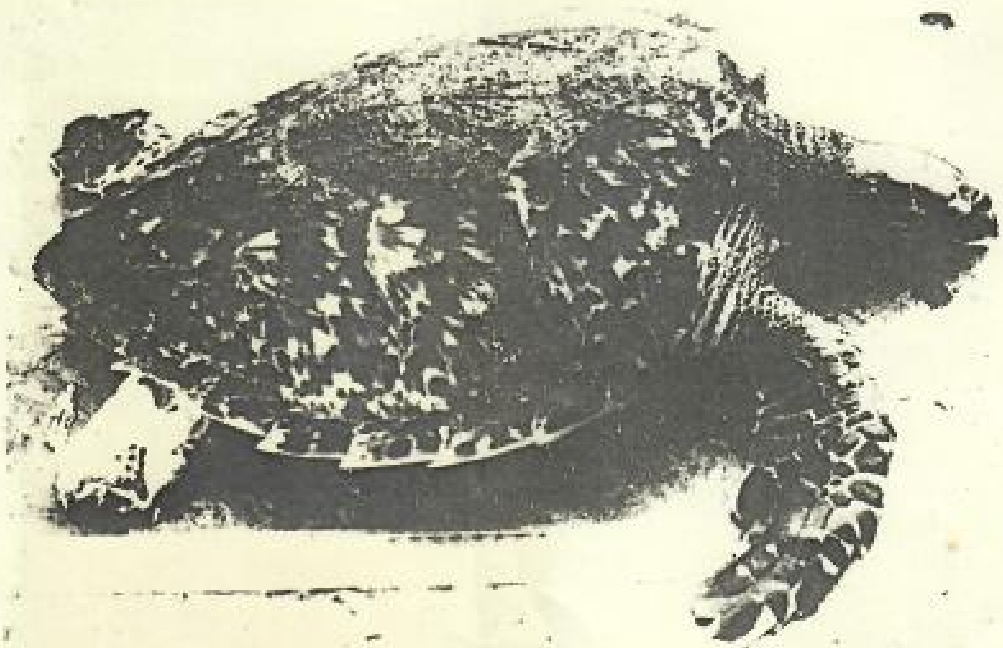
The Planning Committee solicits comments from the herpetological community on all aspects, in particular the choice of a convenient site and content of the congress. Potential hosts for the congress are also invited to communicate. Further announcements will be published in this journal.

Address comments or questions to any member of the Planning Committee or to the Secretary-General: Professor Kraig Adler, Cornell University, Section of Neurobiology and Behavior, Seeley G. Mudd Hall, Ithaca, New York 14853, U.S.A.



Adult male '<u>Lacerta</u>' <u>australis</u> (PEM R3860; 121mm TL) from Olifants River Mountains (3219CC Keerom).

W.R. Branch



Subadult Hawksbill turtle (<u>Eretmochelys</u> <u>imbricata</u>) from Storms River Mouth, Tsitsikama Coastal National Park, killed by an octopus. Note the damaged left hind flipper.

C.D. Buxton

C-8 Honolulu Star-Bulletin Monday, September 10, 1984

Octopuses Kill 2, Reportedly

WELLINGTON, New Zealand (AP) — Two fishermen from the Pacific island nation of Kiribati were recently killed by giant octopuses that held them underwater until they drowned, according to a newspaper report today.

The New Zealand Herald newspaper said the two men, armed with spears, were hunting for octopuses when some of the sea creatures caught hold of them and forced them under the water.

The report did not say when the two men were killed.

Kiribati Natural Resources Minister Babera Kirata was quoted as saying the octopuses were three or four yards long, much bigger than the kind the islanders traditionally kill for food.

Kirata was quoted as saying fishermen usually hunt for the creatures by letting the octopus cling to them, then surfacing and killing the creature by biting a nerve between its eyes.

"We are going to have to find another way of killing octopuses," Kirata was quoted as saying.

Kiribati is a republic consisting of 33 islands scattered across 2,400 miles of ocean near the equator.

AUG 28, 1984 WEEKLY WORLD NEWS

150 islanders killed and 22 boats destroyed in wake of savage attacks by giant devilfish

20-ton stingray hunting human prey

More than 150 South Pacific islanders have ɜen killed in savage attacks by a freakish mon-er of the ocean depths — a 20-ton stingray!

The murderous beast — which can crush a fishing awler like an eggshell — is believed to be a mutation sulting from America's A-bomb test on Bikini atoll in 46.

According to witnesses who ıve seen the incredible mon-er explode from the water ce an erupting volcano, the ingray is almost 200 feet long om its snout to the tip of its hip-like tail and has a wing-an that rivals that of a B-29 mber.

The latest report said at ast 22 fishing boats have en destroyed by the huge vilfish. All but two of the fa-l attacks have occurred in e waters surrounding the ilippine Islands.

The other two attacks oc-rred in the Marshall Islands the east, which leads experts believe the creature was awned in the nuclear con-minated waters off Bikini.

One of those attacks was on an overloaded ferryboat carrying 53 islanders. The 47-foot wooden vessel was smashed to smithereens by the enraged stingray. There were no survivors.

A Philippine gunboat dispatched from Manila to track down and kill the creature hasn't been seen or heard from in over a week and is presumed to be lost.

Fisherman Jose Moranas is one of only a handful of people who has encountered the monster and lived to tell about it. It was a nightmare he said he will never forget.

"No one can imagine the terror I felt when that beast flew out of the water," he said. "His body was so huge it blocked out the sun!

"On its first leap, it missed my boat by only a few yards. But when its immense body slammed back into the water, it created a wave that flipped my boat over like a toy.

"My wife Bella and her brother Carmano were on the boat with me. But suddenly we were all in the water, clinging to the mast of the overturned boat.

"Then the beast made another leap and it crashed down with full force on the boat. Everything seemed to explode in my head and I was plunged deep below the surface.

"I had to struggle with all my strength to get back to the surface.

"When my head came out of the water, my boat was gone and only splinters remained.

"Bella was clinging to our fish box and I swam over to her. We never saw her poor brother Carmano again.

"We drifted in the water for

'His body was so huge it blocked out the sun'

six hours, waiting for the beast to return to finish us. But it did not come back.

"Then finally, another fishing boat spotted us and we were saved.

"But I don't think I will ever go out on the water again. I know that thing is still out there . . . waiting."

The Philippine government has ordered three of its largest gunboats into the out islands. They are equipped with sonar tracking devices and armed with depth charges.

"We have also ordered the dispersal of surface and sub-surface mines," an official in Manila said.

"They will soon be deployed. It is only a matter of time before the creature hits one and blows itself to pieces."

— MICKEY McGUIRE

PREDATOR FILE

CSIRO
MARINE LABORATORIES

Division of Fisheries Research
Division of Oceanography

202 Nicholson Parade, Cronulla, N.S.W.

A Division of the Institute of Animal and Food Sciences
A Division of the Institute of Physical Sciences

PO Box 21, Cronulla, N.S.W. 2230
Telephone (02) 523 6222 Telex 24875

JS/JH FG1/2/21 5 October 1982

Dr G.H. Balazs
University of Hawaii at Manoa
P.O. Box 1346
KANEOHE
Hawaii 96744

Dear Dr Balazs,

Thank you for your letter together with enclosed information and reports on turtles.

Any information on turtle captures from the Taiwanese gillnet fishery would be obtainable through-

Dr Colin Grant
Department of Primary Industry
CANBERRA, ACT 2600

However, I suspect the data would only be rough numbers taken, and would only apply to the times Observers were actually on board the vessels. Although the Taiwanese are meant to record turtles on their log sheets I suspect they don't do so unless an Observer is actually checking on them.

Any time that I am on board I will try and collect more detailed information for you, as well as letting you know of turtles occurring in shark stomachs from all sources.

Yours sincerely,

JOHN STEVENS
Research Scientist

CSIRO
MARINE LABORATORIES

Division of Fisheries Research — A Division of the Institute of Animal and Food Sciences
Division of Oceanography — A Division of the Institute of Physical Sciences

202 Nicholson Parade, Cronulla, N.S.W.

PO Box 21, Cronulla, N.S.W. 2230
Telephone (02) 523 6222 Telex 24875

JS/JH FG1/2/21 16 August 1982

Mr G.H. Balazs
Hawaii Institute of Marine Biology
University of Hawaii at Manoa
P.O. Box 1346 - Coconut Island
Kaneohe, Hawaii 96744
U.S.A.

Dear Mr Balazs,

Thank you for your letter of 30th July enquiring about turtles in shark gillnets and shark stomachs.

No turtles were caught in the gillnet survey we reported on in 'Australian Fisheries' (April 1982) nor did any occur in the stomachs of those particular sharks. However, the Taiwanese have operated a gillnet fishery (taking principally sharks) in the Arafura Sea since the 1970's. Turtles occur not infrequently in the catch although the Taiwanese are supposed to release any caught, or not take them on board if they are already dead. Whether they do or not, when observers are not on board, is another matter.

