h11 Mesozoic aquatic reptiles < freshwater and marine >

When I am, death is not. When death is, I am not. —an adage ascribed to Epicurus.[1]

In the Cenozoic, as soon as mammals gained ascendance on land some, the whales, took to an exclusively aquatic mode of life, and some, the seals, remain transitional to that life style. This is an example of evolutionary relay. In the Mesozoic, when reptiles were in ascendance on the land, then also existed a wide variety of aquatic reptiles. Of those, the crocodiles and the venerable turtles continue today. These are tied to the land for reproductive (egg laying) purposes. Also, they are cold blooded. So, for example, the Galápagos iguana between feedings in the cold sea currents "must bask in the sun to keep their body temperatures up and their biochemistry active," says Ryosuke Motani.[2] Land turtles (tortoises) have become the most completely armored animal ever. Other turtles that, beginning in the Cretaceous took to living in the sea, have evolved conservatively. Salt in the sea for a returning land vertebrate, poses the Ancient Mariner problem of water, water, everywhere but nary a drop to drink. Modern marine turtles have kidneys inadequate to the task of voiding excess salt to avert the problem of dehydrated from eating salty food or drinking seawater. To aid their laboring kidneys, marine turtles are more lachrymose than was ever fictional Tiny Tim's family. Diagnostically, in the identification of their fossils, they have tear (lachrymal) glands (each bigger than their brain) modified to excrete a salt solution more concentrated than seawater. Freshwater turtles (terrapins) shed no more tears than do crocodiles. Terrapins are less-specialized in their retention of wrist, ankle and digit bones that are not consolidated into rigid paddles as in marine turtles. Which of the two terrapin specializations evolved first finds its answer in the fossil discovered by Ren Hirayama in 1998 in the Lower Cretaceous Santana Formation, N.E. Brazil, of a 110 million year old side-plate-sized marine turtle.[3] Although its feet are terrapin-like, this oldest known turtle, *Santanachelys gaffneyi*, had enormous salt glands around the eyes (which indicates it to have been marine, as do the sediments in which it was found).[4] Mesozoic aquatic reptiles were warm-blooded.[5] These were mosasaurs (marine lizards) and plesiosaurs (marine reptiles), which went abruptly extinct at the end of the Cretaceous, and ichthyosaurs (marine reptiles), which dwindled to extinction early in the Late Cretaceous even though they had a history of vigorously branching evolution beginning in the Triassic. Ichthyosaurs were the most highly adapted reptiles for life at sea (but not ever as, save for size, extant are the far more evolved ovoviviparous cutaneous-breathing sea snakes, each with a salt-excreting gland under the tongue and poison-delivering chewing fangs in the rear of the jaw).[6]

Mosasaurs "Meuse lizards" (named for the Meuse River in Holland where the first of their fossils was found) were large (up to 15 meters in length) marine lizards that appeared and became abundant in the Cretaceous. They are the most commonly preserved fossil reptiles in South Dakota. Their ancestors could have been among monitor-like land lizards that were becoming adapted during the Early Cretaceous to an aquatic life style.[7]

Plesiosaurs "Near-lizards," the earliest of ocean-going reptiles, had limbs modified into flexible paddles with a jumble of bones that allowed movement for steering and for moving up and down to "fly" through the water (as sea turtle do) but not to "row" back and forth. They likely glided ashore (loon-like) to lay their eggs in beach sand. Short-necked plesiosaurs with long jaws to compensate, as *Trinacromerum*, exited during the Late Cretaceous. During the Jurassic heyday of these giant marine reptiles, only long-necked forms, sometimes called "ribbon reptiles," existed. The first excavated from the Lias in 1823 and sketched looking like a snake threaded through the body of a turtle by Mary Anning (1799-1847), was declared likely a forgery by Cuvier (until Conybeare had formally described it) as it defied comparative anatomical laws for its species by its too many (35) cervical (neck) vertebrae (living reptiles have but 3; mammals, excepting sloths, 7; and, birds 9 to 23 for swans).[8] Loch Ness in Scotland is said to be inhabited by a solitary survivor. But soundings by sonar (acronym for "sound navigation and ranging" originally developed to detect icebergs ahead, to avoid a Titanic disaster repeat) evidenced none.[9] Which leaves unfathomable, continued interest.

