Perpetuating our fishing tradition

$3.95 ISSUE NO. 25

LAWAIʻA

PAPIO ON A RAT

BIG BLUE WAS 20 YEARS OLD

ANSWERING THE QUESTION OF AGE

ART AND THE SEA

FISHERIES FAMILY & FUN

A HIGH SCHOOL CLASS ABOVE EXPECTATIONS

Stephen Kilfenny's

BARBLESS UKU

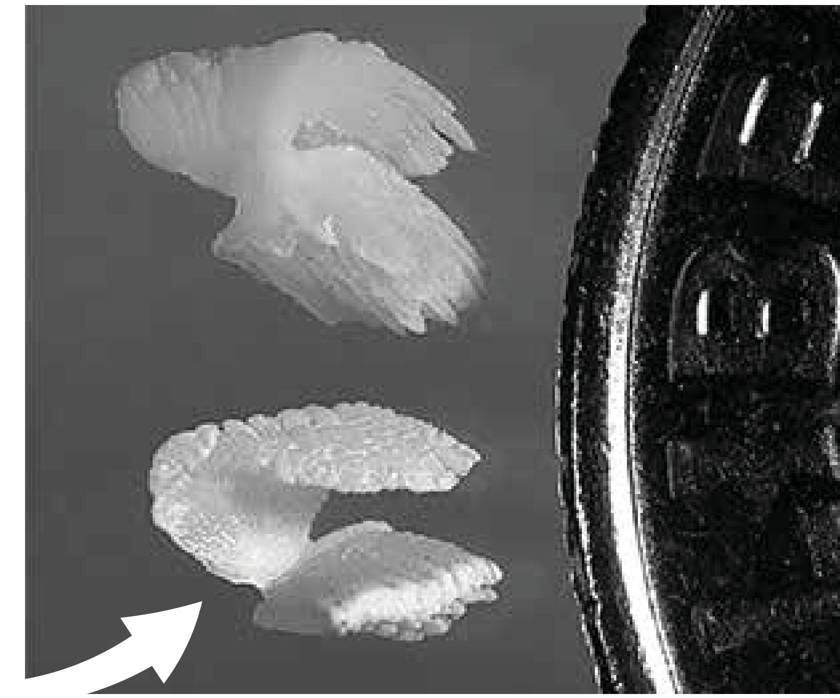
Display until January 31, 2018
$3.95US
25>
0 74470 26690 7

Big Blue was 20 Years Old

BY ALLEN HIA ANDREWS, PH.D.
NOAA FISHERIES – PACIFIC ISLANDS FISHERIES SCIENCE CENTER

A grander blue marlin (>1000 pounds) could be aged for the first time.

If it weren't for the foresight and action of the captain, crew, fisherman, and some well-connected locals, the opportunity would have been lost. Fortunately, measurements were made and the head was saved. Within the head of this 1,245 pound (12.2 feet) blue marlin was the key for answering the question of age—ear stones, also known as otoliths. These stones, which are small calcium carbonate structures, hold the elusive answers for how long fish can live, and the rare opportunity to collect and analyze them for a grander blue marlin had finally come to pass.



Photograph of the grander blue marlin (Makaira nigricans) at time of capture 21 miles south of Honolulu, Hawaii on 1 September 2009. Inset are the small ear stones (otoliths) used to age the fish with the edge of a US dime for scale. The fisherman (Marvin Bethune), Captain Mike Hennessy, and crew (Nate Varnadoe) of the F/V Maggie Joe out of Honolulu landed the 1,245 lb. fish and had the foresight to make the head available for science. Thanks to Jeffrey Muir, Kekoa Seward, and Robert Humphreys for their foresight and collection of the specimen.

