Milestones in Underwater Ichthyology: A Historical Perspective

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Abstract

The history of underwater studies of fish behavior and ecology begins with William Longley in the early 1900s. Longley used a diving helmet and first generation underwater camera to document fish color patterns and behavior. Unfortunately, he died before he could publish all of his work. The scientific community of the day recognized the great importance of these first underwater studies. As a result, Samuel Hildebrand, senior Ichthyologist, United States Fish and Wildlife Service was selected to collate and edit Longley's notes. The resulting manuscript was published in 1941 as the "Systematic catalogue of the fishes of Tortugas, Florida with observations on color, habits and local distribution." This presentation will review the diving technology that Longley used, highlight his discoveries from underwater observations and show its lasting influence on coral reef ecology.

Keywords: fish behavior, Miller-Dunn diving helmet, reef ecology, underwater photography, William Longley

Introduction

The first diving ichthyologist was William H. Longley (who was actually trained as a botanist). He started diving in 1910 using the Miller-Dunn shallow water helmet at the first tropical marine laboratory in the western hemisphere, the Carnegie Marine Laboratory in the Dry Tortugas, Florida. By contrast, the famous William Beebe made his first helmet dive in 1925. Longley is best known for taking the first underwater color photographs in collaboration with Charles Martin for National Geographic Magazine in 1926. Prior to this, Longley used an underwater black and white camera to document fish behavior. Longley's monumental study "Systematic catalogue of the fishes of Tortugas, Florida with observations on color, habits and local distribution" was published in 1941 after his death in 1937. Longley's notes and preliminary manuscript were edited and completed by Samuel Hildebrand, also an ichthyologist. This book was based on Longley's observations of over 25 years of diving using a shallow-water helmet and includes dozens of underwater photographs. It was the first underwater study of fish behavior and set the stage for the generations of diving ichthyologists who followed. This presentation will review the major discoveries by Longley and the diving equipment he used. I will also summarize some subsequent milestones in scientific diving by ichthyologists over the years when scuba first became available (particularly by John Randall) and the further discoveries eventually made possible using rebreathers.

My interest in the studies by Longley developed from research that I had done in collaboration with J. E. Randall. Randall and I had worked on two studies concerning goby behavior and ecology. While reviewing the literature, we found that Longley reported these behaviors for first time. These studies concerned the symbiosis of goby and shrimps in burrows (Randall et al., 2005) and the systematics and behavior of cleaning gobies in the Caribbean (Randall and Lobel, 2009).
Methods

Diving helmets and a replica of Boutan's camera were examined and photographed by the author at the History of Diving Museum, Marathon Florida.

Discussion

Prior to the underwater studies of wild fishes by W. Longley, ichthyologists were confined to collecting fishes using nets, spears and explosives and then preserving the specimens in formalin for later study. The major problem was that the color of the fishes was quickly lost in the preservative. Consequently, there was considerable confusion in taxonomy. Longley's underwater observations of fishes focused on how fishes varied in color patterns during behavior and by sex. He recognized that some fishes that were classified as different species were, in fact, color morphs, age phases or dimorphisms of a single species.

Longley did not write details about his diving technology specifically and only referred to how he collected fishes (dynamite, nets, and spears) anecdotaly. He apparently used the early models of the Miller-Dunn shallow water diving helmet (Figure 1).

![Figure 1. A Miller-Dunn diving helmet style 2.](image)

As best as I can determine, Longley began using a camera based upon the one designed by Louis Boutan (Figure 2). Louis Boutan is credited with having built the first underwater camera and producing the first underwater photos (monochrome) in the 1890s. Boutan was a French marine zoologist and conducted his underwater photography experiments at the Arago Marine Laboratory at
Banyuls-sur-Mer, on France's Mediterranean coast. This camera development preceded Longley's first dives by about 17 years. Longley then teamed up with Charles Martin from National Geographic Society in 1926. Together they were able to produced the first underwater color photographs (http://photography.nationalgeographic.com/photography/photographers/first-underwater-article.html).

Figure 2. The camera built by L. Boutan was possibly the model used by W. Longley to take monochrome photographs underwater.

The remarkable accomplishment by William Longley was that he conducted his underwater research while diving alone and during a time before the behaviors of fishes and other reef creatures were not yet known. He detailed his observations using a wax-covered slate which were later transcribed on paper.

The discoveries made by Longley while diving with the shallow-water helmet include:

a. Synonymy of about 20% of the known fish species at the time that occurred in the Florida Keys.
b. Description of 29 new reef fish species
c. Recognition of the larval transformation of a leptocephalus larva into the juvenile bonefish, *Albula vulpes*.
d. First descriptions of the symbiosis relationship of cleaner fishes and host fishes. He was the first to describe the cleaning behavior of the goby, *Elacatinus oceanops*, juvenile porkfish, *Anisotremus virginicus*, and the juvenile bluehead wrasse, *Thalassoma bifasciatum*.
e. First observations of the nocturnal habits of fishes including color changes.
f. Color changes with behavior of the hogfish, *Lachnolaimus maximus*.
g. First observations of the spawning behavior of several fishes, most notably the damselfishes (Pomacentridae).
h. First observations of the sand diving behavior of the razor wrasse, *Xyrichtys* spp.
i. First observations of the burrowing behavior of the yellowhead jawfish, *Opistognathus aurifrons*.
j. First observations of the symbiotic burrow sharing behavior of the goby, *Nes longus* and the alpheid shrimp, *Alpheus floridanus*.

In many ways, the subsequent discoveries by John E. Randall were built upon the scientific approach that Longley established. Randall also used photography and developed a new technique for photographing fishes in trays in order to accurately document their color patterns (Randall, 1961). To obtain the best-looking specimens with minimal damage, Randall invented the multi-prong minispear (Randall, 1963). Randall's many discoveries were largely based upon being a skilled scuba diver who understood what he was observing. He readily recognized new species and was often the first ichthyologist to dive many remote locations worldwide.

Today, scientists can dive longer and deeper using nitrox and rebreathers. Scientists using rebreathers are now going to where open-circuit scuba divers have not been able to collect before and are discovering new fishes at deeper depths (e.g., Pyle, 1996). Previously unknown behaviors such as the sounds made by fishes during mating are also being discovered using the silent rebreathers and innovative recording technology (e.g., Lobel, 2002).

We can see a simple progression in our diving history. The core element of advancement being based on the gear used to explore the undersea. The importance of the underwater breathing technology to making advancements in our science is obvious. We need to imagine what are the next technological innovations needed that will enable new discoveries in the future.

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**References**