As part of an ongoing shark programme all stomach contents are routinely examined. Turtles certainly occur in the diet of tiger sharks '*Galeocerdo cuvieri*'. I don't have data from the gillnet fishery to hand (although the number of tigers taken is very low) but just to give you an idea I enclose some details from other cruises. I could provide you with more detailed records eventually, should you require them.

Hope this is of some help.

Yours sincerely,

John Stevens

JOHN D. STEVENS
Research Scientist

enc.

TURTLES FROM TIGER SHARK STOMACHS

1) Of 30 tiger sharks examined off Sydney one specimen (299cm TL ♂) contained turtle remains.

2) Of 9 tigers taken off Scholl Island, Western Australia on 7-8/12/79, four contained turtle remains (2.3-3.8m sharks).

3) 27/11/80. A 320cm TL tiger taken in the trawl in the Gulf of Carpentaria contained turtle remains.

4) March 1982. A 186.5cm tiger caught on a longline off Port Hedland, Western Australia, contained 1 whole *Chelonia depressa* (20cm carapace length).

University of Hawaii at Manoa

Hawaii Institute of Marine Biology
P.O.Box 1346 • Coconut Island • Kaneohe, Hawaii 96744
Cable Address: UNIHAW

August 31, 1982

Dr. John D. Stevens
Research Scientist
CSIRO Marine Laboratories
P. O. Box 21
Cronulla, N.S.W. 2230
AUSTRALIA

Dear Dr. Stevens:

Many thanks for your letter of 16 August answering my inquiry about sea turtles in driftnets and in the stomachs of sharks. I appreciated the information that you provided. Two reports that I have authored on these topics have been enclosed in order to give you a perspective for our area of the Pacific.

Needless to say, I am quite interested in obtaining more data on the sea turtles taken by the Taiwanese driftnet fishery in the Arafura Sea. You indicated that observers are periodically aboard these vessels, consequently I am wondering if records exist on numbers, species, sizes and survival rates of sea turtles accidentally taken. Perhaps you can tell me who to write to for these data, if they were gathered.

Yes, if and when your time permits, I would appreciate receiving the records of turtles found in tiger sharks from the gillnet and longline fishery. The record that you sent me of a 20 cm whole flatback turtle found in a shark in Western Australia is, I believe, of special importance. I have pointed this out to my former colleague and friend, Dr. Bob Johannes, in Western Australia. He will probably also be contacting you on this interesting subject.

Again, thank you for your continuing help.

Sincerely,

George H. Balazs
Assistant Marine Biologist

GHB:md

QUESTION: *While diving at a depth of 30 feet off the British Virgin Islands, I saw a 1-inch tangled ball of branchlets on a sea whip. Could the ball-like knot have been the intertwined arms of a basket star?* P.B., Port Edwards, Wisconsin.

ANSWER: Based on your description, you almost certainly saw one of the basket stars in the family Gorgonocephalidae. During the day, these echinoderms frequently hide among the rocks, sponges, hard corals (scleractinians), and horny corals (gorgonians) of a tropical reef. At night, basket stars spread out their finely branched arms to feed. When they hide on a sea whip, or other branched gorgonian, basket stars usually form a tight knot of arms and gorgonian that only they can untangle, when they are ready to feed or move on.

30 feet = 9 meters; 1 inch = 2.54 centimeters 1.63(2)/1.64(4)/3.65 3763

QUESTION: *After catching a 10.5-foot tiger shark, I opened its stomach and found several 6-inch-diameter pieces of turtle shell in it. Would the shark eventually have digested the pieces of shell?* H.W., Rockledge, Florida.

ANSWER: Tiger sharks are capable of digesting turtle shell, crustacean carapace, bone, and molluscan shell, according to Dr. Samuel Gruber of the University of Miami Rosenstiel School of Marine and Atmospheric Science. Gruber has observed samples of all these items in various stages of digestion in the stomachs of tiger sharks. In addition, he has observed undamaged squid beaks around which a thick coating has been secreted, apparently to protect the shark's stomach until the material is regurgitated. 1.52(3) 3764

10.5 feet = 3.2 meters; 6 inches = 15.2 centimeters

QUESTION: *What is the use of the frontal "barbel" on the head of chimaeras?* M.B., Berkeley, California.

ANSWER: The clublike organ on the head of male chimaeras only is not a true barbel, since it is not sensory in nature. The chimaera head projection, which is distinctive in each species, is thought to be used in courtship, as a frontal clasper that leaves obvious scars on the female following mating. All male fishes in this group also have pelvic claspers that are used in internal fertilization.

The chimaeras, sometimes called ratfishes, were once thought to be an evolutionary link between the sharks and the bony fishes, having characteristics of both groups. They are now thought to be highly unusual cartilaginous fishes in a separate subclass, the Holocephali, or "whole head." The name is derived from the unique structure of their heads: the cranium is fused to the upper jaw.

Chimaeras have cartilaginous skeletons, and lay their internally fertilized eggs in horny egg cases. They are elongate fishes, with slender tapering tails. They swim poorly, moving with undulations of the tail and second dorsal fin. 1.52(6) 3765

Sea Secrets®

An Educational Service
of The International
Oceanographic Foundation

Creatures of the Deep
art show—Planet Ocean lobby
November 29–January 6

* * * * *

IOF Sea Safaris (page 13)
• February 9—Lesser Antilles
aboard tall ship Sea Cloud
• March 14—West African coast
aboard M.S. *Lindblad Polaris*
• Caribbean Concorde Hotels
special rates for IOF members

If you are not receiving SEA SECRETS and wish to do so, please write for information regarding membership in the Foundation to the Secretary, The International Oceanographic Foundation, 3979 Rickenbacker Causeway, Virginia Key, Miami, Florida 33149.

Vol. 28, No. 5
September-October 1984
(Fourth Series)

COPY TO "PREDATION FILE"

1 August, 1986

To: George Balazs

From: John Henderson

Subj: Observations of seal/hatchling interaction

On July 23, 1986 (double check date w/Marilyn) on East Island, Marilyn and I were watching a group of 80-100 green sea turtle hatchlings make their way to the water from a recently erupted nest. The time was dusk...about 2030 hrs (I think), and the location was Sector 2, about 30 m west of the old latrine pier.

A recently weaned monk seal pup was swimming in the shallows, 1-2 m from shore, generally investigating the bottom, and rolling in the waves. The identity of the pup was not determined, hence the precise time after weaning isn't known, but I estimate it had been weaned about a month. As the seal swam back and forth, it came into proximity of a hatchling which had just entered the water. (At this time I jokingly remarked to Marilyn something to the effect of "Let's watch this seal eat a hatchling".) When the hatchling was near the seal's head, the seal wheeled in the water, toward the hatchling, as if to further investigate it. The seal wheeled for about one 360-degree turn, and I lost sight of the hatchling, even though I was watching pretty closely. (It was nearly dark, however). The hatchling disappeared from my view in the surge of water created by the seal when it wheeled around. The seal then continued on towards the pier.

As the seal moved on toward the pier, it did not obviously have anything in its mouth. Weaners at this age won't sieze something in their mouth and immediately swallow it; mouthing an item for some time is generally the rule. Thus, I don't think the weaner actually ate the hatchling, or even siezed it in its mouth, but certainly investigated it for at least the 5 sec or so the weaner was wheeling around, after which time the weaner probably lost track of the hatchling.

Other hatchlings were entering the water in the vicinity as the weaner rolled in the waves and swam back & forth, but I saw no other incidents. Furthermore, it did not appear that the weaner had seen the hatchling prior to swimming toward it, but merely encountered the hatchling by chance. Nonetheless, because weaners often investigate items by "mouthing" them, I would say that an encounter such as this could result in mortality of a hatchling if the weaner were sufficiently "interested" and able to maintain sight of the hatchling.

Marine Turtles of Micronesia — Pritchard

limestone islands in the Palau lagoon. The principal nesting months are July and August, but some nesting takes place in June and September, and a few may nest in any month of the year. Their nesting site fidelity is reported to be strong, and they nest at approximately fifteen day intervals two or three times in a season. Favored islands include Eomogan, where Jeff June saw three turtles nesting in one night in late August 1975, and Ngerugelbtang Island, where the turtles often walk the length of a long sand spit before reaching a nesting area safe from tidal inundation. Other islands sometimes used for nesting include Aulong, Ngeangas, Ngobadangel, Unkaseri, and Abappaomogan.

