# Occurrence, Morphology, and Parasitism of Gastric Ulcers in Blue Marlin, *Makaira nigricans*, and Black Marlin, *Makaira indica*, from Hawaii

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## ABSTRACT

**Gastric ulcers were found in 10 of 114 blue marlin, *Makaira nigricans*, and 2 of 3 black marlin, *M. indica*, examined from 1967 to 1969 at the Hawaiian International Billfish Tournament. Parasitic nematodes were found imbedded in the base of ulcers in one blue marlin and two black marlin. The gross and microscopic morphology of the ulcers is given and possible causes are discussed. The most likely cause is either mechanical injury or parasites, or the effect of both in the same stomach.**

The existence of gastric ulcers in man and other mammals, including marine mammals (Geraci and Gerstmann, 1966) is well known. The existence of gastric ulcers in fish was first noted by Aliverdiev and Radzhabov (1968), Evans and Wares (1972), and Iversen and Kelley (in press). We here report additional details on the occurrence, morphology, parasitism, and possible causes of gastric ulcers in blue marlin, *Makaira nigricans*, and black marlin, *M. indica*, landed from 1967 to 1969 during the annual Hawaiian International Billfish Tournament.

## METHODS

One hundred seventeen marlin were captured during daytime trolling in surface or near surface waters just off the west coast of the Island of Hawaii. Each billfish tournament included 5 fishing days during either July or August. Fishing commenced each day at 0800, but the catch was usually not brought to the weighing station until after 1700 when fishing ended, so there often was a lengthy interval between capture and examination of the stomach. After being weighed by tournament officials, each fish was measured, sexed, and examined for stomach contents. Specimens were not refrigerated prior to examination. The estimated maximum interval between capture and examination of marlin containing ulcers was 7.5 h. Histological preparations were by standard paraffin imbedding with hematoxylin and eosin stain.

## RESULTS

Ten of 114 blue marlin and 2 of 3 black marlin contained ulcers, for a combined occurrence of 10.3%. Sex, weight, and length for each marlin with ulcers are given in Table 1. Two black marlin and seven blue marlin stomachs with ulcers were preserved in 10% Formalin[3] for laboratory examination. Two of the black marlin and one of the blue marlin stomachs examined in the laboratory contained ulcers invaded by small parasitic nematodes, *Contracaecum* sp.?, a roundworm which has been reported in billfish stomachs from widely separated localities (Wallace and Wallace, 1942; Morrow, 1952).

The following brief comments on gross and microscopic morphology are based upon examination of one of the black marlin stomachs which contained numerous ulcers, both with and without nematodes. The comments are also descriptive of ulcers in blue marlin.

### Gross Findings

The ulcers were either separate or in clusters

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[3] Reference to commercial products does not imply endorsement by the National Marine Fisheries Service.



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Table 1.—Record of marlins with gastric ulcers captured at the Hawaiian International Billfish Tournament, 1967-69.

| Date captured | Species | Sex | Wt. | Fork length[1] | Estimated elapsed time, capture to examination |
|---|---|---|---|---|---|
| | | | *kg* | *cm* | *h* |
| 4 July, 1967 | *Makaira nigricans* | F | 151.5 | 303.4 | 5.5 |
| 6 July, 1967 | | M | 141.0 | 290.0 | 3.5 |
| 29 July, 1968 | | M | 67.6 | 224.9 | 6.5 |
| 29 July, 1968 | *Makaira indica* | F | 83.9 | 240.9 | 7.5 |
| 31 July, 1968 | | F | 86.2 | 256.1 | 1.5 |
| 1 Aug., 1968 | *Makaira nigricans* | M | 92.5 | 256.8 | 5.0 |
| 2 Aug., 1968 | | M | 67.6 | 230.3 | 3.0 |
| 2 Aug., 1968 | | F | 189.1 | 315.7 | 6.5 |
| 2 Aug., 1968 | | F | 102.0 | 270.3 | 7.5 |
| 21 Aug., 1969 | | M | 102.0 | 268.2 | 6.5 |
| 21 Aug., 1969 | | M | 66.7 | 236.4 | 6.5 |
| 22 Aug., 1969 | | M | 68.5 | 235.3 | 7.0 |

[1] Tip of snout to center of distal edge of caudal fin.

throughout the stomach (Fig. 1). They were noncancerous. Edges were indurated and raised slightly from the surrounding surface. Ulcer margins were rather sharply demarcated. The bases were covered with a dark brown shaggy material and had an indurated feel. Light gray nematodes 5-7 mm in length and less than 0.5 mm in diameter were imbedded in the bases of four ulcers in this stomach (Fig. 2). The bases of the ulcers were very indurated and the induration extended through the wall of the specimen.