You may wonder about the question of fish age and why it would matter. Think of it this way, if you were a lumberjack and your livelihood depended on the rate trees grow, it would be important to know if it took 20 or 50 years to get to harvestable size—it is about yield per unit time and the sustainability of your resource. In

> Otoliths grow in layers, and the crystal that is formed at any point during the life of the fish is conserved over time. Hence, the material grown during the first year of life is as old as that fish, like the core of a tree.

fisheries, you would utilize many different forms of data, like age, to determine the potential vulnerability and risk to your "harvest" of a fish species. The fact about blue marlin at this time is that no one actually knew how long the species can live. There are limited observations and rough estimates of age but when this female grander came in, the age of this uncommonly large blue marlin was anyone's guess.

As a Research Fisheries Biologist working for NOAA Fisheries at the Pacific Islands Fisheries Science Center (PIFSC), my specialty is what can lead to a confirmed age for this grander blue marlin—I figure out how long marine organisms live. It might seem like an odd career, but I have found a special niche in answering some rather obscure questions—how fast can coral, shellfish, turtles, or fishes grow, when do they mature, and how long can they live? The reason for discovering this kind of information is not just about curiosity, but its utility in understanding the dynamics of fishery growth, sustainability and informed management.

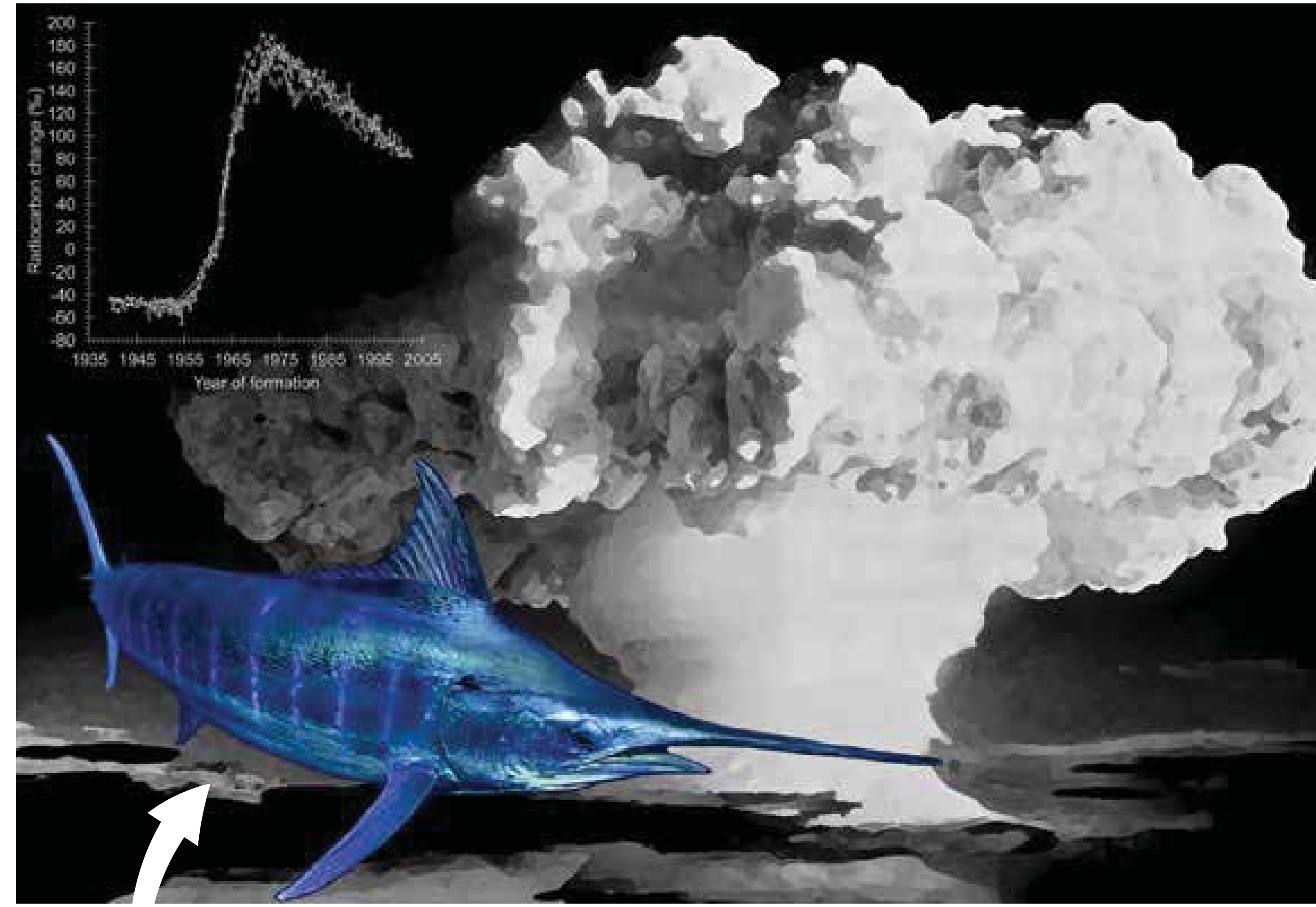
Blue marlin are landed regularly in commercial and recreational fisheries around the world, but studies of age and growth are uncommon and have often led to more questions than answers. In some studies, the maximum age was estimated to be between 20–30 years by looking at growth zones in fin spines and otoliths, much like you see in the rings of a tree. But these counting techniques can only provide an estimate of age because what the rings represent is unknown—the rings or growth zones could form several times a year or less than one per year. As a result, the age could be either over or under estimated. This kind of problem is similar for tropical trees because the seasons are not well defined. It turns out that blue marlin are the most tropical of the billfishes as they remain in the warmest and most oxygen-rich waters; therefore, determining age by counting those growth zones may not be accurate. This is where my area of expertise comes into play—I use records of ocean chemistry stored in the otoliths to determine the age of fish and validate the counting techniques used to provide age estimates.