Douglas Faulkner reports that hawksbills are plentiful in the Palau lagoon, and may be seen virtually every day by a competent scuba diver. Immature hawksbills are also reported to be numerous in the Kayangel Lagoon. However, Robert Owen, Conservation Officer for Micronesia and resident in Palau since 1949, reports a gradual but steady decline in abundance. Natural predators are relatively few, and no natural egg predators have been reported. However, the young turtles are doubtless preyed upon by fish and birds, and the larger ones are sometimes eaten by crocodiles *(Crocodylus porosus)*; Owen reported that about 6 of the 300 crocodiles shot during a control project some years ago contained fragments of hawksbills in their stomachs. Human pressure, moreover, is intense. Jim McVey (in. litt. to G. Balazs, December 3,1974) writes that "A conservative estimate of human predation on nests in Palau would be 80%." Adult turtles too are highly persecuted. Although the Trust Territory Code forbids capture of nesting turtles or of individuals under 27" in length, enforcement is almost non-existent; Robert Owen reports that he would be in personal danger if he attempted to enforce the law, but that he is still trying to persuade storekeepers on Palau not to sell hawksbill products. Nevertheless, almost any group of Palauans out in a motor boat will drop all other activities if a turtle is spotted, and will give chase, catching the turtle by spearing it. An entire carapace will sell for about $75; considerably more if it has been embellished with elaborate carvings. The efficiency of the islander turtle hunting technique is well described by Wilson(1976) as follows:

> On islands such as Palau and Ponape, turtles in shallow areas are often chased by outboard motorboats. Fishermen stand in the bow, hanging on to a line searching for them, while the boat travels at high speed across the reef flats. For a turtle discovered here, escape is all but impossible as the water is usually shallow, the reef flat, and sometimes a mile or so wide. A high-speed chase follows during which the turtle is eventually speared by the skilled fishermen.

The hawksbills are caught partially for food, but principally for sale as souvenirs and handcrafts. Tourism increased almost 300% with the advent of reliable air service to Palau in the early 1970's, and many of these tourists are from Japan; the Japanese appear to have an insatiable appetite for hawksbill products. Those Americans who purchase hawksbill products are liable to have them confiscated on arrival back in Honolulu, and probably rather few are purchased now with the intention of importing them to the U.S.

Sporadic attempts have been made to increase the productivity of hawksbills in Palau by means of "head-starting" programs. The earliest such attempt, recorded by an Anonymous author (1957), was made by a Palauan businessman named Lomisang in 1955. The purpose was to raise hatchling hawksbills to a commercially valuable size, and to return 10% to the ocean as a conservation measure. At one time Lomisang had as many as 700 turtles in his pond on Pelelieu; however, the scheme lacked official sanction, being technically illegal since it involved raiding natural turtle nests. Moreover, local people discovered his turtles and he suffered from theft, and the obtaining and preparation of food for the young turtles became prohibitively expensive. When a storm destroyed the Pelelieu shark file

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

3/24/82

To : George

From: Larry

In reference to the NE Region "contract" for Chesapeake Bay sea turtle see Molly Lutcavage's MA Thesis acknowledgements.

If a report exists, I'll see if I can get a copy and send to you.

TRANSMITTAL FORM CD-82A (10-67)
PRESCRIBED BY DAO 214-2

☆ U.S.GPO:1979-0-665-010/1207

To George Balazs
for info...:
get Molly's permission
to cite , OK

THE STATUS OF MARINE TURTLES IN CHESAPEAKE BAY AND VIRGINIA COASTAL WATERS

A Thesis

Presented to

The Faculty of the School of Marine Science

The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

---

by

Maryellen Lutcavage

1981

ACKNOWLEDGEMENTS

Many thanks to my committee members Jack Brooks, Bart Theberge, Marvin Wass and Chris Welch for their guidance. Barbara Crewe, Claudia Walthall, Nancy Peters, Annette Stubbs, Ann Rooney Char, Ron Ayres, Barry Truitt, Bill English, Bill Walls and Jim Owens deserve recognition for logistic and moral support.

For their special contributions to this effort I wish to thank my major professor Jack Musick for direction and encouragement, and Mo Lynch, who provided initial support for studying sea turtles in Virginia. Vic Zullo (University of North Carolina) and John Killingley (Scripps) graciously donated their time for barnacle analysis. I am especially grateful to friends who have shared the indescribable delights of turtle patrols, and to Joe Sypek, Gene Burreson, Dave Zwerner, Don Hayward, Butch Jones, and Gary Gaston for solving mysteries.

This work was supported by a grant-in-aid from Sigma Xi, the Scientific Research Society, New Haven, Connecticut and by a fellowship stipend from the National Marine Fisheries Service.

NMFS / NE REGION "CONTRACT" FOR CHESAPEAKE BAY STUDY.

ABSTRACT

The Chesapeake Bay serves as a seasonal foraging ground for subadult loggerhead (Caretta caretta) and Atlantic ridley (Lepidochelys kempii) sea turtles. The abundance, distribution, activities, and mortality of loggerhead, ridley, and leatherback (Dermochelys coriacea) turtles were examined. Sea turtles occur in the study region from May through November, with peak abundance in June. Based on commensal organisms and isotope analysis of barnacles, Virginia loggerheads may be derived from nesting beaches in the southeastern U.S.

Substantial sea turtle mortality occurs in Virginia. In 1980, of a total of 828 turtles counted, 288 were carcasses. Major identified mortality sources were accidental capture in poundnet hedging, boat damage, human-induced injury, and predation by the tiger shark (Galeocerdo cuvieri).

Seventy-seven sea turtles were tagged and released, with six recaptures in the Chesapeake area. Two forms of incidental catch in poundnets create management problems for Virginia sea turtles.

death difficult. Out of 145 carcasses examined in 1979, the following have been identified as likely causes of death:

7 or	5%	dead in poundnet hedging, including one ridley and one leatherback.
9	6%	damaged by boats or propellors.
3	2%	found with bullet wounds.
1		died after rod and reel capture.
1	<1%	loggerhead died with a fractured skull inflicted with a blunt object.

For 1980, out of 214 carcasses, the following sources of mortality have been identified:

64 or	30%	dead in poundnet hedging
15	7%	damaged by boats or propellors
7	3%	killed for sale of carcass
1		died in haul seine
1	<1%	died after long line capture
2		one loggerhead and one leatherback were found entangled in crab pot lines.

Two loggerheads survived head wounds inflicted by humans. There is unconfirmed evidence that a few turtles were killed by gunshots.

Predation

Members of the Virginia Beach Sharkers club and other sport and commercial fishermen have reported findings loggerhead parts in the stomach of the Tiger shark, Galeocerdo cuvieri, taken off Virginia Beach and the Eastern Shore. Club members reported that tiger sharks "almost always" have loggerheads in their stomachs.

One tiger shark landed on 7 September 1980 contained the relatively intact remains of three moderate sized loggerheads (Jack Randolph, personal communication). I have found several loggerhead

Are sharks feeding on turtle corpse's killed or drowned by other means or actively chasing down "live" loggerheads?

carcasses with large crescent-shaped wounds that had healed over. These were most likely inflicted by sharks.

In 1980 two loggerheads (carapace length estimated at 70 cm based on skull size) were found in the stomach of a tiger shark landed off Chincoteague, Virginia. Loggerheads have been recorded from Galeocerdo in North Carolina (Gudger, 1949) in New England by Shoop (1980) and in Hawaii by Balazs (1979). Tiger sharks are most common in the Virginia coastal area in the late spring and early summer (Lawler, E.F., Jr. 1976; Musick, unpublished data) and may take loggerheads as they travel through coastal waters. No other natural predators of larger loggerheads are common in the study region.

Incidental Catch and Poundnet Study

In 1980, a minimum of 284 sea turtles were reported captured alive in the head of poundnets in the study area. Seventy-five or about 26% of those were tagged before release. Three tagged turtles, including one tagged by R. Byles after long line capture (K555), were *L. kempii* and 72 were *C. caretta*. Only one male, a loggerhead from the Potomac River mouth tagged in late summer, was reported captured.

Sizes of measured sea turtles captured by watermen ranged from 46.0 to 102 cm carapace length straightline (CLS, N=43), with a mean carapace length of 61.4 cm. This value falls only slightly short of the overall mean for area loggerheads CLS=65.4 cm (N=123). Tagged turtle carapace length frequencies are provided in Figure 18. A ridley captured in a poundnet measured 40 cm CLS and K555 measured

Oct 4 5-B ~24" CL Turtle in stomach - Flesh mostly Dissolved.

GENUS - Epinephelus Family - Serranidae

A74

WINNERS AND LOSER, AFTER ONE-HOUR FIGHT—Roland Kouke, second from left, was swimming 30 feet under water off West Molokai when he saw this 450-pound sea bass heading for him. "I freaked out," the Maunawili man said. After a one-hour struggle, he and his three friends, Jay White, Harold Fenton and Kurt Mench, succeeded in spearing the fish and getting it to the surface. And without SCUBA gear, too.

Neighbor Island News

Catch of the day: 554-pound sea bass

KIHEI — Russell Mori, a Kihei housepainter, has a fish story that none of his friends is likely to match for a long time.

Mori on Tuesday night hauled in a 554-pound giant sea bass after a one-hour, 47-minute fight on an ulua pole using 60-pound-test line.

It's probably a record for Hawaii, and is a near world record.

Dan Trapp, a fishing buddy who was with Mori Tuesday, said the world's record for sea bass is 563 pounds for a fish caught off California.