## Microscopic Findings

The base of this ulcer was covered by granulation tissue with a dense proliferation of fibroblasts and an infiltration of acute and chronic inflammatory cells (Fig. 3). The fibrous proliferation extended through the entire wall and obliterated the usual muscular layers. Remnants of the nematodes were identified throughout the ulcer base. Generally, there was an intense granulomatosis inflammatory reaction surrounding the parasite. This consisted of inflammatory cells and histiocytes. In some instances the inflammatory reaction had subsided and only laminar layers of fibrous tissue remained (Fig. 4).

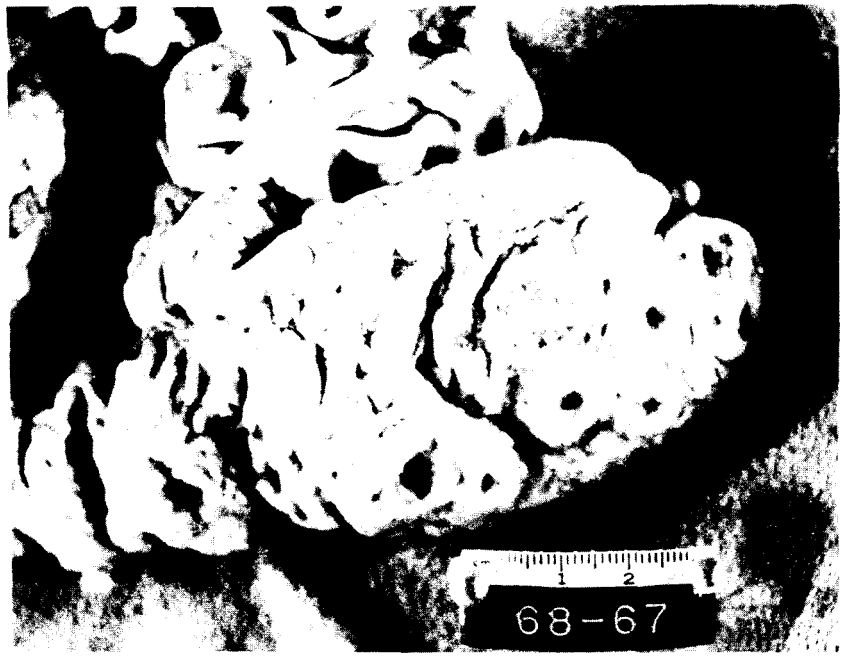


Figure 1.—Multiple ulcerations varying from 3 to 13 mm scattered over the mucosal surface of a stomach from a female black marlin. Weight of marlin 86.2 kg; fork length 256.1 cm.

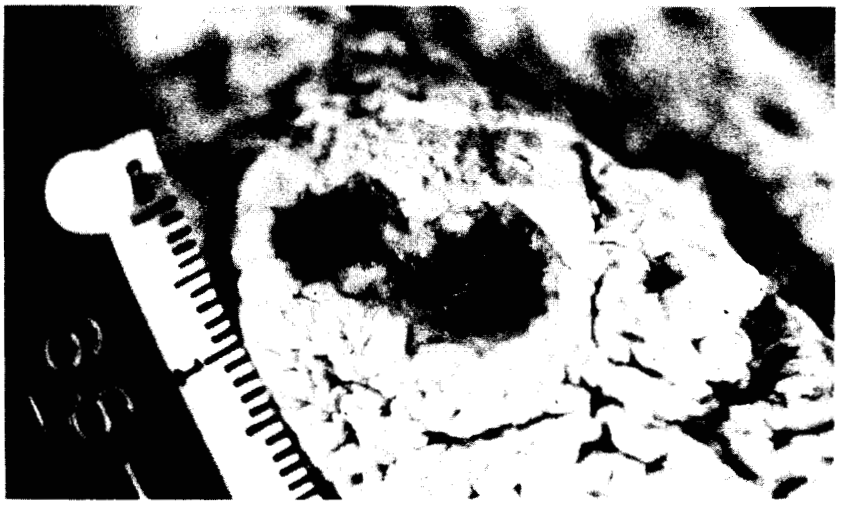

Figure 2.—Closeup view of same black marlin stomach showing nematodes burrowing in base of ulcer.