In the 1950s and 1960s, mankind did a series of experiments that changed the course of history. Nuclear bombs were designed and detonated in various parts of the world, and they created radioactive signals that can be traced to every environment on the planet, including the ocean. While this is something that should be terrifying and it should never happen again, these signals have provided an opportunity to do some good. Specifically, for marine fishes, it is the change in radiocarbon (harmless to humans) that allows us to determine the age of fish because the signal is incorporated directly into the otolith and is stored through the life of the fish. An otolith is like a marine environment recorder tracking everywhere the fish went through its entire lifespan.

Otoliths grow in layers, and the crystal that is formed at any point during the life of the fish is conserved over time. Hence, the material grown during the first year of life is as old as that fish, like the core of a tree. If a fish you caught today was born decades ago, then the radiocarbon levels in the first year of life for that fish would line up with the local radiocarbon records to provide a valid birth date.

The complication with this approach, however, is how would you know what the signal was for the ocean in the waters where that fish lived? The answer is with reef building corals. Like the fish ear stone, corals grow in layers every year, and we know from other observations how old corals are by counting the bands that go back in time. So, think about it, if the otolith and coral stored the same marine radiocarbon record, we can then measure the radiocarbon in the birth year otolith material of any fish and line up the measurement with the coral radiocarbon record. Alignment of the fish radiocarbon measurement with the coral record gives us a birth year and thus an age for that fish. For example, opakapaka (Hawaiian pink snapper) were once thought to live to a maximum age of just 5 or 18 years, but measurements of bomb radiocarbon in the otolith core proved they can live more than 40 years.