And Mori might have held the record if he and Trapp hadn't bled the fish when they brought it in. But they weren't thinking of records, only of making the giant a little easier to carry.

Mori was shore fishing and using an octopus head for bait on a relatively small Mustad hook, Trapp said. But Mori swam the line out, taking it about 150 yards from shore in 40 to 50 feet of water.

When the fish hit, he said, they knew immediately that it was not an ulua. Instead of quick, hard pulls, the fish just pulled slowly and steadily, dragging the line out of the reel, he said. They guessed that it might be a sting ray and worried when Mori couldn't turn it, because he had only about 325 yards of line on the reel, Trapp said.

"When he brought 'em to shore, I went down to look and I told him, 'Eh, you wen' hook one baby whale,'" Trapp said.

The fish was sold to Upcountry Fishery, which has resold it to Erik's Seafood Broiler in Lahaina. But first it is supposed to go on display, possibly in tomorrow's Makawao Rodeo parade and then at the restaurant.

Holo Honokowai deal: Maui County Council members have accepted an agreement negotiated with the owner of the Holo Honokowai apartments to provide at least 48

Predation File

Free Diver Captures 384-lb Giant Sea Bass

by Dan Robertson

Dan Robertson's big sea bass was a grueling physical ordeal.

■ I think it's only fair to say thanks to Dr. Newbell at Straub Hospital. He did major surgery on my head and ear earlier this year. He also said I wouldn't dive again; but when I mentioned just how much diving meant to me he told me at least to go slowly, which I did.

So here goes my story. My old friend Miguel Munoy and I were working together and diving when we were able to find the time. Because Miguel expressed some interest in shooting a large ulua, I took it upon myself to show him the ropes or at least the places that were so successful for me in the past.

On one particular day we had a late start and didn't get going until noon. The ledge we chose was way out in about 70 feet of water, and there were several caves in the ledge. As we took off from the point toward the deep, I noticed the current was running in a southerly direction, which was quite unusual because the current there consistently ran in a northerly direction.

I have always had the best luck shooting large ulua when the current was running the strongest. At one time or another, I have seen every kind of game fish you can think of—tuna, mahimahi, ono, and even large sharks.

As we pulled our way up the ledge I noticed that I was in poor physical shape and wasn't sure I could even reach the caves. But I continued on. I had very short bottom times throughout the dive. The first three caves were empty, but I noticed something on the ledge so I kept going against the current. The small reef fish were staying very close to the top of the reef, and they were very jumpy. That has always meant that some kind of predator was cruising the area. So with the most active cave still ahead we pulled on. About 100 yards before the cave I spotted a bass just under a shallow ledge. It appeared to be at least 100 lbs, so I quickly asked Miguel to hold onto the back of my trailing line. I had never seen this type of fish before, so it was hard to estimate its size. I really pushed myself just to make the depth and get off a solid shot. I was able to do that, but the shot was not good enough. I quickly realized the fish was much bigger than I had first thought, and I had missed the brain. In my hurry to return to the surface the fish headed north at such a pace there was no chance to stop it or even slow it down, for that matter. Miguel and I just looked at each other in disbelief. I remember thinking that I had just lost a new gun, which had taken quite a bit of time to make and wasn't even mine. (I had made it for a friend.) I figured if the fish had been hurt badly enough it just might stop at the cave, which was up ahead. As I pulled myself toward the cave I saw my trailing line tangled on the reef just in front of the cave. I really thought the fish had broken it off, but as I looked closer I saw the gun floating parallel to the bottom instead of straight up, which was how the gun would have floated if the fish had broken free. As I dove down to free the tangle I looked toward the cave opening. The fish was there looking quite a bit bigger than anything I had dealt with in the past.

I pulled the tangle free and headed for the surface. Once there I tried to pull the fish from the cave. I knew that if the bass headed for deep water, which was very close, we would have very little chance of stopping the fish. I told Miguel to be ready to help. As I pulled, the fish ran deeper into the cave. I heard the high-pitched scream of 600-lb test cable running across the roof of the cave. Shortly thereafter I heard the popping sound of the cable breaking. In the meantime Miguel had shot a kahala that had come by to see what all the excitement was about.

I knew I could only make a few dives at this depth. That would give us very little chance to bring the fish home. The fish had not left the cave, so as Miguel reloaded I dove to relocate the fish. It had moved deeper into the cave. My next shot entered the fish just behind the gill plates, and once again I tried to pull the fish from the cave.

The run that followed was short but powerful. The fish pulled itself free but in doing so hurt itself badly. I saw blood exiting the mouth of the cave, so I reloaded and dove again. Each time I went down the fish seemed to grow larger. That time I shot the fish just behind the head. As I returned to the surface I kept the line as free as possible.

Once on the surface I tried to pull the fish free again. After several minutes I was able to bring it out the front of the cave. At that point I noticed the spear was badly damaged and the fish was on by just one barb. I slowly pulled the fish toward the surface. When the fish was about 5 feet from the top, both barbs fell off the spear and the fish came free. I grabbed onto the original spear, which was still in the fish's head, and tied the bass off with my trailing line.

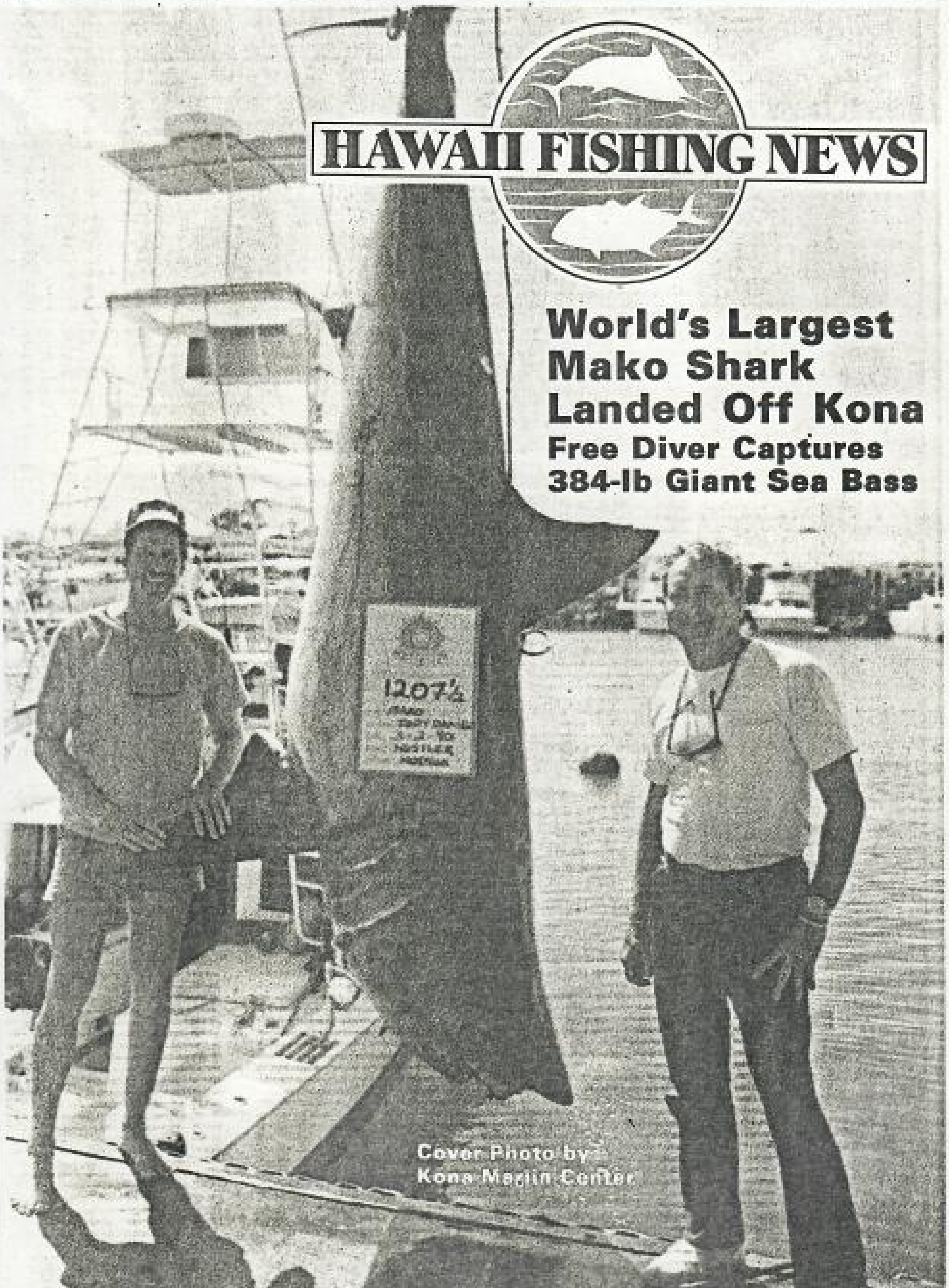
At that point the fight was pretty much over and the hard part began. We pulled the fish half a mile through the current toward shore. Then we found out that it wasn't much fun loading a fish that size into a pickup truck. We took our fish to the ice house to weigh in. The bass weighed 384 lbs, and that included a 25-lb turtle it had swallowed whole.

