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# Gerrothorax maritimus: Late Triassic Plagiosaurid Skeletons Reveal the First Fully Marine Amphibian

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Two articulated 237-million-year-old skeletons from pelagic limestone beds in Guizhou Province, China -- paired with marine strontium isotope ratios and interlocking dermal osteoderms -- demonstrate how an armored temnospondyl overcame the osmotic barrier to colonize the open sea [1, 2] .

## Breaking the Tetrapod Osmotic Barrier: Discovery in the Guizhou Pelagic Basin

Across the 370-million-year evolutionary history of tetrapods, amniote lineages -- including ichthyosaurs, plesiosaurs, mosasaurs, sea turtles, cetaceans, pinnipeds, and penguins -- repeatedly reinvaded the world's oceans [1, 4] . Amphibians, by contrast, have remained conspicuously absent from fully marine ecosystems. Among more than 8,700 extant lissamphibian species (frogs, salamanders, and caecilians), none permanently inhabit the open ocean, and fewer than 2% tolerate even brackish estuarine salinities, most famously the crab-eating frog ( Fejervarya cancrivora ) [5] . Because modern amphibians rely on thin, highly vascularized, unkeratinized skin for cutaneous gas exchange and water uptake, immersion in hyperosmotic seawater (~35 PSU, ~1,000 mOsm/kg) triggers rapid transcutaneous dehydration and lethal plasma hypernatremia [5] .

In a landmark study published in Nature Ecology & Evolution , an international paleontological team led by Professor Ryosuke Motani at the University of California, Davis, alongside researchers from Peking University and the Geological Museum of Guizhou, has overturned the long-standing assumption that amphibians were physiologically excluded from pelagic marine realms [1, 2] . The researchers describe Gerrothorax maritimus , a new species of plagiosaurid temnospondyl recovered from ~237-million-year-old (Middle-to-Late Triassic, Ladinian-Carnian boundary) marine carbonate strata in Guizhou Province, southwestern China [1] . Represented by two nearly complete, articulated skeletons measuring approximately 75 to 90 cm (30 to 35 inches) in total length, G. maritimus provides the first definitive fossil and geochemical evidence of an amphibian that completed its entire life cycle at sea [1, 2] .

## Taphonomic & Strontium Isotope Verification of an Open-Ocean Habitat

Earlier reports of coastal or deltaic temnospondyls -- most notably Early Triassic trematosaurids such as Aphaneramma and Wantzosaurus -- left lingering debate over whether those animals were transient euryhaline foragers that bred in freshwater rivers or carcasses washed offshore by flood plumes [4] . To test whether Gerrothorax maritimus was a true marine resident rather than an allochthonous drift specimen, Motani and colleagues combined high-resolution taphonomic analysis with trace-element and strontium isotope ( 87 Sr/ 86 Sr) geochemistry [1] .

Both skeletons were excavated from fine-grained, laminated pelagic micrites deposited in the Nanpanjiang Basin hundreds of kilometers from the nearest paleoshoreline, preserved alongside obligate pelagic marine reptiles including ichthyosaurs ( Qianichthyosaurus ), sauropterygians (nothosaurs and pachypleurosaurs), and marine actinopterygian fishes [1, 2] . Crucially, both specimens preserve delicate, easily disarticulated skeletal elements in life position -- including distal phalanges of all four limbs, hyobranchial ossifications supporting internal gills, and an unbroken mosaic of hundreds of interlocking dermal osteoderms [1] . Post-mortem fluvial transport across hundreds of kilometers of open ocean would have stripped the distal digits and scattered the dermal armor prior to burial. Furthermore, 87 Sr/ 86 Sr ratios measured from bioapatite in the bone and tooth enamel match the global Late Triassic marine seawater curve (~0.7076-0.7078) and co-occurring ichthyosaur standards, ruling out freshwater residency prior to death [1, 4] .

| Paleobiological Parameter | | Gerrothorax maritimus (Guizhou, China) | | Continental Congener ( G. pulcherrimus ) | | Early Triassic Trematosaurids ( Aphaneramma ) | | Extant Euryhaline Lissamphibian ( Fejervarya cancrivora ) |

| Geological Age & Horizon | | ~237 Ma (Ladinian-Carnian, Late Triassic) | | ~235-201 Ma (Middle-Late Triassic, Europe/Greenland) | | ~251-247 Ma (Early Triassic, global coastal) | | Holocene (Southeast Asian mangrove swamps) |

