THE GROWTH AND MORTALITY OF SINARAPAN (MISTICHTHYS LUZONENSIS) IN LAKE MANAPAO, BUHI, CAMARINES SUR PROVINCE, PHILIPPINES

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ABSTRACT

The parameters of the von Bertalanffy growth function were estimated from length-frequency data of ‘sinarapan’ (Misticthys luzonensis Smith 1902; Family Gobiidae) collected in 1988-1989 in Lake Manapao, Philippines, one of the few natural habitats of this tiny fish, which reaches at most 2.5 cm and may be the “world’s smallest commercial fish.” Various aspects of the biology of sinarapan, which is on the IUCN Red List of Threatened Species (as “conservation-dependent”), are discussed, relative to their conservation in the face of exploitation by an uncontrolled fishery and the presence of invasive predatory species. This gains greater significance in view of the near total collapse of sinarapan stocks in Lakes Buhi and Bato where the species was once exceedingly abundant.

INTRODUCTION

Knowledge of the vital population parameters of fish is essential both for understanding their basic biology and for designing rational exploitation policies. The case of ‘sinarapan’ (Misticthys luzonensis Smith 1902), the world’s “smallest commercial fish”, in Lakes Buhi and Bato, in the Bicol Region of the Philippines, is a case in point. The minute fish was extremely abundant in both lakes from the 1930s to the 1960s, but had almost completely disappeared by 1980. Two hypotheses were offered by Gindelberger (1981b) for the near extinction of sinarapan in Lake Buhi: (i) overfishing by motorized ‘sakag’, i.e., collapsible Y-shaped push net, and (ii) predation by the introduced tilapia Oreochromis mossambicus. Reliable data (e.g., catch and effort data from well-planned surveys) to test these hypotheses are not available.

The dearth of field data is coupled with the general lack of published information on the species. During the heyday of the sinarapan fishery, no one has ever thought of the ruinous turns of events its fishery would be in a decade later. The motorization of sakag, employees of the then Bureau of Fisheries and Aquatic Resources (BFAR) and artisanal fishers agree, led to the overfishing of both lakes, besides destroying much of the bottom structures that provided habitat and refuges for this goby. Lake Manapao, where this study was performed, was thus, at that time, one of the few remaining natural freshwater bodies where the goby occurred in any abundance.

Lake Manapao (3.75 ha area and 7.6 m mean water depth) is a tarn or mountain lakelet in San Ramon, in Camarines Sur Province. It is 102 m above sea level and lies approximately 13°26’ N, 132°29’ E. It was probably formed, together with Lake Katugday, after the last eruption of Mount Iriga in 1641. Despite being declared a “sanctuary” for sinarapan by virtue of a municipal ordinance in 1982, Lake Manapao is still being fished by fishers residing along the nearby mountain slopes. Tilapia, common carp, mudfish, and catfish (all introduced species) constitute the bulk of the catch. Sergistid shrimps, which aside from tilapia and mudfish, are suspected to prey on sinarapan, also occur in the lake.

Sinarapan is viewed as a delicacy and is of great economic value to people residing along the lakeshore areas of Lakes Buhi and Bato, who, according to Gindelberger (1981b), eat this minute fish for breakfast, lunch, and dinner. The collapse of the commercial sinarapan fishery of Lake Buhi in early 1979 removed the major source of livelihood of 200 fishers (Gindelberger 1982).
There are very few published studies on *sinarapan*. Smith (1902) presented a description of its external morphology and its habitat, while Te Winkel (1935) discussed aspects of its anatomy with emphasis on the effect of its small size, respiration, and a general discussion of its habitat. Pauly (1982) demonstrated, based on data in Te Winkel (1935), a limiting role of gill size on the growth of *sinarapan*. The elongated body of *sinarapan* is covered by deciduous ctenoid scales extending from the first dorsal to the posterior margin of the gill cover (Herre 1927). *Sinarapan* can be distinguished from similar freshwater gobies by its three-spined first dorsal fin.

Based on its teeth on the jaws and the pharynx and its exceptionally short digestive tract (Te Winkel 1935), Gindelberger (1981a) suggested that *sinarapan* is zooplankton feeder. In a 10-month study by Traichaiyaporn (1985) in Lake Katugday, she identified 53 phytoplankton species that constituted 30-50% of the stomach content of *sinarapan*. However, she suggested that the “ingestion of the phytoplankton was incidental to the swallowing of the zooplankton which they selectively feed.”

