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Limulus In the Limelight: Exploring An Ancient Species

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Gluttons of Chappell

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Exploring An Ancient Species

By John T. Tanacredi, Ph. D.
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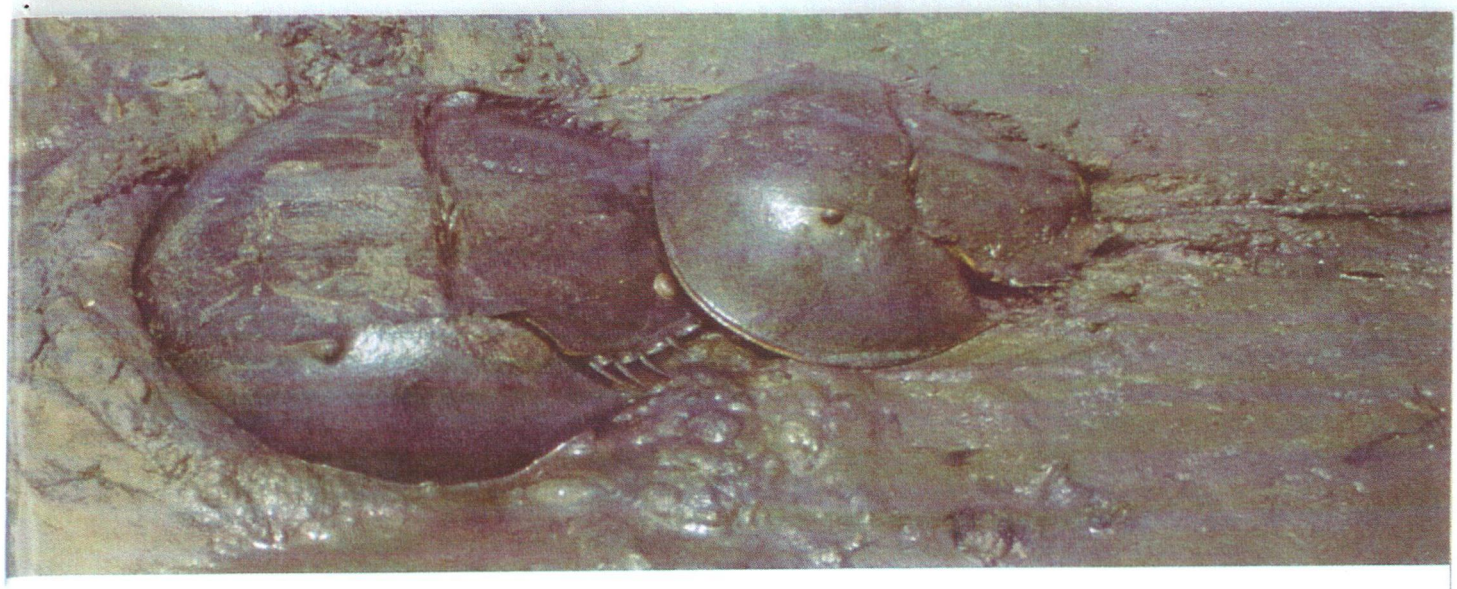
In an era when sports numbers shatter historical ceilings (especially in baseball) and fall by the wayside like fall leaves, a most enduring record of life continues to crawl along emerging from the sea early each spring pronouncing their incredible "record" of existence... over 350 million years. Now there is a number that even the rarified air of baseball salaries can admire. Yet, today the remarkable sea creature which endured over 100 million years of dramatically changing earth history prior to the existence of the dinosaurs, and which is comprised of only four species globally, is being tested for its survivability as at no other time in their known history. Human activities pose the most significant threat to *Limulus polyphemus*, the only North American horseshoe crab species, and have dramatically impacted the other three species found along the southeastern shore of Asia; so much so that in Japan for example only a few thousand of a single horseshoe crabs species remain.

The biology and "uses" of horseshoe crabs have been written about for some time. I remember the stories explained to me of their biological "oddities" by docents at the New York Aquarium (part of the then New York Zoological Society, today known as the Wildlife Conservation Society). As a born and bread Brooklynite, I always felt the Aquarium in Coney Island was kindred and should have been Christened the name of its location (I still haven't gotten over the Brooklyn Dodgers leaving Brooklyn, so bear with me). Except possibly research covering their "compound" eyes, which were the subject of the 1967 Nobel Prize in science exploring the human eyes' mechanics, to the telson (tail) used to right the overturned crab and not "shoot their stinger at you" when you wade into the shoreline shallows, there still is very little that is known about these unique organisms' ecology, except possibly in its mutualistic relationship to migrating bird populations. In fact, the most dramatic recent-time restriction on horseshoe crab adult harvesting, was prompted by the reduced shore bird numbers observed along the southern New Jersey shoreline for over five years. New Jersey temporarily closed down the eel fisheries in Delaware Bay and along the New Jersey shore, so that an assessment of the horseshoe crab populations could be conducted. The restriction didn't last long, and in 1999, 2.5 million horseshoe crabs were "legally" (by permit), collected for New Jersey eel potters use. (Niles, L., 2000)

