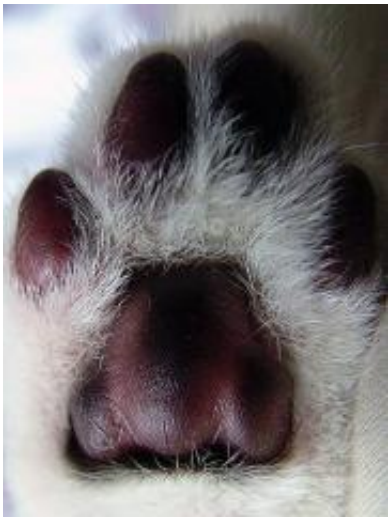
'Ageless' animals give scientists clues on how to overcome the aging process

March 1 2011, By Carrie Arnold



Credit: TheGiantVermin via flickr

Ornithologist Ian Nisbet loves to share two photos of himself with his beloved terns.

The first photo is from 1973, when a dark-haired and spry Nisbet was banding chicks of the small sea bird off the rocky Cape Cod coast. The second photo was taken 33 years later and shows a grizzled, silver-haired Nisbet holding a 29 year old tern, one of the oldest on record. Nisbet's body shows common signs of wear and tear -- gray hair, wrinkles, achy joints. The tern, however, shows none of these outward signs, despite being the equivalent of a human centenarian.

"The Holy Grail of gerontology is finding how to prevent or reverse aging, and seabirds have discovered some of that," Nisbet said. "We just wish we knew what exactly that was."

Terns don't even demonstrate diminished physical abilities as they age. They aren't the only animals that have combined a long lifespan with minimal signs of aging; other seabirds, alligators, crocodiles, and some tortoises also seem to sip from the Fountain of Youth. Although medical advances have extended the human lifespan, these same advances haven't been able to prevent the inimical onslaught of old age. Scientists hope that by studying the secrets of ageless critters, humans will one day be able to pause the hands of time.

The average American born in 2007 will live for 77.9 years, according for the Centers for Disease Control and Prevention. Humans weren't always so long-lived -- even just a century ago, the average lifespan was 49.2 years. Clearly, technology has dramatically altered aging in humans.

Annette Baudisch, a biologist at the Max Planck Institute for Demographic Research in Rostock, Germany, used detailed mathematical models to show that all of these medical and technological advances have ironically increased the speed with which people experience of the consequences of the aging process.

Aging, Baudisch said, is simply the process of growing older. All plants and animals get older. The main difference between humans and organisms like common terns is how growing older affects the risk of dying.

Before medical and technological advances like clean water, vaccines, and better living conditions dramatically altered lifespan, humans were more likely to die during infancy, childhood, and young adulthood. This pattern meant that fewer humans survived to die at older ages, and that

the overall percentage of humans dying old was much lower than in modern populations in the industrialized world. By plotting the risk of death over time, Baudisch found that each animal species has its own unique shape. There's even variation among groups of humans. For hunter-gatherers, the shape looked something like a lopsided U: relatively high during infancy, decreasing somewhat during adolescence and young adulthood, and then increasing again with age, but the shape for modern humans looks entirely different. Baudisch's models, which she published on February 14 in *Trends in Ecology and Evolution* found that risk of death for modern Swedes remained very flat and very low until the population reached its 50s and 60s, whereupon it dramatically zoomed skyward.

Instead of viewing the dramatic increase in risk of death with aging as a curse, Baudisch sees it as "a luxury that we can show this much aging without getting eaten by a tiger."

In some animals, like freshwater hydras, risk of death remains pretty constant during life. For other animals, like the tern, the risk of death actually decreases with age. It seems almost counter-intuitive: an older tern is less likely to die than a younger one.

"My 29-year-old tern was still breeding," Nisbet said. The oldest terns produced the healthiest offspring and were actually more likely to survive the year than younger terns.

In a 2005 article in *Physiology*, biologists João Pedro de Magalhães of the University of Liverpool and George Church of Harvard University said that natural selection optimizes reproduction, not aging. After an animal has raised its offspring, the additional population places a strain on limited resources. An aging and dying parent, then, can benefit its offspring. However, de Magalhães noted, animals that don't appear to age produce more robust offspring as they get older, which makes it

more advantageous for them to continue to reproduce.

Aging isn't all in the gonads, however. Years of studying have provided tantalizing clues for how and why cells become old and die. All chromosomes contain protective caps known as telomeres, which are largest in young cells. Copying chromosomes slowly cuts off the ends of the telomeres, just as the edge of a page might get cut off when making a photocopy. If too many words get cut off a photocopied page, the page is difficult to read. When the telomeres grow too short, the cell dies.

The telomeres of Nisbet's common terns, which he has studied extensively, shorten much more slowly than in similar-sized animals. If telomeres are cut off more slowly, then an animal's cells will age more slowly. The terns also have an enzyme called telomerase that can add back bits of the telomeres that were chopped off. In most animals, telomerase usually stops working shortly after birth. But Nisbet found that, in the common tern, telomerase remains active throughout life, which allows terns to replace what telomeres they do lose. Each species loses telomeres at a different rate, and scientists are still trying to figure out what affects telomere length in various plants and animals.

Another major theory that helps explain the aging process is the accumulation of cell damage from metabolism. When the body breaks down food for energy, the process is very similar to a steady fire. Even small fires in home fireplaces release small amounts of pollutants. In the body, the "pollutants" are known as free radicals, tiny molecules that pack a destructive wallop. Over time, these free radicals can cause significant damage in the cell. Scientists like Denham Harman -- who developed the idea in the 1950s -- believe that aging results from the accumulation of free radical damage in the cell.

Although there is no major scientific consensus on what causes aging, researchers have begun to try and prevent the worst side effects from

human aging. One of the most common and controversial methods is called Caloric Restriction for Longevity. By consuming around 75 percent of the traditionally-recommended amount of calories, along with nutritional supplements, people hope to stave off deleterious effects of aging. Restricting calories isn't just a fad diet; it is backed up by a number of animal and human studies. Perhaps most importantly, the strategy decreases levels of a hormone known as insulin-like growth factor 1.

A study published on February 16 in *Science Translational Medicine* found that humans with a genetic mutation that made them produce far less than the typical amount of IGF1 had virtually no cases of age-related cancer or diabetes and had significantly fewer signs of aging. The study, led by Valter Longo, a gerontologist at the University of Southern California, and Jaime Guevara-Aguirre, a biologist at the Institute of Endocrinology, Metabolism and Reproduction in Ecuador, showed the links between growth and aging.

When an organism doesn't get the signal to grow, it can invest its energy into preserving and conserving the resources it already has, Longo said. "They invest a lot in protective mechanisms," he noted, "but it doesn't always translate into extraordinary lifespans."

Benjamin Franklin's famous statement that the only two certainties in life were death and taxes has thus far been proven correct. Death is inevitable, but by studying how elderly animals stay strong, scientists may one day make aging optional.

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