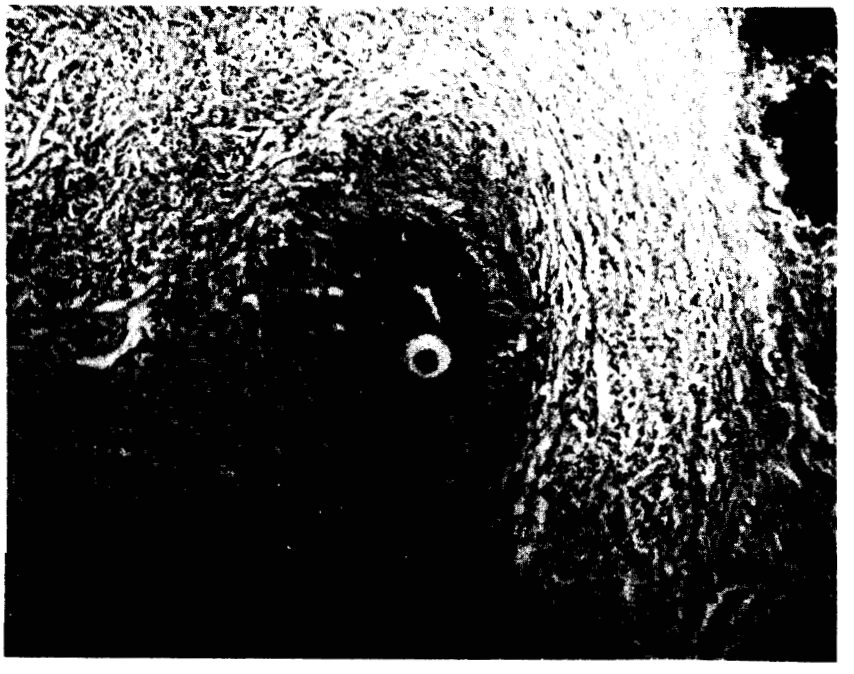

Figure 3.—Microscopic section of base of ulcer from same black marlin showing extensive fibrosis and subacute inflammatory response surrounding portions of nematode sectioned in two areas (H & E stain, 25×).

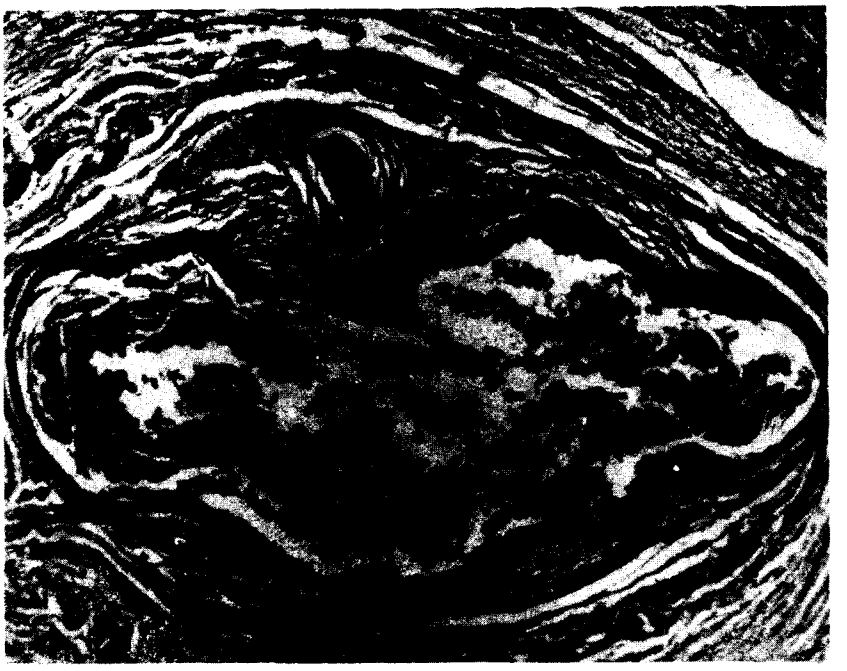

Figure 4.—Microscopic section of base of ulcer from same black marlin showing extensive fibrosis laminated around old nematodal debris (H & E stain, 25×).