| Depositional Environment | | Offshore pelagic carbonate basin (>150 km from land) | | Freshwater lacustrine, fluvial & brackish deltaic beds | | Nearshore deltaic & epicontinental marine shelves | | Intertidal brackish mangroves (up to ~28-35 PSU) |

| Body Length & Habitus | | ~75-90 cm; dorsoventrally flattened benthic disc | | ~90-100 cm; dorsoventrally flattened benthic ambush predator | | ~150-200 cm; elongate gavial-like piscivore | | ~6-8 cm; terrestrial/semi-aquatic anuran |

| Integumentary Barrier | | Dense, overlapping dorsal & ventral bony osteoderm carapace | | Pustular dermal osteoderms + gastral scales | | Lightly ossified dermal scales; exposed skin | | Permeable unarmored skin + high plasma urea (~300-480 mM) |

| Respiratory Apparatus | | 3 pairs of ossified ceratobranchials (internal gills, neotenic) | | 3 pairs of ossified ceratobranchials with gill rakers | | Adult pulmonary respiration; larval gills | | Cutaneous + buccopharyngeal + pulmonary respiration |

| Geochemical Signature | | Marine 87 Sr/ 86 Sr bioapatite match with ichthyosaurs | | Continental freshwater/brackish 87 Sr/ 86 Sr ratios | | Mixed estuarine/coastal delta 18 O & 87 Sr/ 86 Sr | | Transient urea/Na + osmoregulatory elevation |

## Dermal Osteoderm Armor & Neotenic Gill Architecture as Osmoregulatory Shields

How did a stem-amphibian survive continuous immersion in Late Triassic seawater without succumbing to osmotic desiccation? The anatomy of Gerrothorax maritimus points to a dual morphological and physiological solution centered on its extreme plagiosaurid body plan [1, 3] . Unlike modern lissamphibians, which secondarily lost the heavy dermal bone plating of Paleozoic tetrapods to maximize cutaneous respiration, plagiosaurids retained -- and dramatically hypertrophied -- their

ancestral dermal armor [3] . Both the dorsal trunk and the flat ventral plastron of G. maritimus were encased in a continuous pavement of thick, tightly sutured osteoderms ornamented with tubercular ridges [1, 3] .

This heavily mineralized dermal carapace drastically reduced the surface area of exposed, permeable epidermis in contact with surrounding seawater, functioning much like the cosmoid scales of marine coelacanths or the osteoderm shields of placodont reptiles [1] . By sealing the body wall against passive transcutaneous water efflux and sodium influx, G. maritimus decoupled its integument from gas exchange. Instead, respiration was routed entirely through three pairs of robust, ossified branchial arches (ceratobranchials) housed within a posteriorly open gill chamber [1, 3] . As an obligately neotenic (paedomorphic) tetrapod that retained larval internal gills throughout adulthood, G. maritimus could concentrate specialized ion-transporting mitochondria -rich (chloride) cells along its branchial epithelium to actively excrete excess Na + and Cl ions, likely supplemented by renal and dietary urea retention [1, 5] .

## Benthic Suction-Feeding Biomechanics in the Triassic Marine Recovery

Beyond solving the physiological challenge of marine osmoregulation , Gerrothorax maritimus occupied a specialized biomechanical niche on the Triassic seafloor [1, 2] . With a broad, parabolic skull measuring nearly twice as wide as it was long, upwardly directed orbits positioned on the dorsal skull roof, and a dorsoventrally compressed trunk, G. maritimus was an ecological analog to modern benthic ambush predators such as wobbegong sharks ( Orectolobus ), angelsharks ( Squatina ), and monkfish ( Lophius ) [1, 3] .

Resting motionless on the carbonate seabed -- weighted down by its pachyostotic (densely ossified) ribs, clavicles, and dermal armor -- the amphibian waited for demersal fishes or crustaceans to swim over its snout [1, 3] . Biomechanical reconstructions of the plagiosaurid atlanto-occipital joint and epaxial musculature show that rather than dropping its lower jaw into the sediment, G. maritimus rapidly elevated its upper cranium while depressing its ossified hyobranchial apparatus [3] . This sudden expansion of the buccopharyngeal cavity generated a high-velocity hydrodynamic suction vortex, drawing prey inward across marginal rows of sharp, recurved labyrinthodont teeth before expelling excess water through the posterior gill slits [1, 3] . Its discovery in the Guizhou marine assemblage underscores the extraordinary evolutionary experimentation that followed the End-Permian mass extinction (~251.9 Ma), demonstrating that armored temnospondyls competed directly alongside early marine reptiles in offshore benthic food webs [1, 2] .

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