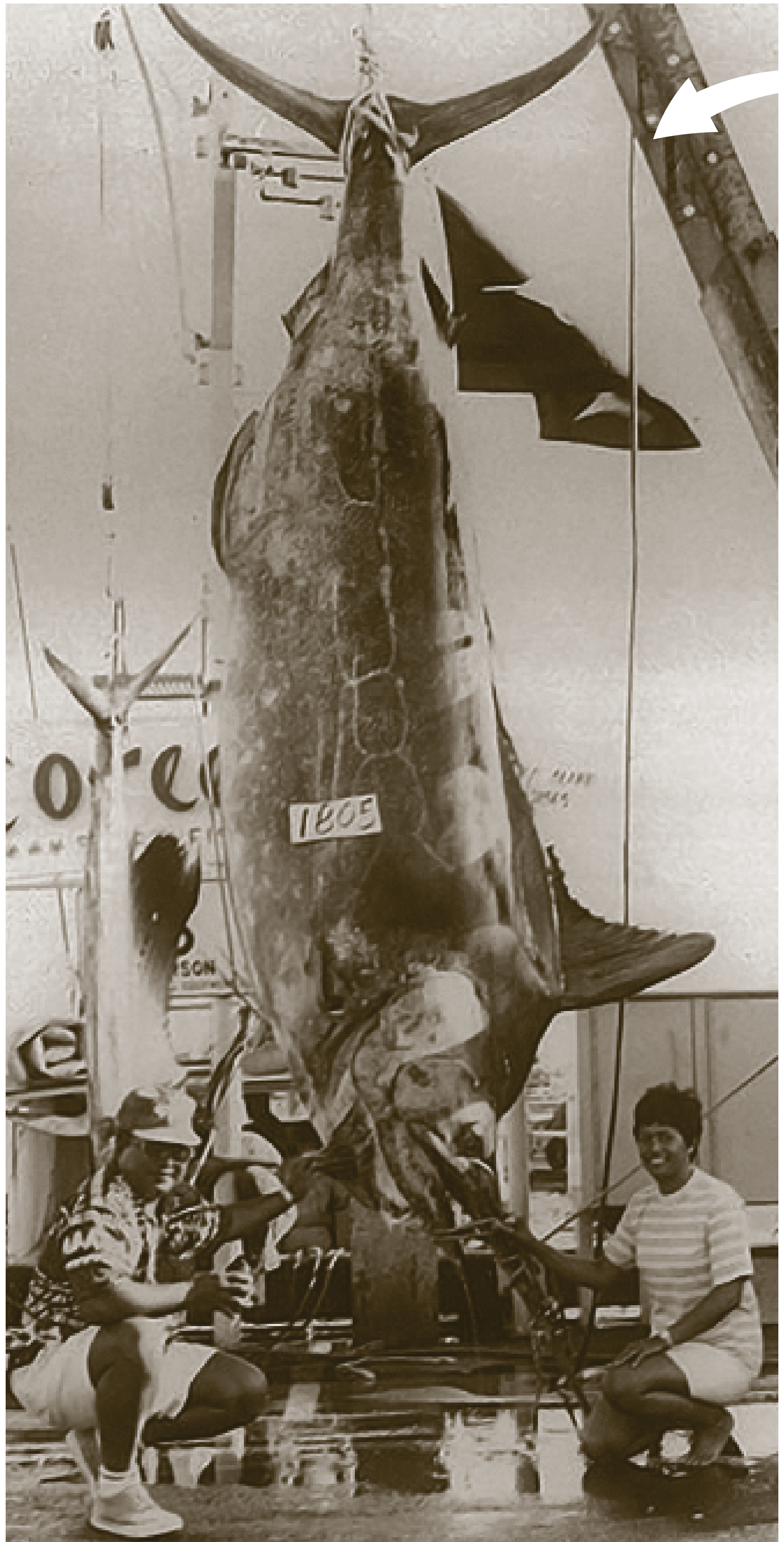
Back to this grander blue marlin—the head was saved and it made its way to a guy that is one of the best at removing otoliths from fish, Jeff Sampaga of the PIFSC. The astounding thing about the otoliths from this huge fish is that they are actually very small. In typical cases, like with the opakapaka, the otoliths of an adult weigh 0.3 grams (0.01 oz) or the equivalent of 15 grains of uncooked white rice. It's not a lot, but it is much more than the otolith of a blue marlin—this grander had an otolith that weighed just 0.008 grams (0.0003 oz), which is less than half of a single grain of rice. Small and not much material to deal with, but also consider that I need to make a chemistry measurement on just the first year of growth! Based on otoliths from the smallest and youngest fish, the first year of growth was approximately 1% of the white rice grain. This grander was landed in 2009, and when I started working for the PIFSC in 2010, the prospects of using this otolith for bomb radiocarbon dating were nil; there just was not enough material to do an analysis. But as of last year, technology caught up allowing us to run the numbers on birth year material from this blue marlin. Low and behold, this fish was just 20 years old.



