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On the record of pug-headedness in snapper, *Pagrus auratus* (Forster, 1801) (Perciformes, Sparidae) from New Zealand

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Pug-headedness in the snapper Pagrus auratus *is reported for the first time from New Zealand, based on a specimen (aged 2$^+$) collected from Whangarei Harbour. Severe damage to the underlying bones of the mouth and snout regions was noted. The mouth of the specimen was virtually closed. Several factors were attributed to the cause of these anomalies among which are genetic and epigenetic causes.*

Key words: skeletal abnormality, pug-hedness, snapper, New Zealand

INTRODUCTION

The snapper, *Pagrus auratus* (Forster), is a major commercial and recreational species in New Zealand (PAUL, 1968). The snapper inhabits warmer coastal waters - particularly in the northern North Island and Bay of Plenty regions. It is mainly caught by bottom longline or trawling, generally from depths of 10-100 meters (SEA FOOD COUNCIL, 2007). Fish developmental anomalies occur in hatchery-raised fish and in wild populations. Comprehensive bibliographies of reported abnormalities were prepared by DAWSON (1964, 1966, 1971).

Pug-headedness is an anomalous condition in fish which has been reported from a broad variety of fish groups (MANSUETI, 1960; DAWSON, 1964, 1966, 1971; WARLEN, 1969; DAWSON & HEAL, 1971; NAKAMURA, 1977; SHARIFF *et al.*, 1986). The condition affects the skeletal formation of the head particularly that of the upper jaw, resulting in an abnormally shorter upper jaw in relation to the lower jaw.

In 1553, Piere Belon (in GUDGER, 1930), the French naturalist, published the first figure of a pug-headed female salmonid. First reports of fish pug-headedness have been discussed by GUDGER (1930).

Since 1553, just over 120 published works reported this condition, mostly from Europe and North America (DAWSON, 1964, 1966, 1971; DAWSON & HEAL, 1971). This is the first report of pug-headedness in a fish from New Zealand.

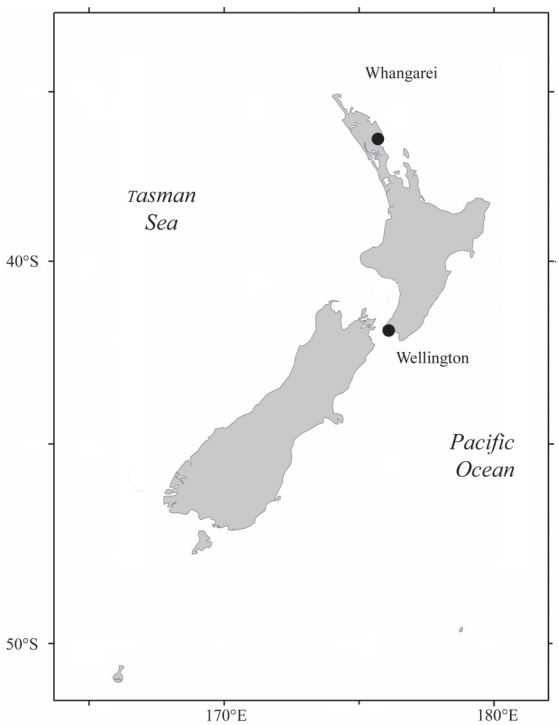

Fig. 1. Map of New Zealand showing the sampling area

MATERIAL AND METHODS

A pug-headed snapper, *Pagrus auratus* (Forster, 1801) (age 2^{+}) was collected on the 4th of November 2005 at 14.2 m depth from station 2WRE015, 35° 49.887'S; 174° 28.997'E in the lower Whangarei Harbour at Mair Bank (Marsden Point) (Fig. 1). The specimen (Figs. 2B, 3) was collected by NIWA as part of a baseline survey of Whangarei. It was collected by small traps and is preserved in the NIWA collection (NIWA 16350). Age was determined using fish scales viewed under a light microscope. A normal specimen (total length 200 mm) was obtained from the same survey (2WRE018; 01/11/2006, 35° 50.069'S; 174° 29.401'E, 9.1m) for comparison (Fig. 2A).

