Evidence for Attacks by the Bathypelagic Fish Anotopterus pharao
(Myzophiformes) on Pacific Salmon (Oncorhynchus spp.).

D.W. Welch, L. Margolis, M.A. Henderson & S. McKinnell
Biological Sciences Branch,
Pacific Biological Station,
Dept. of Fisheries and Oceans,
Nanaimo, B.C.
Canada V9R 5K6

Submitted to the
INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION
by the
CANADIAN NATIONAL SECTION

October, 1991

This paper may be cited in the following manner:
Welch, et al. (in press). Evidence for attacks by the bathypelagic fish Anotopterus pharao
(Myzophiformes) on Pacific salmon (Oncorhynchus spp.). 11 p. Canadian Journal of
Fisheries and Aquatic Sciences. (Document also submitted to the Annual Meeting of
the International North Pacific Fisheries Commission, Tokyo, Japan, October 1991)
ABSTRACT

Adult Pacific salmon (Oncorhynchus spp.) returning from offshore waters to spawn frequently bear a wide range of wounds and scars. One of the most common wounds is a single slash-mark on the posterior third of one side of the body, running postero-ventrally from near the dorsal fin at a roughly 45° angle. The evidence is reviewed for the occurrence of slash-marked salmon around the Pacific Rim over the past 30 yrs. A jaw fragment removed from the wound of a slash-marked sockeye salmon (O. nerka) and identified as belonging to a daggertooth (Anotopterus pharao: order Myctophiformes), a highly modified bathypelagic fish, provides the first direct evidence for the cause of these wounds. Given the frequency of slash-marked adult salmon in coastal fisheries, A. pharao may be a significant cause of mortality in Pacific salmon that has previously gone unrecognized.

INTRODUCTION

Pacific salmon with unusual slash marks have been caught in coastal and high-seas areas of the North Pacific for many years (Sano 1959a, b; 1960; 1962; Jewell 1961; Fiscus 1963; Seibel et al. 1984; Gilhousen 1989; Henderson et al. 1990). In 1990, approximately 5% of adult sockeye salmon (Oncorhynchus nerka) caught in coastal waters of British Columbia bore these marks (Henderson et al. 1990), and in some years the prevalence has reached 12% (Gilhousen 1989). A typical slash runs at an approximately 45° angle, occurs on only one side of the body, and appears as if made with a sharp knife (Fig. 1). The slash usually starts posterior of the dorsal fin near the lateral line and extends posterioventrally towards the ventral fin. At time of capture the condition of the wound ranges from fresh, with blood still oozing from the cut surfaces, to completely healed. In many cases the slash is deep enough to cut through the body wall and expose the internal organs (Gilhousen 1989).

The severity of the wound suggests that significant mortality may occur, but the characteristic occurrence of a single slash on only one side of the body is puzzling. We report the first direct evidence for an attack causing such a slash by a daggertooth (Anotopterus pharao), a bathypelagic fish (order Myctophiformes, family Anotopteridae), on sockeye salmon.

DAGGERTOOTH BIOLOGY

Anotopterus pharao is an extremely specialized member of the Myctophiformes, and the only extant member of the monotypic family Anotopteridae. It is broadly distributed throughout the world’s oceans in temperate and sub-arctic waters (Hubbs et al. 1953). A slender, snake-like fish seldom exceeding 85 cm total length and 5 cm in diameter, its diminutive size makes it an unlikely predator on adult salmon, although its night-time presence in surface waters does coincide with the nocturnal distribution of
Pacific salmon. Judging from gillnet catches on the high seas (Neave 1959; Taylor 1959; International North Pacific Fisheries Commission Squid Driftnet Observer Program, 1989-90 unpublished data), *A. pharao* occurs in surface (<10 m) waters of the North Pacific at night, but very little is known about its biology. Rofen (1966, p. 507) suggested that it can readily avoid collecting nets, and is probably much more abundant than catch records indicate. For this reason, circumstantial evidence for its involvement in widespread attacks on the dominant members of the pelagic fish fauna in the North Pacific are of particular interest.

**MATERIALS**

On about 12 August 1990, Captain P. Burgess (P.O. Box 2988, Parksville, B.C. Canada V0R 2S0), while trolling for salmon aboard the F/V Summer’s Retreat southwest of Cape St. James, Queen Charlotte Islands (roughly 51°N, 132°W), caught a wounded sockeye salmon with a fish jaw fragment deeply embedded in its flesh.

Captain Burgess described the wound as a fresh cut running "in the standard way" on an approximately 2.3 kg sockeye salmon. From memory, he drew the slash as extending about two-thirds the depth of the fish, starting below the posterior insertion of the dorsal fin and extending down diagonally into the base of the ventral fin. He stated that when his deckhand tried to clean the fish the knife struck a hard object. They used the knife to dislodge a jaw bone with teeth from the bottom of the wound. The jaw fragment includes both left and right maxillary bones, which carry three and two large teeth, respectively (Fig. 2). Captain Burgess stated that the teeth were oriented downward and buried in the base of the fin with the 4 cm jaw fragment completely embedded in the flesh, and the shattered end of the bone flush with the surface of the wound.

**IDENTIFICATION**

The remarkably reduced bone structure of the jaw and the anteriorly recurved teeth leave little doubt that the fragment is the upper jaw from *Anotopterus pharao* (Fig. 3). In addition, microscopic examination of both the anterior and posterior surfaces of the teeth reveals a series of extremely fine serrations that are also present in preserved *A. pharao* specimens held in collections of the University of British Columbia and the Royal British Columbia Provincial Museum.