## DISCUSSION

Several possible causes of the ulcers may be considered. They are (1) mechanical injury to the stomach lining from sharply pointed food items, (2) parasites, (3) digestive processes due to gastric secretions between the time of death and time of examination, and (4) excess gastric secretions.

The most likely cause is either mechanical injury or parasites, or the effect of both in the same stomach. Blue and black marlins feed heavily on fish, many having sharply pointed projections. Examples are the dorsal spines of skipjack tuna, *Katsuwonus pelamis,* and yellowfin tuna, *Thunnus albacares*. Both of these tunas are commonly eaten by marlins. We have recovered a sliver of bonelike material from beneath the epithelium of the stomach of a marlin captured during a billfish tournament. Other examples are the spiny puffers, Diodontidae, which sometimes occur in marlin stomachs. Spiny puffer remains were found in one of the stomachs containing an ulcer, and it is possible that multiple punctures of the stomach lining could occur after engulfment of such food. Multiple punctures could also be caused by engulfment of prey items with sharp spines during successive feedings. This could explain instances of multiple ulcers in some of the marlin stomachs. For example, the black marlin stomach shown in Figure 1 had six ulcers wider than 10 mm and over 50 smaller ulcers less than 10 mm wide.

Evans and Wares (1972) reported finding gastric ulcers in 14% of 563 striped marlin, *Tetrapturus audax,* and 22% of 151 sailfish, *Istiophorus platypterus,* examined in Mexican and southern California waters in 1968. They did not, however, cite the presence of nematodes, either in stomachs with or without ulcers. They also suggest spines of prey species may have caused the ulcers.

In those ulcers containing nematodes, it is uncertain if the ulcers were caused by the nematodes, or if the nematodes took advantage of the ulcer and burrowed inward. Other workers have found a high percentage occurrence of nematodes in marlin stomachs without citing the presence of ulcers. Wallace and Wallace (1942) found *Contracaecum incurvum* in 60 of 86 stomachs of white marlin, *T. albidus,* captured off Ocean City, Maryland. Morrow (1952) reported finding *C. incurvum* in each of 53 stomachs of striped marlin, *M. mitsukurii* ( = *T. audax*), from New Zealand. If this nematode causes ulcers, its association with ulcers should be common, which is not the case, according to pub-

lished reports. This implies mechanical injury is the most likely cause, with the ulcers being further aggravated in those stomachs containing parasitic nematodes.

Digestive action by gastric secretions after death is another possibility, but it seems highly unlikely the large size of some ulcers could develop even during the lengthy interval between capture and preservation of the stomach. For example, the 83.9 kg black marlin captured in 1968 had one ulcer that was 40 mm long, 27 mm wide, and 10 mm deep (measurements after preservation in Formalin). In addition, 30 nematodes and necrotic tissue were present in the pit of this ulcer.

High concentrations of free circulating histamine might possibly cause ulcers by increasing gastric acid secretions. It is known that histamine has an ulcerogenic effect on warm-blooded animals (Hay et al., 1942). Geraci and Gerstmann (1966) have suggested that histamine from a diet of inadequately preserved fish caused gastric ulcers in a captive bottle-nosed dolphin, *Tursiops truncatus*. Fresh fish contain negligible amounts of histamine, but under conditions of inadequate preservation, decarboxylation results in the formation of histamine from histidine (Geraci and Gerstmann, 1966). Since marlin feed on fresh fish, it seems unlikely much of the prey's histidine may find its way into the marlin's blood stream as histamine. Further, the effect of histamine on gastric secretions in teleosts is unknown. In the spiny dogfish shark, *Squalus acanthias*, perfusion of isolated gastric mucosa with histamine resulted in an increased secretion of acid 1 to 1.5 times the amount secreted by isolated dogfish gastric mucosa not perfused with histamine, but high concentrations of histamine were required (Hogben, 1967).

Increased gastric secretion from behaviorally induced stress conceivably might have an ulcerogenic effect on marlin. The average sex ratio of blue marlin landed during Hawaiian International Billfish Tournaments from 1962 to 1972 has been 3.3 males:1 female, while blue marlin caught by commercial fishing in subsurface waters in Hawaii have an almost 1:1 sex ratio (Strasburg, 1970). It has been suggested the unequal sex ratio of blue marlin caught during the tournaments may indicate a spawning aggregation. Such an aggregation conceivably might be stress-inducing but this is highly speculative and probably unrelated to ulcer occurrence. Adequate data on the sex ratio of black marlin are not available.

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