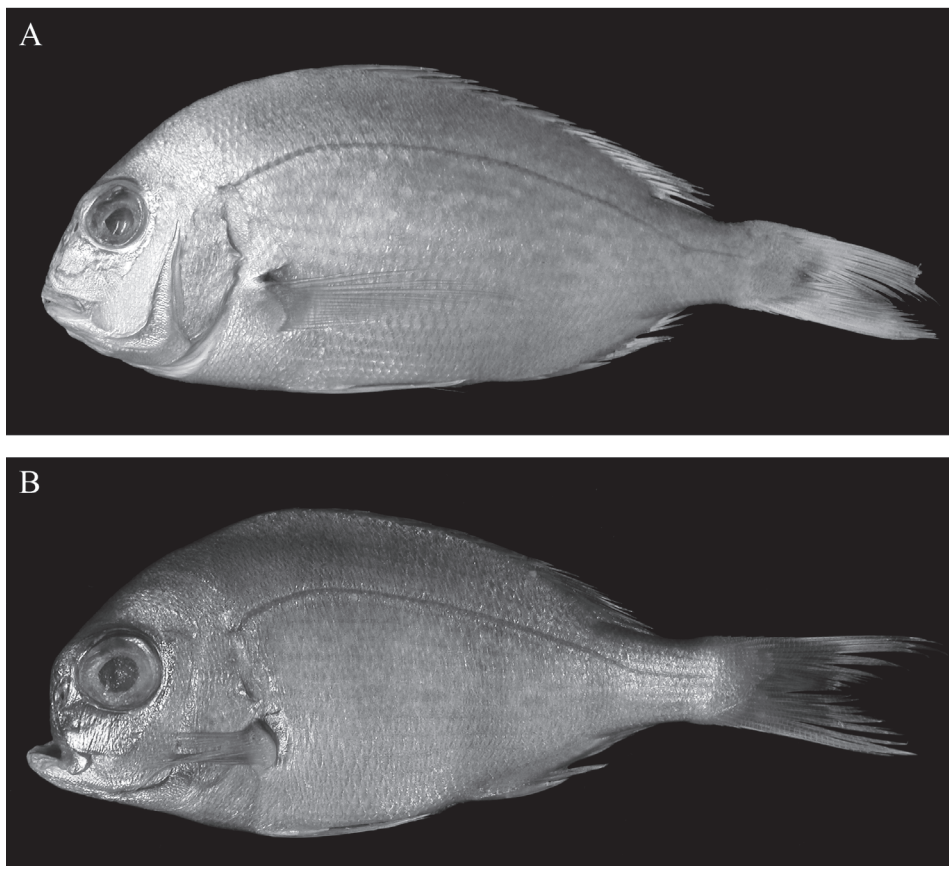

Fig. 2. Pagrus auratus, *A. Normal specimen (200 mm TL) (NIWA # 11906); B. Abnormal specimen (135 mm TL) (NIWA # 16350)*