. . . Dan

HAWAII FISHING NEWS

World's Largest Mako Shark Landed Off Kona

Free Diver Captures 384-lb Giant Sea Bass



Cover Photo by: Kona Marlin Center

April 1990
Volume 15, No.3
$2.50
0 74470 66778 04

29 May 90

Hi George

Thanks for sending the copy of the article. I had not seen it, although I was aware that turtles are prey of large groupers. I have never seen this large species, Epinephelus lanceolatus, in Hawaii. However, I have seen photos of it that were taken in relatively shallow water, and the closely related E. itajara in the tropical Atlantic lives in shallow water. So if this species is common in Hawaii I would expect it to have been seen more often than it has. The smaller E. quernus is common on shallow reefs in the NWHI and on deeper reefs around the major Islands, but there is no evidence that the much larger E. lanceolatus has a similar distribution.

Best wishes,

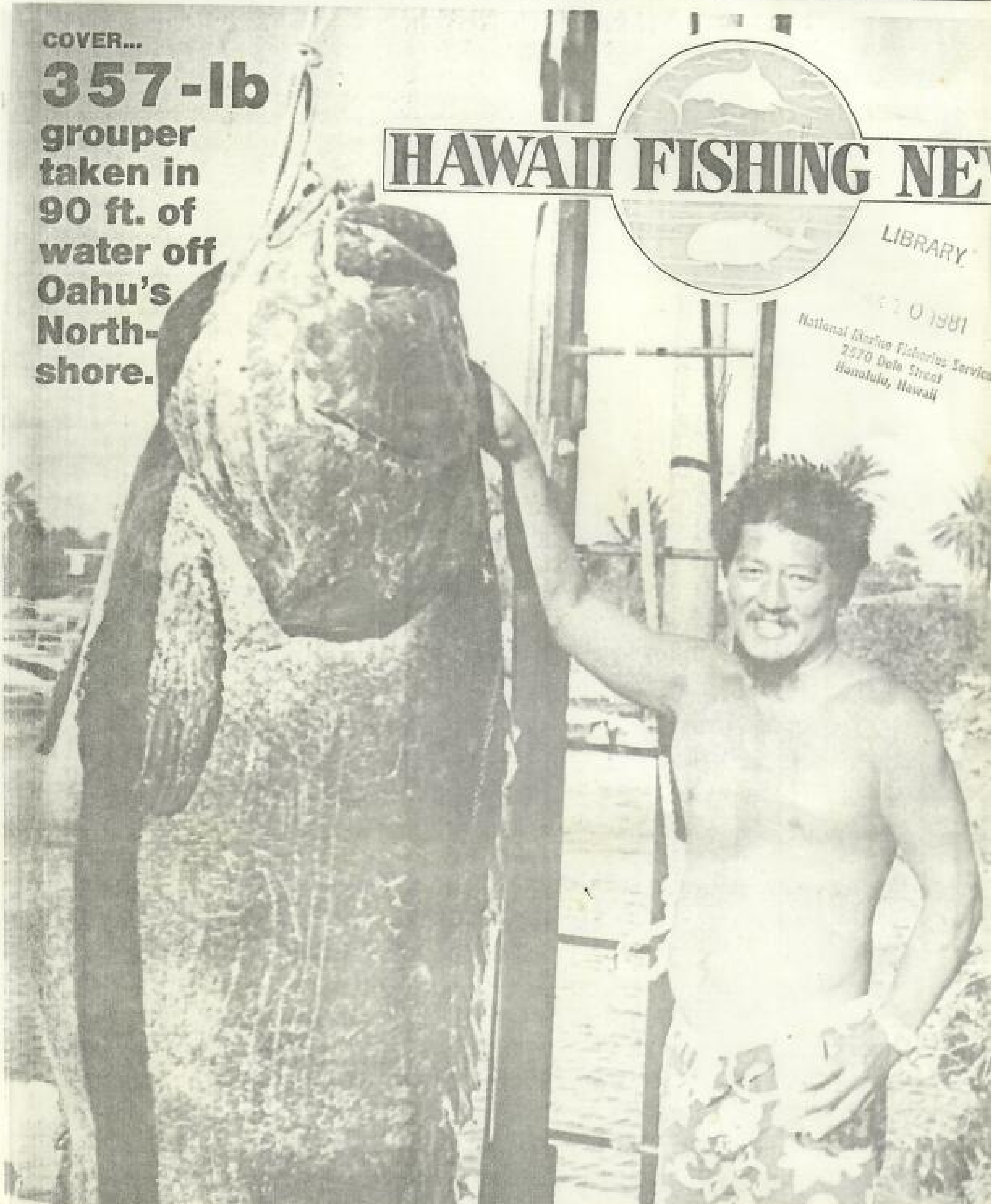
Ted

File- Johnson, Chuck

MARCH 1981
Volume 6 Number 2

HAWAII FISHING NEWS

COVER...
357-lb grouper taken in 90 ft. of water off Oahu's North-shore.



COVER STORY

NORTHSHORE DIVER BAGS 357-lb. GROUPER

by Chuck Johnston

■ First reported in **HFN** by Alana McKinney (Oahu's Northshore, January 1981), we've been in search of a photograph and finally came up with one with the help of Les Walls and Richard Keller.

Richard Keller, also a member of the **Hui Lu'u Kai Dive Club**, gave this account of the capture of the 7-foot 357-lb. giant sea bass:

Club members Charlie Hookala and Vernon Kim were snorkeling in about 90 feet of water, looking for schools of taape and weke to surround with nets for sale to local markets, when Charlie came swimming back to the dive boat yelling for a tank and spear gun.

He had just spotted the big sea bass near the bottom of an open sandy area. When Charlie returned to the area, the large bass was still cruising, presumably also in search of smaller prey. When Charlie descended to the bottom, gun in hand, the grouper approached as if to size him up as a possible entree. Instead Charlie gave him a close-range shot to the head which caused the 300-pound-plus giant to take off full speed ahead and directly into a vertical wall of coral reef. Now aided by diving companion Vernon Kim, another shot to the dazed monster's head and the prize was captured.

The fish was sold at auction the following day for better than a dollar a pound.

EDITOR'S NOTE: The **Hui Lu'u Kai Dive Club** is a member of the **Hawaii Council of Dive Clubs.** The club is currently seeking new members, current membership is 35. The club meets the first Thursday of each month at the **Haleiwa Sands Restaurant** near Haleiwa Beach Park, just south of the old bridge. For more information, contact Richard Keller evenings (ph. 623-2774).

In an attempt to further identify the species and find out additional pertinent data about the fish, I contacted Dr. Jack Randall of the Bishop Museum.

Dr. Randall's first reaction was one of hope that he could get the specimen in whole to be preserved for positive identification and future study. As earlier stated, this one had already been baptized in shoyu sauce and fed to the multitudes. We would like to ask that if in the future, any **HFN** readers capture such a prize, that they call Dr. Jack Randall (phone: bus. 847-3511 or res. 235-1652). He will see that credit is given to the donor or the museum will purchase it for a dollar a pound for a large specimen in good condition.

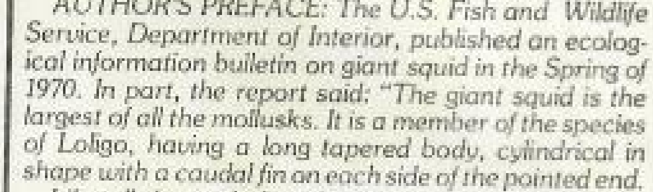
Dr. Randall guessed from the size and description that the grouper was probably of the *Epinephelus lanceolatus* species which has been often misidentified as *Epinephelus tauvina.* Unfortunately the Bishop Museum has in its possession only a head cast of one of these huge fellows, and until now no good photographs. If an angler or diver doesn't want to give up his catch the museum would still be very grateful for photos of any large groupers taken in state waters. **HFN** would like to publish and then forward these pictures if available.

"The Sea Mo[...] Nightmare of [...] Mel Yoshida"

by KANI EVANS
Hawaii's Outdoor Reporter

AUTHOR'S PREFACE: The U.S. Fish and Wildlife Service, Department of Interior, published an ecological information bulletin on giant squid in the Spring of 1970. In part, the report said: "The giant squid is the largest of all the mollusks. It is a member of the species of Loligo, having a long tapered body, cylindrical in shape with a caudal fin on each side of the pointed end.

Like all the cephalopods, it has ten arms or feelers bearing suction cups which help the squid to capture its food. Giant squid are found in the open sea of the warm oceans of the world and very few people have seen one of these huge creatures alive. Sometimes, dead giant squid are washed ashore on beaches and people coming upon them tell stories of having seen great sea monsters.