Some of the most basic biological information about a species still eludes us in describing horseshoe crabs. The aging of horseshoe crabs, for example, has in many respects been an indirect method. It takes approximately 10 years for horseshoe crabs to mature to adulthood, molting off youthful carapaces

Laughing gulls like this one are commonly seen around (and on) horseshoe crabs.



Here we see two horseshoe crabs copulating in mud at low tide.

16 to 17 times depending on its gender; females molt 17 times, males 16. The significance of this is still unknown and could be more than just polymorphism. Once molted to adulthood they will not molt again for the remainder of their approximately 20-year lives. The age of a horseshoe crab is usually determined by the level of encrusting organisms (i.e. bryozoans, slipper shells, algae, etc.) on their shells.

Limulus' linkage to the shore blends into the biology of a number of species. The life cycle of this invertebrate affects the life cycle of, and is synchronized with the life cycle of several vertebrate species; not the least of which are humans. The first time I observed the "shorebird season" in Delaware Bay on a shore beach near Cape May, NJ, it was truly a shorebird convention with species like Red Knots (*Calidris canutus*) on their way to Canadian arctic breeding grounds coming from as far as the tip of South America. The shoreline appeared to be frothing as if a clothes washer went haywire and discharged soapy waters and bubbling detergents along the coast. This was due to the churning of the waves and their breaking right upon the horseshoe crabs as they released eggs and sperm.

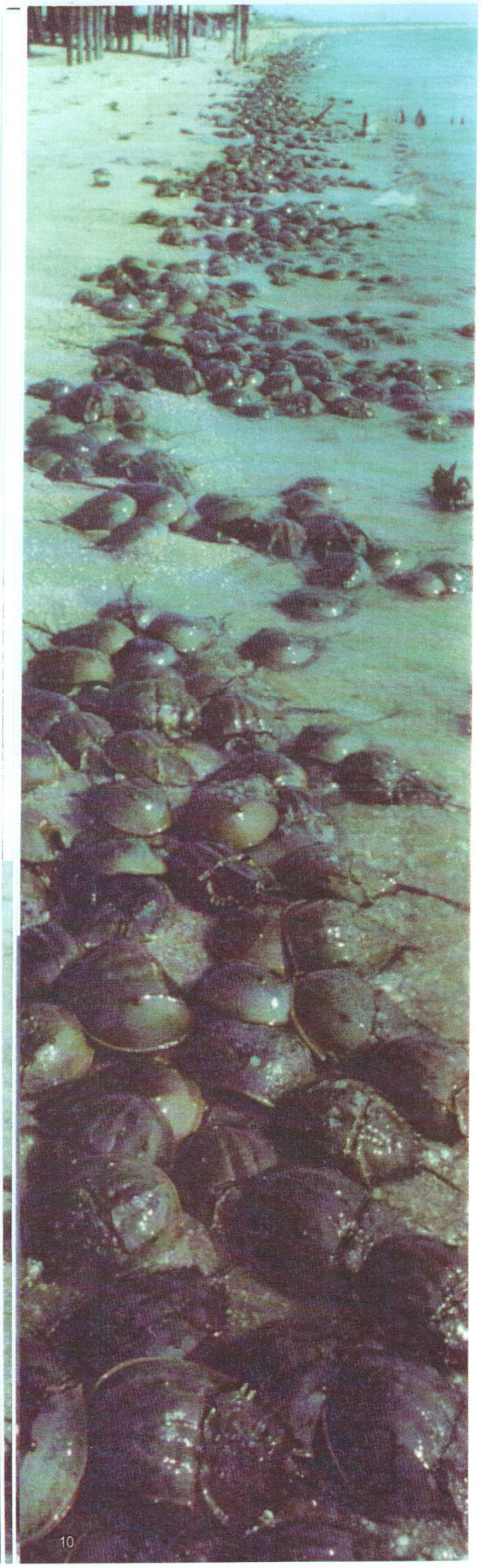
Since 1990 the spawning population in Delaware Bay, which has a history of harvesting crabs dating back to the 1870's when over 4 million were taken from the Bay, has declined. Both conch (*Strombus gigas*) and eel (*Anguilla rostrata*) fisheries continue to harvest females rather than alternative baits and will harvest immature horseshoe crabs, which molt for the last time in the fall. Efforts to allow harvesting offshore, primarily after spawning season, eliminate the most potentially fertile portion of the spawning population. (Berkson, J. and C. Shuster, 1999).