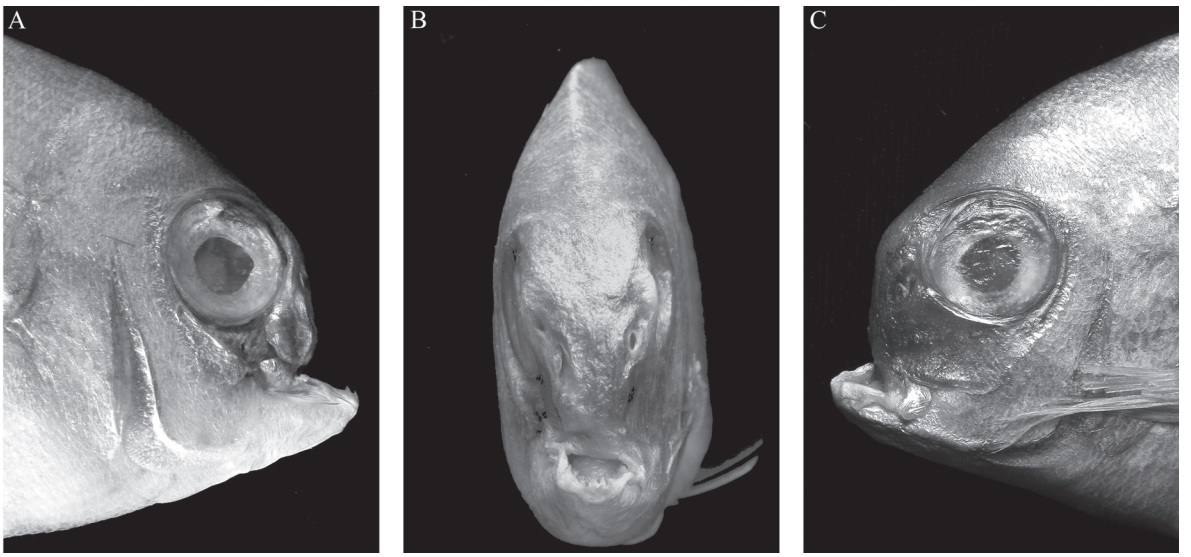

Fig. 3. Head of pug-headed specimen of Pagrus auratus*, (NIWA # 16350) A. right view; B. front view; C. left view*

RESULTS

Measurements for the pug-headed specimen are as follows: total length 135 mm, standard length 115 mm, head length 34 mm, pre-orbital length 0 mm (no snout), pre-dorsal fin length 30 mm, pre-pectoral length 36 mm, upper jaw length 0 mm (no jaw), and lower jaw length 15 mm.

The following features were observed in the pug-headed specimen (Fig. 2B, 3): The snout is absent. Mouth is nearly closed by a flap of a skin leaving only a small opening. On the right

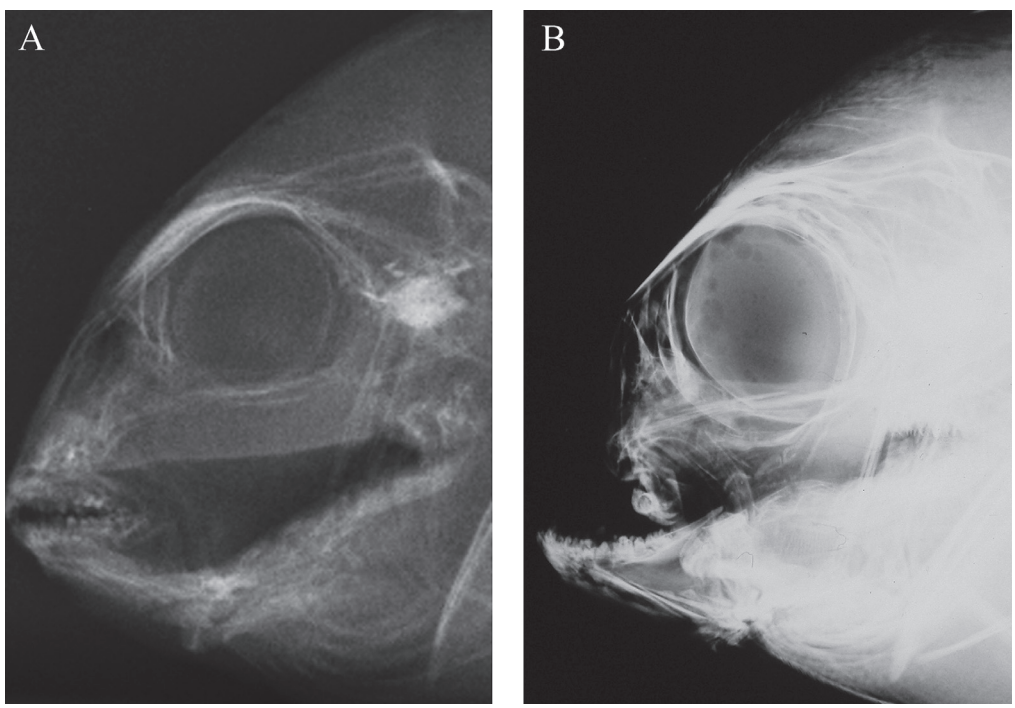

Fig. 4. X-radiographs showing skeletal structure of snapper Pagrus auratus*, A. normal specimen (X-Ray) (NIWA # 11906; taken using Philips Optimus; B. abnormal specimen (NIWA # 16350; taken using mammography machine Siemens mammomat)*