Subsurface image of a blue marlin pictured with the mushroom cloud of nuclear test "Mike" during Operation Ivy in 1952. This was a 10 Mt nuclear test that provided part of the change in radiocarbon that was recorded in the otolith of the grander blue marlin. The inset figure (upper left) shows how radiocarbon changed in the waters of the Hawaiian Archipelago over the last 60 years—shown are coral records ranging from Kona, Hawaii Island to Kure Atoll. The alignment of radiocarbon from the earliest otolith growth with the declining side of the coral records led to a birth year of 1989 and an age of 20 years.

When the 20-year lifespan was revealed, my supervisor said, "I don't know whether I am surprised or disappointed." Perhaps it is some of both. The disappointment comes from the perspective that we expect large organisms to have a lifespan that is intuitive or based on other observations of large, long-lived animals, like elephant (~60 years), orca (~90 years), or bowhead whale (100–200 years). The surprise is that this fish would need to grow very rapidly to reach this size. Mahi mahi are a good example of a very fast growing marine fish—they can reach more than 3 feet in length in one year—but to envision a mahi mahi growing to the size of this grander and at a similar rate is difficult to conceive. But there is evidence that blue marlin can grow very rapidly from studies of the youngest fish. As described earlier, there are growth zones that can be counted and can represent annual growth (one ring per year), but there are also microscopic zones in otoliths called daily increments (one ring per day). These increments are usually visible only in the earliest growth of fishes where the rate is most rapid. It is well known that these increments can validate early growth rates and they have been counted for blue marlin. This species can growth to lengths of 1–2 m (3-6 ft.) in just 1–2 years. If you continue this growth trajectory, it is easy to imagine that the grander blue marlin was just 20 years old.

Other evidence that blue marlin are fast growing comes from long-term observations of landings, like at the annual Kona Tournament. Landings of grander blue marlin do not appear to have changed in decades of fishing, hence, it follows that they grow very quickly and that the resource is resilient. But what about the elusive fish that may approach 2000 pounds?



Perhaps the best documented landing, that of Capt. Cornelius and Gail Choy's monster in 1970, an 1805-pound blue marlin caught on the Coreen C, exemplified this perspective. Could that fish be much older than the grander described here? Choy's monster was unusual from a couple of perspectives; its length (14.2 feet) was unexpectedly low for its weight (using other well measured fish to document the relationship), and the girth was unusual (see picture that clearly shows an unusual body depth). It should have weighed closer to and a little less than Capt. Bart Miller's blue, a fish 14.8 feet in length that was captured off Kona in 1986 and weighed 1,654 pounds. This fish was estimated to be 20 years old from the counts made in otoliths and fin spines. Could Choy's monster have been a slower growing individual with a greater age?

There is a little-known factor in the landing of Choy's monster—that fish had a 100- to 200-pound tuna caught in its throat. This was discovered after the weighing and was never subtracted from the weight of that fish, which could explain the unusual girth and the greater than expected weight. But it must also be considered that other blue marlin likely had food in their bellies and that this dietary increase to weight would be a common factor. It follows to mention that there are reports of 2000-pound blue marlin that were caught and either got away, were released, or were cut free of the line during commercial operations because of the inconvenience and low value. Regardless of the truth in these estimates for the largest blue marlin, it is likely that fish this size are very rare and, therefore, not an important part of the overall population dynamics that are important to fishery sustainability.

Choy's monster is the biggest marlin ever caught on rod-and-reel and weighed 1805 pounds at 14.2 feet. Hooked by vacationers (not pictured), Captain Cornelius Choy and daughter Gail Choy-Kaleiki landed the fish off Honolulu, Hawaii on 10 June 1970.

In the end, it is fortuitous that blue marlin can grow so quickly. Replacement of the fished population is more secure with high growth rates. Hence, the annual tournaments that rely on the somewhat elusive grander blue marlin, with their associated socioeconomic value, may be viable well into the future.