The giant squid is pale gray in color and its body is covered by red spots. As with the smaller members of the squid family, it has a sac of inky fluid and, when the squid is alarmed or angry, its red spots become brilliant in hue and it emits great clouds of the inky fluid as it literally jets away from its enemies. Scientific records indicate that the giant squid grows to be about 20 feet long and its great arms stretch out to approximately 35 feet in front of the creature's head."

■ It was Tuesday, February 10, 1981. The seas around Oahu were in terrible shape. Increasing southwesterly winds were whipping the waters into a seething mass of

Dan[...] ramp. [...] *ALOH[...]*

A fe[...] over s[...] way to[...] tained [...] the re[...] elevate[...] of twis[...] ing to [...]

The [...] the ha[...] hull an[...]

Unde[...] treache[...] that, w[...] closed [...] ever, s[...] with a [...] seat on[...] faced a[...]

The [...] of the [...] *LEI AL[...]* The litt[...] impact [...] back of[...] to side.

Fortu[...] the boa[...] turned [...] toward [...] surroun[...] spray bl[...] *LEI AL[...]* and pau[...] ing out [...]

dazed monster's head and the prize was captured.

The fish was sold at auction the following day for better than a dollar a pound.

EDITOR'S NOTE: The **Hui Lu'u Kai Dive Club** is a member of the **Hawaii Council of Dive Clubs.** The club is currently seeking new members, current membership is 35. The club meets the first Thursday of each month at the **Haleiwa Sands Restaurant** near Haleiwa Beach Park, just south of the old bridge. For more information, contact Richard Keller evenings (ph. 623-2774).

In an attempt to further identify the species and find out additional pertinent data about the fish, I contacted Dr. Jack Randall of the Bishop Museum.

Dr. Randall's first reaction was one of hope that he could get the specimen in whole to be preserved for positive identification and future study. As earlier stated, this one had already been baptized in shoyu sauce and fed to the multitudes. We would like to ask that if in the future, any **HFN** readers capture such a prize, that they call Dr. Jack Randall (phone: bus. 847-3511 or res. 235-1652). He will see that credit is given to the donor or the museum will purchase it for a dollar a pound for a large specimen in good condition.

Dr. Randall guessed from the size and description that the grouper was probably of the *Epinephelus lanceolatus* species which has been often misidentified as *Epinephelus tauvina*. Unfortunately the Bishop Museum has in its possession only a head cast of one of these huge fellows, and until now no good photographs. If an angler or diver doesn't want to give up his catch the museum would still be very grateful for photos of any large groupers taken in state waters. **HFN** would like to publish and then forward these pictures if available.

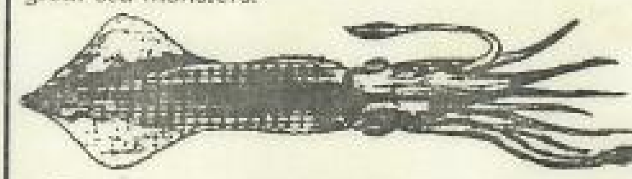
I mentioned to Dr. Randall the fact that the large fish approached the diver in a fearless manner and also that Dr. Dick Brock of Kaneohe had cautioned me regarding tales of large groupers being known to swallow people. This brought an interesting and blood curdling third-hand account of a story that came out of Durbin, South Africa via Israel. The story, so it goes' is that one of the local natives, who often swam off a pier, disappeared suddenly after entering the water. the very next day what seemed a strange coincidence occurred when a second swimmer disappeared quickly and unexpectedly in the same manner. These two mishaps caused curious and concerned locals to be more observant than normal of the waters around and under the pier. Two giant groupers were soon spotted. Evidently they had taken up residence beneath the pier. Next came the anglers whom were successful in hooking and capturing one of the pair. And, you guessed it, the stomach contents of the big fish contained skeletal remains of one of the missing swimmers.

Richard tells me that Hui Lu'u Kai club members have seen groupers estimated to be in excess of 500 lbs. in northshore waters and this particular species is reported to obtain lengths of 12 feet. Needless to say, caution is advised if by chance you happen across one of thes fellows while diving in his domain

. . . Chuck

AUTHOR'S PREFACE: The U.S. Fish and Wildlife Service, Department of Interior, published an ecological information bulletin on giant squid in the Spring of 1970. In part, the report said: "The giant squid is the largest of all the mollusks. It is a member of the species of Laligo, having a long tapered body, cylindrical in shape with a caudal fin on each side of the pointed end.

Like all the cephalopods, it has ten arms or feelers bearing suction cups which help the squid to capture its food. Giant squid are found in the open sea of the warm oceans of the world and very few people have seen one of these huge creatures alive. Sometimes, dead giant squid are washed ashore on beaches and people coming upon them tell stories of having seen great sea monsters.



The giant squid is pale gray in color and its body is covered by red spots. As with the smaller members of the squid family, it has a sac of inky fluid and, when the squid is alarmed or angry, its red spots become brilliant in hue and it emits great clouds of the inky fluid as it literally jets away from its enemies. Scientific records indicate that the giant squid grows to be about 20 feet long and its great arms stretch out to approximately 35 feet in front of the creature's head."

■ It was Tuesday, February 10, 1981. The seas around Oahu were in terrible shape. Increasing southwesterly winds were whipping the waters into a seething mass of whitecaps. Large ocean swells had caused a high surf watch for the north and west shores of all islands.

Mel Yoshida, a retired industrial mechanic living in Kaneohe, peered out at the dark wax paper sky and, for a moment, he felt a twings of disappointment. He and his friend, Danny Maeda, another windward Oahu fisherman, had planned to go fishing today. Mel's boat, a 13-foot 8-inch long outboard, sat on the trailer out in the driveway. It was all fueled up and the portable icebox was filled with ice.

Mel, a veteran boatman and fisherman, had gone to sea for the day on many occasions when the waters of the windward side had been in bad shape and the husky 240-pound skipper had always come back with fish on ice.

Shortly after 6:00 am his rig rolled to a stop in front of Danny Maeda's house and Mel's grinning partner eased into the seat, slamming the door behind him. "Eh, howz it?" he asked. Mel just nodded and grunted. The two men and the boat turned off the highway and rolled out onto the big pier at Heeia Kea Harbor. There were no other boats at the launching ramp and the swirling winds caused a metal sign to rattle where it was attached to a light pole. The larger boats, tied up in their slips alongside the cement pier, heaved and rocked in the early morning light as the wind wooed through their superstructure and low hanging clouds scudded off to the northeast.

A few
over sm
way to t
tained o
the remo
elevated
of twisti
ing to th
The w
the hard
hull and
Unde
treacher
that, wh
closed t
ever, so
with a g
seat on
faced a
The t
of the s
LEI AL
The litt
impact
back of
to side.
Fortu
the boa
turned t
toward
surroun
spray bl
LEI AL
and pau
ing out
The s
as the *L*
the ocea
brown b
and a t
two fish
schools
wheel a
There
he does
130-pou
—excep
fish—ar
lures an
the year
rainbow-
plastic p
measure
ing it to t
water ar
suddenly
other. H
brake fo
if a fish
Mel pa
rest of th
high, cu

SLP - 259-7933

Lionel - 533-1327

Henry Rosa -
396-6665

Hawaii Fishing News
1314 South King
Suite 1256
-96814

Tel. 521-672

ISLAND

OF PASSAGE

CHARLES VALENTINE visits an historic outpost at the crossroads of the Great Barrier Reef.

ON DECK at seven ... bright sun and calm sea .. the morning a simple pen and wash of turquoise shallows and pale cerulean skies. The innocent yellow beach beyond the bow is Pandora Cay, now unsuccessfully renamed.

The sands form a low plateau. There are a few driftwood coconut palms and yesterday, shallow waves nudged a dozen thin translucent scutes from the carapace of a Hawksbill turtle against the edge. As the thin plates of tortoiseshell clicked together the slight sound carried in the sussuration of wind across the reef flats.

I knew the Bounty mutineers had been locked in a cage when the *Pandora* foundered on this reef in 1791. Four drowned. Yesterday, I learned that the 10 mutineers who survived and landed here were denied shelter with the *Pandora's* crew. Each day they buried themselves to the neck in that yellow sand. Imprisoned by heat, light and immense space, they lived within a succession of such slight sounds. Without hope, their humanity a delusion, the mutineers survived to reach trial in London. Four were acquitted and six hanged.

Still at anchor in the lee of the deep fishhook-shaped reef south-east of Pandora and due north of Raine Island ... banks of low cloud on the rim of the sea and the low sun hot and direct as it lifts above them ... the wind 15 to 20 knots, as ever from the southeast.

In spite of the mawkish gallantry of its name, *Explorer II* is a comprehen-

Etched against Raine Island's historic tower, a seabird flees the author's approach.

QUANTAS

sively suburban twin-hulled power boat, with huge drinks refrigerators aft and waterproof carpets for'rard of a spacious kitchen. Not a ship to evoke dreams but a comfortable enough platform for endless photographs of coral cays and notes on old envelopes.