**DISCUSSION**

This jaw fragment is the first evidence of an attack by *A. pharao* on Pacific salmon. The report is interesting because the identity of the organism making the characteristic slash marks has been the source of considerable conjecture. Sano (1959a, b; 1960; 1962) and Gilhousen (1989) attributed these slash marks to attacks by the salmon shark (*Lamna ditropis*), but the linear nature of the single razor-like slash and
the location of the wound on only one side of the body makes this identification questionable. These slashes are not surface wounds, but in many cases extend deep into the body cavity (Fig. 1). In most cases there is little evidence of tissue damage other than at the wound site, and scales close to the edge of the slash are undisturbed. If they were the result of a shark attack, multiple deep lacerations would be expected on both sides of the body. In recent years the frequent occurrence of slash marks has prompted some North American fishermen to claim that they are caused by the monofilament gillnets used in the high-seas squid driftnet fishery. However, the wounds are clearly not net marks (personal observation).

From the location and orientation of the jaw fragment, it seems clear that the upper jaw became embedded in the pelvic girdle after cutting through the body musculature. Presumably, this provided sufficient leverage for the sockeye to shatter and tear off the jaw. Both the orientation and 4 cm depth of the wound are consistent with the characteristic diagonal slash marks found on many other sockeye salmon. Although Captain Burgess did not save the salmon from which the jaw was taken, his description of the wound is consistent with others described from salmon throughout the North Pacific. Because of Captain Burgess’ forthright and consistent description of events, we have no reason to question the veracity of the facts as reported to us.

Anotopterus pharao has been mentioned by Hartt (1980, p.52) as a potential predator on juvenile salmon and a possible source of “predator scars” on salmon; however, no justification was given for including A. pharao in a list of salmon predators. Hartt did not examine the stomach contents of A. pharao, but in a telephone discussion during preparation of this report he stated to one of us (D.W.W.) that on two occasions he had observed A. pharao “attached” to the side of adult salmon caught by long-lines on the high seas (A.C. Hartt, 308 Alderwood St., Coupville, Wash. USA 98239, personal communication). This further strengthens our view that A. pharao may be responsible for at least some of the wounds observed in coastal fisheries during the return spawning migration.

The unusual forward curve to the maxillary teeth of A. pharao, with their finely serrated edges, are clearly adapted for cutting the flesh of prey. In preserved specimens the left and right maxillary bones are closely parallel, and the teeth are spaced such that they give the appearance of a single tooth row running down the medial line of the mouth. This arrangement of a single row of forwardly curved maxillary teeth on a strongly reduced and fragile jaw, plus the small size of the mandibular teeth, suggest that A. pharao usually releases its prey after attacking. It is possible that it first cripples its prey by cutting through the body musculature before attempting to feed. The morphology of the jaws is also consistent with the repeated observations of a single deep slash wound that occurs on only one side of the body of salmon.

Wounds to the opposite side of the body are not reported in the literature describing slash wounds on salmon. We have found no information on the feeding
behaviour of *A. pharao*, but the fine needle-like teeth on the mandible (Fig. 3) would seem to be ill-adapted for holding strongly struggling prey because of their small size, and their retrorse orientation is in striking contrast to the orientation of the maxillary teeth. Marks left by the mandibular teeth of *A. pharao* may be relatively inconspicuous and therefore overlooked in descriptions of the slash marks, or it is possible that *A. pharao* initially attacks in such a way that the teeth of the lower jaw do not come in contact with the body. Closer examination for the presence of teeth marks on the side of the body opposite to that carrying the slash marks is clearly needed.

CONCLUSIONS

Based on a comparison of the jaw fragment with preserved specimens, we estimate the total length of the daggertooth was roughly 80 cm. *A. pharao* is carnivorous, and its distensible stomach and unattached pectoral girdle allow it to swallow large prey (Rofen 1966). Two specimens of *A. pharao* measuring 75 and 82 cm caught in Davis Strait (Northwest Atlantic region) were found to contain two (28 and 30 cm in length) and three (unmeasured) *Paralepis coregonoides* (Postolakii 1962). Nevertheless, a 2.3 kg maturing sockeye salmon is almost certainly too large for an 80 cm *A. pharao* to swallow, and the loss of much of the upper jaw indicates that attacking large prey is not without risk. However, *A. pharao* may be capable of feeding successfully on smaller salmon of size similar to that of the prey reported by Postolakii (1962). As up to 12% of adult sockeye salmon returning to British Columbia waters each year bear slash marks, the potential significance of *A. pharao* as a cause of mortality for juvenile Pacific salmon therefore needs to be evaluated.

ACKNOWLEDGMENTS

We thank Captain P. Burgess and the crew of the F/V Summer’s Retreat for bringing the jaw to our attention, and for their forbearance with our repeated questions. We also thank Drs. R. Carveth, A. Peden, and N.J. Wilimovsky for provision of reference material from their research collections, Mr. A.C. Hartt for sharing his field observations on *Anotopterus*, and Mr. E. Warneboldt for his expert photography.
LITERATURE CITED


Fig. 1. Slash-marked adult sockeye salmon caught in the 1989 British Columbia coastal fishery.

Fig. 2. Jaw fragment of the salmon predator. Anterior is to the left, and shattered bone is evident to the right of the last tooth. Both left and right maxillary bones are present, but closely parallel and not separately visible in the photograph. Note the unusual recurved nature of the teeth. Both anterior and posterior surfaces of the teeth have finely serrated edges not evident in the photograph.

Fig. 3. (TOP) Comparison of the jaw fragment with an upper jaw of Anotopterus pharaon, collected from a shark's stomach (University of British Columbia Ichthyological Collection No. BC 60-164). Note the weak bone structure and the recurved teeth.

(BOTTOM) Close up of the head of an adult Anotopterus pharaon, ca. 85 cm FL, taken at 51°N, 175°W on 25 Aug 1956 (Royal B.C. Provincial Museum, Group C30, BC71-123).