side of the head and due to the ventral extension of the skin, the lower right nostril is also stretched and deformed. All infra-orbital bones are missing except the anterior bone which is completely deformed and twisted anteriorly and ventrally. The left side of the pre-maxilla is deformed, twisted downward and forward. The right side of the premaxilla is short, completely deformed, and projected backward.

The osteological deformity was compared with the normal specimen (Fig. 4A). Internally, the frontal bones are deformed and projected downward and the maxilla, the ectopterygoid, the parashpenoid, and the palatine bones are all severely deformed. The frontal bones are with calcified knobs projected dorsally (Fig. 4B).

DISCUSSION

HICKEY *et al*. (1977) defined degrees of pug-headedness among striped bass, *Morone saxatilis*, recognising four stages: normal, primary, secondary and tertiary. These stages fit all pug-headed cases previously reported in other teleost fishes. The present case of severe pug-headedness in *P. auratus* represents the tertiary stage of HICKEY *et al*. (1977).

Pug-headedness may have a debilitating effect on the fish's ability to breathe and feed (HICKEY, 1973) resulting in a lack of competitive ability for food (BORTONE, 1972).

Causes of pug-headedness may be genetic or epigenetic (DAHLBERG, 1970; SLOFF, 1982). Genetic anomalies result from mutations or recombination of genes and are heritable provided but they are not lethal (BROWDER *et al*., 1993). Epigenetic defects are acquired during the development of the embryo or larvae especially for the hatchery population of fish (SHARIFF *et al.,* 1986). It is well known that anomalies can also result epigenetically from the influence of variation in water temperature, salinity, dissolved oxygen, diet, solar radiation, and chemical pollution (BERRA & RAY-JEAN, 1981). Variations in water temperature, salinity, and dissolved oxygen were recorded in Whangarei Harbour 2003, when the abnormal fish in question was born. During this year, there were variations of 4 °C in water temperature, 3.3 g m^{-3} in dissolved oxygen and 2.8 g l^{-1} in salinity which are all within expected limits for the area (STEWART, 2006 personal communication). Data on other environmental factors such as solar radiation are not available for Whangarei Harbour.

Heavy metals, such as zinc, are directly linked to pug-headedness in fish (SLOFF, 1982). High levels of zinc (389 mg kg^{-1}) are consistently present in both the sediment (389 mg kg^{-1}), storm water drains (97.4 mg kg^{-1}), and freshwater resources (12.7 mg kg^{-1}) of the Hatea River estuary, at the head of Whangarei Harbour (WEBSTER *et al*., 2000). The likely source of zinc is from runoff and effluent entering Whangarei Harbour through the Hatea River, Waiarohia Stream and storm waters draining the central business and industrial districts of Whangarei City. The presence of heavy industry in the area, such as the Marsden Point Oil Refinery situated near where the specimen was collected, would almost certainly contribute to heavy metal contamination in Whangarei Harbour. Quantitative studies should be conducted to further investigate possible links between pug-headedness and water quality in Whangarei Harbour.

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Bilješka o deformacijama glave pagra balavca, *Pagrus auratus* (Forster, 1801) (Perciformes, Sparidae) sa Novog Zelanda

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SAŽETAK

Deformacije glave kod pagra balavca *Pagrus auratus* je po prvi put zabilježen u Novom Zelandu, na temelju jedinke (starosti 2^+) sakupljene u luci Whangarei. Uočeno je ozbiljno oštećenje kostiju donje čeljusti gubice. Usta kod jedinke su gotovo zatvorena. Uzrokom ovog deformiteta smatra se nekoliko čimbenika, između kojih genetski i epigenetski.

Ključne riječi: abnormalnost skeleta, deformacije glave, pagar balavac, Novi Zeland