**MATERIALS AND METHODS**

The data used here, extracted from the Master’s thesis of the first author (Soliman 1989), consisted of 10-month length-frequencies (L/F) collected from May 1988 to April 1989 and paired length-weight measurements of 151 individuals of *sinarapan* collected in parallel with the L/F data.

A push net, locally called a *sakag* was used to collect *sinarapan* samples from Manapao. The small catchment area of the lake let (c. 3 ha) allowed the reliable execution of stratified random sampling procedure. Two strata (A and B) were designated based on preliminary sampling in March 1988, with more hauls in the high-density stratum. The selectivity of *sakag* can be assumed to be low, given its meshes of 1 mm². The sampling gear was operated by thrusting 2/3 of the total length of its 2 pole supports into the water; the push net, positioned in the boat’s bow, was pushed forward while the boat was paddled (a motorboat was not available, due to the remoteness of the lake). Organisms other than *sinarapan* (e.g., tilapia, shrimps, other gobies) were sorted out of the catch.

There were 9 to 10 hauls per month, all taken during one sampling date at 08:00-11:00 hours. The absence of length-frequency samples in August and September 1988 was due to the heavy rains that flooded the road to the site.

Length measurements (± 0.5 mm) were done under a magnifier, using an improvised fish measuring sheet calibrated using a Vernier caliper. During the analyses, however, the length-frequency data were grouped into twenty 1.0 mm class intervals. A log regression model was fitted to the Total lengths (L) and their corresponding weights (W), estimated using an electronic balance (gravid females were not included in this model).

The length frequency data for 10 sampling months were entered in a format accessible to the ELEFAN software (Gayanilo and Pauly 1989)⁵, which was used to estimate the parameters of the von Bertalanffy growth function (von Bertalanffy 1938) and total mortality (Z) of *sinarapan*. The latter, which was estimated from a length-converted catch curve, was decomposed into fishing mortality (F) using \( Z = F + M \), with \( M \) estimated from the empirical equation of Pauly (1980; 1984).

**RESULTS AND DISCUSSION**

The relations of total length to live weight in *sinarapan* is given in Figure 1. Its estimated exponent (\( b = 3.45 \)) significantly differed from 3, indicating positive allometric growth.

⁵ Now available in R, see Pauly, D. and A. Greenberg (Editors). 2013. ELEFAN in R: A new tool for length-frequency analysis. Fisheries Centre Research Reports 21(3) Fisheries Centre, University of British Columbia, Canada, 52 pp.
Figure 2 presents the growth curve for 2 seasonal cohorts of *sinarapan* (*L\(_\infty\) = 24.6 mm and K = 2.25 year\(^{-1}\)\)) superposed on the available length-frequency (L/F) data, as restructured by the ELEFAN software to emphasize peaks and troughs in the original L/F data (solid line: main cohort; dotted line: secondary cohort). The relatively high K value obtained is typical of most short-lived tropical fish (see FishBase; [www.fishbase.org](http://www.fishbase.org)).

The total mortality estimated through a catch curve (not shown) was 9.23 year\(^{-1}\), and the M and F estimates were 6.201 and 3.033 year\(^{-1}\), respectively. It must be emphasized that these estimates are very tentative, notably because Pauly’s empirical equation did not include, for its derivation, fishes as small as *sinarapan*.

The high estimate of M may be compatible with high predation experienced by a fish such as *sinarapan*, which does not guard its eggs and young (Gindelberger 1981a). After the females extrude ripe eggs into the water (with some becoming attached to plant roots), the male fertilizes them; then the eggs are abandoned. This makes the eggs and young vulnerable to predators and adverse environmental factors (e.g., sulphur upwelling).

Lake Manapao is a *sinarapan* sanctuary in the sense that it is still abundant here, while it has virtually disappeared from Lakes Buhi, Bato, and Katugday. The estimate of exploitation rate (E = F/Z = 0.33) is relatively low and is consistent with Lake Manapao functioning as a ‘sanctuary’ of sorts.

With the almost complete disappearance of the Lakes Bato, Buhi, and Katugday populations, Lake Manapao is the only remaining source of *sinarapan* for study, which we recall, is (as of the writing; January 2017) on the IUCN Red List of Threatened Species (as “conservation-dependent”). Hence, studies will have to be carefully planned, and not unduly impact on its populations. This should be considered in the future, notably by the Fisheries and Aquaculture Divisions of the Department of Agriculture.

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