Due to the dependence of coastal migratory shorebirds such as Red Knots (*Calidrus canutus*), Ruddy Turnstones (*Arenaria interpres*), Saunderlings (*Calidris pusilla*) on the food resource provided by millions of horseshoe crab eggs laid at the critical time of peak shorebird migration, these eggs become the primary energy source (weight gains of 40% reported), (Castro, G. et. at., 1989) to support their marathon migration north to the Arctic. The horseshoe crab densities of Delaware Bay have not been found in any other locations on the Atlantic Coast from Maine to Florida. Surface egg densities is the prime factor in attracting up to 1 million shorebirds each year since 1980 when records started being taken for Delaware Bay (Clark, K.E. et al., 1993). The significance of the shorebird impacts globally cannot be overstated. There are approximately 50 shorebird species out of a known total of 177 species in the Western Hemisphere, and they fill dinstinct and unique coastal shoreline niches. Birds that winter in Argentina and Brazil along the Atlantic coastline will follow the Atlantic flyway onto the Arctic. Starting in Argentina, upward of 30% body fat from copious quantities of Horseshoe crab eggs, and then, on to Hudson's Bay or further north to meet up with the summer hatching of flies in their nesting sites in Canada. These stopovers support more than 500,000 shorebirds each year, (Corvin, J., 1998).

Limulus polyphemus is the only "American" species found from Nova Scotia to Florida and into the Gulf of Mexico. Three other species live along the shores of Asia and the East Indies. 60 million years ago, all horseshoe crabs were concentrated in European waters. Then, for some unknown reason, they migrated never to return. Thus the geographic distribution of all four species in only 2 regions.

Studies of the horseshoe crab's eyes have also given scientists vital information about eye disorders such as retinites pigmentosa, which causes tunnel vision and can lead to total blindness. It is the study of the crabs' blue blood caused by a pigment called hemocyanin, which causes the blood to turn bluish in color upon exposure to the air. Limulus lysate a blood faction produced only by this crab is used to research on spinal meningitis, blood clotting and cancer.

Captured crabs are taken to laboratories where blood samples are taken from approximately 250,000 crabs annually for the bio-technical industry worth an estimated $50 million annually. The females lay their eggs (upward of 4,000 per female) up to 8" deep in the sand deposited at the level of the beach



This photograph, taken on the New Jersey side of Delaware Bay, shows an impressive number of horseshoe crabs gathering along the beach.

reached only by the high tides, which occur during the new and full moon. Laying eggs at the high water mark protects the eggs from fish predation such as eels, minnows and juvenile striped bass, but it is the 95,000 red knots estimated to gather at Delaware Bay consuming an estimated 248 tons of eggs that places predation pressure on horseshoe crabs.

Besides over-harvesting, shoreline dynamics and human development have reduced their habitat. Some scientists have indicated that sea level rise, due to global warming phenomena may also be impacting population numbers. Sandy beaches are also dwindling due to erosion and general shoreline retreat. Without reversing these trends, over-harvesting will potentially prove the deathnell of a species that has survived for thousands of millennia.

Scientific research, in support of future population management is sorely needed. Due to the limited "season" for horseshoe crabs, observations are varied in determinations of what would appear to be a fairly simple piece of data for these organisms; namely, the average sex ratios for breeding populations. Different values have been reported for spawning beaches, (Harrington, B. and C. Shuster, 1999) of 5:1 and 3:1 (male to female) to 1:1 for an overall sex ration estimate, (Shuster, C. and M. Botton, 1985).

There are few regulations protecting this animal along the east coast of the U.S. Based upon reported landings (which are notoriously underestimates of actual removal) in New Jersey alone, (Rudloe, A. 1980) harvests have increased in three years from approximately 250,000 in 1993 to over 600,000 in 1996.

The crabs have been used since the 1950's for chitin coatings of suture materials, which have been shown to enhance healing by 35-50%, (Rudloe, A. 1980; NMFP, 1998). There is limited harvesting for blood in leukemia and other cancer research as well as other research associated with endotoxins and other control therapies.

Horseshoe crab habitat is from "muddy" (silt-clay) bottoms (when not spawning) to a gravely/shell substrate. When a sandy beach is not available for spawning, the female will attempt to make nests in a beach of oyster shells or gravel, but will tend to avoid areas of exposed peat. In Chesapeake Bay, the juvenile loggerhead turtles that summer in the bay feed heavily on the crabs. Small fish also feed extensively on the eggs and larvae of *Limulus*. Other predators include such disparate creatures as sharks, sea gulls, boat-tailed grackles and raccoons. Horseshoe crabs are therefore a significant component of the coastal ecosystem of our North American Atlantic estuaries, (Prior, R.B., 1990).