At 8am I could see Raine Island tower on the horizon, a slight vertical mark on an horizon break of white water at the edge of the Coral Sea. After days of watching the flat passage of seabirds from treeless cays, the distant tower claimed the wide prospect. At 10 miles it measured only a small fraction of a little fingernail held at arm's length against the intense light, enough to snare all the fine threads of the seas beyond the bows of *Explorer II*.

These were the sudden deeps of a safe passage through the northern reefs that brought a nondescript sand cay into maritime history 150 years ago.

At 8.30am we lost the lee of the reef and made for Raine in the diesel dump of a drowsy sea. Everyone crowded the bridge but John Cornelius went to the after galley to sit out the awkward roll with his books.

I was used to seeing him work alone. He counted the winter-nesting birds wherever we landed. Late in the morning I watched him begin work on Raine. He walked westward across the wide sands windblown to the nor-west of the tear-shaped island, a small and diminishing figure. White and black seabirds rose about him, disturbed by a

single human on the beaches of their sanctuary. Three species of boobies flew beneath a high layer of soaring frigate birds and then white terns lifted through a cloud of black noddies. The skies of Raine became a paperweight snowstorm. Counting had begun.

Such a mass of birds above a single cay signals a mass of fish to sustain them. We had reached a pulse of uncommon strength in the southwest Pacific. The deep surge that punches through the Raine Island passage lifts

A frigate bird, right, soars on a thermal current. The grave of Annie Eliza Ellis, below, wife of one of Raine's 19th Century managers, reminds visitors of the island's previous importance.

rich waters from a 2000 fathom drop-off on the ocean side of this thin strip of sand and grasses. Each year its force carries turtle hatchlings from Raine across northern Australia to the Arafura Sea and northwards into Melanesia.

Debris of animal life lies everywhere across the 21 hectares of Raine Island and John Cornelius was now in the central depression beyond the dune. He counted nests and young in the seabird smell of guano, old bones and long dead turtles and worked within the day-long shrieks, the pipes and random rattles, the anger and despair of seabirds.

He walked in a flat hot desert dotted with mounds of broken rock and earth left by guano miners when digging stopped here in 1892. Ten thousand tons of the rich fertiliser was lifted from Raine in two years. John Cornelius has an eye for such traces. On other cays he had shown me rocks set as fireplaces by Europeans for boiling beche de mer for trade with China.

Beach rock forms on the cays as guano phosphates leach through coral sand. This is the grey-white phosphatic rock quarried by 20 convict masons to build the tower in 1844. Skilled stonemasons cut more of it and repaired the crumbling upper courses of the tower in 1987. The original British Admiralty plans show a roofed and slash painted tower set on a small treeless sandbank. The tower was unmanned and unlighted but for several years it was the crucial turning point for sailing ships out of Sydney Cove bound for Batavia, Bengal and China.

Today frigate birds soared in the tower's silent thermals as John Cornelius walked toward it beneath a screaming umbrella of gulls and terns.

He had written notes for a history of this cay and walked within the dimension of his studies. In 1841 John MacGillivray, here as naturalist on H.M. Corvette *Fly*, described Raine as "one of those vast breeding places of birds, of which none but an eye-witness can form an adequate idea ... so thickly strewn with eggs we could not walk about without occasionally crushing them underfoot".

Masked boobies, one of many bird species nestling on Raine Island which is the largest seabird rookery in Australian waters.

The Bounty's brutal sequel

PANDORA Cay, adjacent to Raine Island, has a curious place in naval history because of its link with the infamous mutiny on the Bounty.

The mutiny occurred on 28 April 1789 in mid-Pacific when rebellious crewmen seized the British warship *Bounty* and forced its master Captain William Bligh into the ship's 23-foot longboat.

Bligh and the 19 crewmen who remained loyal to him were set adrift with meagre provisions: 28 gallons of water, 150 pounds of bread, 32 pounds of pork, six bottles of wine and six quarts of rum.

Defying the odds, Bligh sailed the open boat 3618 miles to Timor and eventually returned to England. The British Admiralty then sent the 24-gun frigate HMS *Pandora*, under the command of Captain Edward Edwards, to find the mutineers and bring them to England for trial.

During its return voyage, the *Pandora* sank after striking the Great Barrier Reef at night. Four of the mutineers drowned while still manacled in the small round deck-house prison known as Pandora's Box.

After 19 days on Pandora Cay, the survivors set sail in four small boats for Timor. During the voyage the mutineers were deliberately starved and tied without shelter to the boats' floors. Their trials at Portsmouth in September 1792 established an enduring public interest in Bligh's character, the ferocious maritime discipline of the day and the subsequent history of those Bounty mutineers who escaped to establish their own world on Pitcairn Island.

Raine Island is the great seabird island of Australian waters and now the world's last great nesting ground of the green turtle. Turtles lay their eggs on Raine Island each summer, sometimes in exceptional numbers.

Dr Alastair Birtles, of Townsville, landed here in 1974 on his way back from an expedition to the Torres Strait. At night he found the beach thick with turtles. "We were walking on turtles . . . all one could hear was the swish of the sand and the slap of their flippers on their carapaces. There was a great tropical storm coming up with pillars of black cloud and their backs were just glistening in the full moon".

Turtles in such numbers strip Raine Island of its grasses, herbs and shrubs and the early beaches, he said, looked like a tank battle field the morning after. There have been further exceptional seasons since 1974 but the cycle is still unexplained.

Today was another day, another season. In July the turtles ranged beyond the Arafura and Coral Seas to Indonesia, Melanesia and the open Pacific. The sands of Raine ran smooth and steep from a low ridge to a broken line of beach-rock along the northern shore.

At 10.20am I waded up to the clean

Seabirds at Raine

A S I came up from Orford Ness, in the
diesel dump of a drowsy sea.
Green thoughts of distant days lay in the wake,
As palm and fibro dwindled in the lee.
Beyond the pearlers, the tower of Raine,
I knew the night and know again,
Out here where the brimming reef flats run,
Under the moon, beneath this sun,
Sorrows and seabirds weave as one.

— **CHARLES VALENTINE**

sand again for the first time since the high summer of 1976. At that time I used to swim here, watching schools of silver angel fish about my hands and feet. As I began to walk toward the tower I remembered the day I renounced this simple pleasure and stopped swimming. In the reef-flat shallows it seemed that a jammed outboard was smashing a partially submerged ship's dory on hidden rocks. In fact, it was a tiger shark breaking and eating the complete shell of a fully grown turtle.

As clouds passed across the sun and shadows fell across the cay, the tower dimmed and brightened. The weathered stone pulsed with the day's succession of slow and sudden changes in light energy from the sun.

Without scale, the distant tower appeared far higher than its true 45 feet and this illusion persisted until I stopped near a drifted rainforest tree on the steep shelving sand. Three white skeletons, turtles which had toppled from the low beach rock cliff, lay on their backs stretched in the rigor of their dry deaths beneath the horizontal slats of a government notice.

The sign cut the dark shadow of the single entrance and the tower suddenly lost its illusory proportions. Once again it stood in scale with the fortifications of Raffles' Singapore and Batavia and the earlier beacons of an English Channel alive with preparations to receive a Spanish armada.

The British Admiralty held to ancient models as its new forts and beacons reached a wider world. One of them, a stone tower also with 45 courses of masonry, has stood at Naxos in the Cyclades since the days of Hellenistic Greece.

Today the Raine Island tower stands as it was built in 1844. Elsewhere there has been innovation and change but this tower soon became redundant. A safer northern passage to Torres Strait was charted within a few years of the Raine tower's completion and, in little more than a hundred years, with compasses, sextants and all brass-bound instruments of survey and dominion long packed away, the world's fourth and final great maritime empire began to fold its flags and honors.

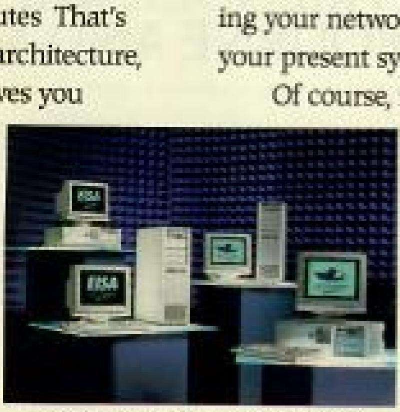
The tower on Raine Island was left to the perpetual winds and the passage of seabirds. I had reached a rare and significant relict of early implacable resolution.

Charles Valentine is a Melbourne-based freelance writer.

AST Upgradeability. It Takes You From 386SX To 486/33 In Minutes.

Only AST offers a 386SX™ computer that upgrades to i486™ power — and beyond — in minutes. That's because only AST features Cupid-32™ architecture, our patent-pending technology that gives you the flexibility you need to keep pace with your changing CAD/CAM/CAE requirements.

