

Age, Growth, and Reproductive Biology of Deep-Water Chondrichthyans

Charles F. Cotton

Dissertation, Virginia Institute of Marine Science, 2010

Abstract

Nearly half of the known species of sharks in the world live in the deep sea, yet little is known of the biology or life history of these important predators of the deep. Fishing effort for deep-water sharks, both targeted and incidental, has been increasing worldwide over the last few decades. However, in most cases the impact of this harvest is unknown due to the paucity in landings data and the lack of stock assessments for these species. This research was conducted to provide some of the basic life history information needed to improve the understanding and properly manage deep-water sharks. Specifically, information is presented herein on age determination using dorsal fin spines; the potential for radiometric age validation using dorsal fin spines; the age, growth, and reproductive biology of *Squalus mitsukurii* from Hawaiian waters; and the reproductive biology and embryonic development of *Centrophorus cf. niaukang* and *Etmopterus princeps*.

Dorsal fin spines offer an alternate structure for age determination in phalacanthous chondrichthyans. In this study, I sought to identify optimal methods of age determination using dorsal fin spines of 14 species of squaliform sharks and two species of holocephalans. Growth bands can be found in three zones of the fin spine: on the enamel cap (if present), at the base of the whole spine, or in the inner dentine layer. Each of these three methods was applied to fin spines from these 16 species. Results of each method are compared and discussed, with an optimal aging method suggested for each species. Radiometric methods have been used to validate age estimates from teleost otoliths, shark vertebrae, and coral skeletons. The radioisotopes ^{210}Pb and ^{226}Ra were ineffective for age determination of dorsal fin spines, possibly due to a violation of the assumption of constant isotopic uptake, or conversely the spine may not act as a closed system.

A study of age, growth and reproductive biology of *Squalus mitsukurii* was conducted near Oahu, Hawaii. Age estimates ranged from 3 to 26 years for females and 6 to 23 years for males. Growth parameters estimated with multiple growth models indicated that this a K-selected species, characterized by high longevity, late maturity, and slow growth. Observed fecundity also indicated that reproductive output is low for this species.

A study of embryonic development in *Centrophorus cf. niaukang* and *Etmopterus princeps* indicated that the process of embryogenesis results in a range in organic matter depletion from the time of fertilization to parturition. *Centrophorus cf. niaukang* embryos showed a reduction of 19.5% in organic matter, while *E. princeps* embryos showed a reduction of 7.8% in organic matter over the course of embryonic development. These results indicate that at

least one of these species may be matrotrophic. Observed fecundity and maturity ogives are also presented for each species.

This study on age determination, growth, and reproductive biology of several species of deep-water sharks and holocephalans indicated that these are K-selected species. Future harvest of these species should proceed with caution, as they are prone to overexploitation and localized depletion.