All in all, we have the classic symptoms of anthropocentric perceived needs driving a species down a

track to extinction. Some may say this is an overstatement and that we have enough time to develop a management plan for this species. Our track record unfortunately in protection or preservation of sustainable populations in natural systems does not reflect this as a salient approach. There must be a moratorium on horseshoe crab harvesting for a minimum of three to five years coupled with an intensive investigation into an appropriate management scheme. Only then can we make a more informed decision on the protection and long term preservation of a species that has taken 350 million years to make only to be undone in less than a century.

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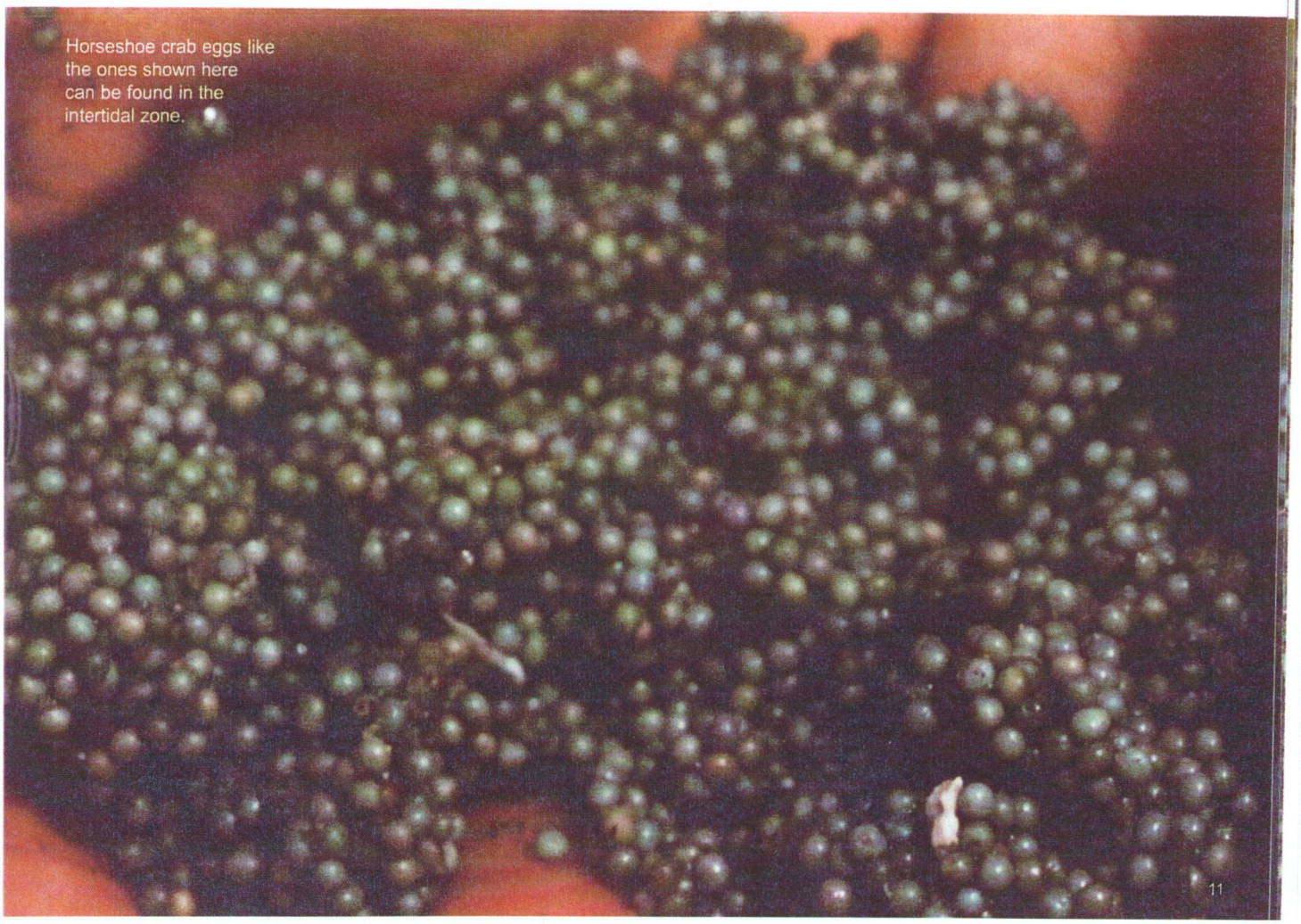

Horseshoe crab eggs like the ones shown here can be found in the intertidal zone.