Filled with power, the Premium® 386SX/16 boasts a 16 MHz, 80386SX™ processor, 16 KB cache memory architecture, and support for an 80387SX™ coprocessor. And since it's a member of AST's family of Cupid-32 desktop and tower computers, our Premium 386SX/16 can be easily upgraded. With a single, simple board swap, you can advance to the next level of power or all the way to our Premium 486/33E, featuring Extended Industry Standard Architecture, an integrated 80387™-compatible coprocessor and up to 48 MB of RAM.



AST offers an entire family of award-winning Premium 386SX, 386™ & i486 systems.

Thanks to Cupid-32 upgradeability, you can now increase your CAD/CAM/CAE capabilities quickly and conveniently without transferring files, disrupting your network or altering the compatibility of your present system.

Of course, instant upgradeability isn't the only reason to buy an AST Premium computer. There's also our quality, reliability, and outstanding support. It's all part of AST's commitment to our customers.

Don't wait another minute. For more information on AST's Cupid-32 systems, call **61-2-418-7444**.

AST® COMPUTERS

The Power Of Choice.

Corporate Headquarters: AST Research Inc. 16215 Alton Parkway, P.O. Box 19658, Irvine, CA 92713-9658, USA. Tel: 714-727-4141
AST Asia/Pacific Room 2902, Citicorp Centre, 18 Whitfield Road, Causeway Bay, Hong Kong. Tel: 852-8064333 **AST Europe Ltd.** AST House, 2 Goat Wharf, Brentford Middlesex, TW8 0BA, England. Tel: 44-81-568-4350

Sales Offices: AST Research ANZ Pty Ltd. • Unit 5, 706 Mowbray Road, Lane Cove, NSW 2066, Australia. Tel: 61-2-418-7444 • Level 7, 195-201 Willis Street, Wellington, New Zealand. Tel: 64-4-845294

Addendum to report to the U. S. Marine Mammal Commission:
Predation on the Hawaiian Monk Seal by L. R. Taylor and G. L. Naftel

ANALYSES OF TURTLE PARTS RECOVERED FROM SHARK STOMACHS SAMPLED AT PEARL AND HERMES REEF AND FRENCH FRIGATE SHOALS, NORTHWESTERN HAWAIIAN ISLANDS

Internal Summary Report

by

G. H. Balazs
Hawaii Institute of Marine Biology
June 1977

Introduction

During April and May 1977, shark fishing was conducted at Pearl and Hermes Reef and French Frigate Shoals in conjunction with investigations of shark predation on the Hawaiian monk seal, *Monachus schauinslandi*. Dr. Leighton Taylor and Mr. Skip Naftel are the co-investigators of this research project, with the vessel EASY RIDER being used for capture operations.

Preliminary examinations of stomach contents by the co-investigators revealed that eight of the sharks captured had been feeding on sea turtles. All of the sharks involved were identified as large tiger sharks (*Galeocerdo cuvieri*). Turtle parts were subsequently made available to me for evaluation with respect to species, numbers, and sizes of turtles represented. Information on the species and numbers of sharks caught as well as details of other items recovered from the stomachs will be presented elsewhere by Dr. Taylor and Mr. Naftel.

Background

It is well-known that in Hawaii and other areas of the world sea turtles are a regular dietary component of tiger sharks (Sarangdhar, 1943; Gudger, 1948, 1949; Ikehara, 1960; Tester, 1969; Fujimoto and Sakuda, 1971). However, with the exception of several earlier examinations which I have made, no systematic analyses have been conducted of recovered turtle parts in order to gain ecological data relevant to the turtle populations involved. Such analyses have considerable potential for providing information on natural mortality rates by size categories, incidence of turtles at particular locations, carapace colorations, food sources used by the turtles and other important factors. In essence, recovery and analyses of turtle parts from shark stomachs permits access to information that would otherwise be very difficult and in some cases impossible to obtain by other techniques.

Methods

The various turtle parts from each of the eight shark stomachs were visually examined and identified as to particular body structure. Intact parts, consisting principally of scutes (carapace and plastron) and the horny beaks covering the jaws, were measured and compared with specimens from turtles of a known size contained in my reference collection. Estimates were then made of the original sizes of the turtles represented. The number of turtles present in each shark's stomach was determined by the size and incidence of body parts, and variations in the pattern and coloration of scutes.

Findings

Results of the analyses are presented in Table 1. All of the parts were identifiable as having originated from green turtles (*Chelonia mydas*). A maximum of 15 different turtles was found to be present in the eight sharks. The four sharks captured at Pearl and Hermes Reef contained eight turtles, while the four sharks captured at French Frigate Shoals contained seven turtles. A single shark from Pearl and Hermes Reef accounted for five turtles.

The estimated straight carapace lengths ranged from 15 to 37 inches, with three turtles being greater than 32 inches and therefore large enough to have been sexually mature. All three of these individuals were from sharks captured at French Frigate Shoals, the colonial breeding site for Hawaiian green turtles during the months of April to September.

Most of the parts consisted of keratinized structures of epidermal origin, such as scutes and beaks. This suggests that such horny material is more resistant to the digestive processes of tiger sharks than bone and tissue. The length of time that a keratinized structure may be retained in a tiger shark's stomach is an important but unknown factor.

With the possible exception of the distal portion of a left front limb found in shark No. 16, it is logical to conclude that all of the recovered parts represented turtle fatalities. There is, however, the possibility that in some instances mortality may have been unrelated to shark attack and occurred prior to ingestion.

Literature Cited

Fujimoto, M. M. and H. M. Sakuda (1972) The 1971 shark control and research program final report. Division of Fish and Game, Department of Land and Natural Resources, State of Hawaii, 37 pp.

Gudger, E. W. (1948) Stomach contents of tiger sharks, Galeocerdo, reported from the Pacific and Indian Oceans. The Australian Museum Magazine, Sept., 282-7.

Gudger, E. W. (1949) Natural history notes on tiger sharks, *Galeocerdo tigrinus*, caught at Key West, Florida, with emphasis on food and feeding habits. Copeia, 1: 39-47.

Ikehara, I. I. (1961) Billy Weaver shark research and control program final report. Division of Fish and Game, Department of Agriculture and Conservation, State of Hawaii: 25 pp.

Sarangdar, P. N. (1943) Tiger shark - feeding and breeding habits. J. Bombay Nat. Hist. Soc., 44(1): 102-10.

Tester, A. L. (1969) Cooperative shark research and control program - final report 1967-69. University of Hawaii, 47 pp.

Table 1. Results of Analyses

Capture location and shark ID no.	Capture date	Turtle parts present	No. turtles represented	Estimated sizes: straight carapace length (inches)	Estimated sizes: approximate weight (lbs)
Pearl and Hermes Reef					
4	20 April 1977	horny beaks covering jaws; scutes from carapace	5	21	45
				22	60
				22	60
				25	90
				25	90
16	20 April	distal portion of left front limb	1	15	15
20	21 April	portion of carapace and plastron; pelvic girdle	1	16	25
30	23 April	scutes from carapace; portion of rib	1	29	140
Total			8		

Table 1. Continued.

Capture location and shark ID no.	Capture date	Turtle parts present	No. turtles represented	Estimated sizes straight carapace length (inches)	Estimated sizes approximate weight (lbs)
French Frigate Shoals					
54	19 May	scutes from plastron; scale from tail	1	25	90
56	19 May	scutes from carapace	3	21	45
				37	275
				37	275
66	20 May	complete carapace (2); complete head (2)	2	15	15
				16	25
71	20 May	scutes from plastron; rib and vertebrae	1	33	200
Total			7		

Addendum to Analyses of Turtle Parts Recovered
from Shark Stomachs - 20 July 1977 by G. H. Balazs

In conjunction with telemetry studies, additional shark fishing was conducted at French Frigate Shoals during June 1977 by Messrs. Taylor, Naftel and a research associate, Tim Tricas. One of the tiger sharks captured (ID no. 9) was found to contain a juvenile green turtle measuring 16 1/8 inches in carapace length. Except for a severed right front limb, this specimen was recovered intact with little evidence of deterioration from digestive action. In addition, the same shark also contained carapace scutes and partially digested ribs and vertebrae of an adult green turtle estimated to measure 36 inches in carapace length.

Like other data presented in the body of this report, the recovery of only carapace scutes, ribs and vertebrae presents an enigma as to the whereabouts of the remainder of the turtle. Some of the more plausible explanations are listed as follows.

1. Only a portion of the turtle was ever ingested by the shark, with the remainder perhaps being consumed by other sharks.
2. The entire turtle was eaten by the shark, however, pieces were regurgitated either before being hooked or while struggling on the hook.
3. The entire turtle was eaten by the shark and all pieces but those recovered underwent digestive action and passed on along the intestinal tract in an unrecognizable form.

If the keratinized structures are in fact exceptionally resistant to digestion, the last explanation (no. 3) would seem to be the least likely in that only 13 of the 38 carapace scutes (present in *Chelonia*) were found in the shark's stomach. In addition, there were no scutes from the plastron or horny beaks from the jaws. The carapace scutes that were present showed no signs of deterioration from digestion. It is therefore unlikely that structures of the same chemical composition could have undergone such radically different rates of digestion.