Ichthyosaurs "Fish lizards," formal name given by Charles Konig to the Lyme "crocodile," a children's find in 1811 by Joseph (1796-1849) the brother of Mary Anning (famous for her continued fossil collecting as a livelihood in the Lias (Jurassic) sea-cliff exposure, Dorset, England, where: "She sells sea shells by the sea shore. / And the shells she sells are surely sea shells. / Since she sells shells by the sea shore, / I'm sure the shells she sells are seashore shells.") has priority (by a year) over "*Proteosaurus*" coined by Sir Everard Home in inept issuances beginning in 1814 that featured the creature as a crocodile when he could find small germs of conical teeth contained within the larger teeth—the hallmark of a reptile—or later, when he could not, a bird, then a fish, then a fish-like bird without wings, and all between the labor of publishing under his own name the technical notes (which he then burned) of the "founder of modern surgery" his late brother-in-law John Hunter.

Ichthyosaurs were reptiles that went extinct 25 million years before the end of the Cretaceous. They were as throughly marine as are dolphins [10] and, like them, there was no way they could move on land: limbs had become modified into a flexible paddles with a jumble of bones that would allow movement only for steering. Their pelvis was vestigial and not attached to the backbone. Their marine adaptations required a special solution for the continuance of their issue. Possibly, as for some snakes and lizards, eggs were held in the mother's body until they hatched. Speculation ended when the fossil of an ichthyosaur was found with the skeletons of seven "unborn" ichthyosaurs partly within and some drifted out of its body cavity. Skeptical claims that this was not a mother and that the young were a meal (coprolites studied by Buckland,[11] and inspiring the rhyme: "Approach, approach, ingenuous youth/And learn this fundamental truth/The noble science of geology/Is firmly based on Coprology," had shown that young were often cannibalized) is not supported by toothmarks or partial digestion evidence; and in their arrangement, whole young are tumbling out of the cloacal area and not the stomach cavity. As in that specimen, the study of icthyosaurs is greatly aided by fossilizations that include carbonization of soft parts. This type of preservation allowed earlier reconstructions of the icthyosaur tail that had been restored as a straight structure to be corrected to its broken look. The upper part of its shark-like tail fin was not supported by bone. Also, on the icthyosaur back with no bony support for it, there was a large central fin.

Late Triassic ichthyosaurs found in the Union Canyon in the Shoshone Mountains, Nevada, were giants (about the size of a modern sperm whale) with 6 foot long front fins, 25 foot long tails, and 10 foot long skulls with elongate jaws filled with conical teeth. These, named *Shonisaunls popularis* for the surrounding mountain range, were originally excavated by gold prospectors from the mining town of Berlin (now a well-preserved ghost town and part of Nevada's Berlin-Icthyosaur State Park). As the ichthyosaurs were not filter feeders (as is the blue whale, which is the largest swimming vertebrate today) they (as the 23 m long one that Elizabeth Nicholls excavated from 210 million year old marine limestone at Sikanni Chief River, northern British Columbia) hold the record for largest carnivores ever (*T. Rex* is small by comparison).[12] Ichthyosaurs fish-shaped body plan was achieved by the end of the Middle Triassic (when the first dinosaurs, as *Eoraptor*, appeared)[13] and within 20 million years from the appearance of their earliest members 250 million years ago.[14]

Phytosaurs [15] "Plant lizards" were crocodile-like reptiles and not herbivorous (plant-eating) lizards. Phytosaurs went extinct at the end of the Triassic and were not ancestral to crocodiles. Evolutionary relay has placed crocodiles that resemble phytosaurs in the ecological niche that they once occupied. Fossils of several phytosaur genera are abundantly present in freshwater sediments of Late Triassic age and are rare before then. Their fossils occur in North America and Europe but not in the southern continents. This indicates that when they lived they were restricted to the equatorial part of Pangea. An adaptation to their amphibious life style was the far back position of their nostril openings, almost between the eyes, and in some, the two openings were elevated, volcanic-craterlike. An ancestral feature that relates them to the bipedal reptilian stock from which the dinosaurs also arose, is that in the course of their evolution their hindlegs remained considerably longer than their forelegs.

Placodonts [16] and **Nothosaurs** [17] were Triassic lizards. The seacow-shaped placodonts, with teeth specialized to crush mollusks, were the first reptiles to go fully marine. They diverged, during the Triassic, from among the fish-and-cephalopod-eating amphibious nothosaurs. ❑