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Review Article

Ontogenetic Development in the Extinctradiodonts *Squillannorum Laminam* (Birch 2002) And *Kabutops maximus* (Oak 1995)

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ABSTRACT

The growth stages of the Late Cretaceous radiodonts *Squillannorumlaminam* (Birch 2002) and *Kabutops maximus* (Oak 1995) are identified and characterized. Three growth stages are distinguishable in both species by the presence and absence of several clearly identifiable growth characters, and suggest ecological segregation of juveniles and adults, with juveniles hunting small prey in open waters and adults hunting larger prey in the shallows.

Keywords: Ontogeny; Radiodonta; Paleocene-eocene thermal maximum

Squillannorumlaminam (Birch 2002) and *Kabutops maximus* (Oak 1995) are sister taxaradiodonts from the Late Cretaceous Stwarzac Pozory Formation of Japan [1-2]. Clearly distinct larval, juvenile, and adult stages have been identified, but exact ontogenetic changes have yet to be distinguished [1]. This study will identify the changes that occur throughout the ontogeny of both species.

S. laminam is a large radiodont; the largest specimen is 1.5 meters long and likely weighed about 70 kilograms [2-3]. Larvae and juveniles were fully aquatic, but adults were aquatic hunters that were bipedal and rested on land [4]. Their large claws could exert 25,344.0982 psi on prey items like trilobites, and their armored exoskeleton was likely able to withstand attacks from any of their contemporaries (barring other *S. laminam*) including large crinoids (*Cradily* spp.), sea turtles, mollusks, Actinistians, stromatolites, echinoderms, brachiopods, Actinopterigians, and Carvanhadae sharks [2,5,6]. They were likely strong enough to lift and hurl boulders, and their bite force is estimated to be three- quarters of the strength of its claws [5]. *S. laminam* and most of its contemporaries from the Stwarzac Pozory Formation all went extinct at the end of the Paleocene-Eocene Thermal Maximum [7-8].

K. maximus is smaller than *S. laminam*, with the largest specimen being 1.3 meters long and estimated to weigh about 40 kilograms [9-10]. Its life history is similar to *S. laminam*, with aquatic larvae and juveniles and semi terrestrial adults [4]. Like *S. laminam*, they possess impressive claws, but the mouths of *K. maximus* are poorly adapted to eat meat, however, and it has been suggested that they secreted an enzyme that broke down tissue into an aqueous state which could be eaten by *K. maximus* [11].

S. laminam is known from at least three specimens: an adult specimen (ORBMNMM 404) from the underground tunnels below Oreburgh City, Hokkaido Prefecture, Japan; a juvenile specimen (ORBMNMM 111) from the desert of Kumamoto Prefecture, Japan; and a larval specimen (ORBMNMM 113) from a tunnel underneath Fallarbor Town, Oita Prefecture, Japan [9]. All specimens are stored in the collections of the Oreburgh Mining Museum in Oreburgh City, Hokkaido Prefecture, Japan.

ORBMNMM 111 was discovered by May Birch while exploring the northeastern corner of theCentralHoenn Desert. It is a single clawwith articulated partial distal limb, and three frontal planar wing fragments, likely wings II-IV. The claw is robust and segmented into four parts, with the secondmostproximal segment the largest. Proximal segments overlap distal ones, and the partial distal limb is gracile. ORBMNMM 404 was discovered by a miner who reported the discovery to the Oreburgh Mining Museum which excavated the fossil under the direction of Roark Ishi, and is a complete carapace with appendages I-II and frontal planar wings I-III, with intact ocular rings, a clear opercular expansion, a large tail, frontal planar fins, and a snout-vent length of 1.3 meters.

K. maximus is known from at least three specimens: an adult specimen (ORBMNMM 141) from underground tunnels drilled for a canal in Canalave City, Hokkaido Prefecture, Japan; a juvenile specimen (ORBMNMM 140) from a tunnel underneath Mt. Otsukimi in Gunma Prefecture, Japan; and a larval specimen (ORBMNMM N-00-B) from a primarily archaeological excavation in the Ruins of Alph in Nara Prefecture, Japan.

ORBMNMM 141 was discovered by a team led by Byron Ishi, and is a complete carapace with appendages I-II, with impressive

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pectoral claws, wide three lobed cranium, and a snout-vent length of 0.65 meters. ORBMNMM 140 was found by a local boy who obtained it from a nerdy man after a violent altercation and later brought it to the Pewter Museum of Science (Kanagawa Prefecture, Japan), from which it was transferred to the Oreburgh Mining Museum where it was accessioned. It, too, is a complete carapace, with a snout-vent length of 0.51 meters.

From these specimens, growth characters were identified for each species, and a data matrix was created in Prosopis [12] and executed in Clademaster [13]. One tree was recovered for S. laminam, with a consistency index of 1.00 (excluding uninformative characters 1.00), a homoplasy index of 1.00 (excluding uninformative characters 1.00), a retention index of 1.00, a rescaled consistency index of 1.00, an HP of 75.00, an AT of 125.00, a DE of 100.00, an SA of 70.00, an SD of 80.00, and an SP of 45.00.

Three growth stages were recovered, and are termed Basic, Stage 1, and Stage 2. Stage 1 is exemplified by ORBMNMM 111 (commonly referred to as Anorith) and is diagnosed by a grey exoskeleton, a segmented thorax, a caudal fork, four pairs of frontal planar wings, and dorsotemporal craniocaudal lines. Stage 2 is exemplified by ORBMNMM 404 (commonly referred to as Armaldo) and is diagnosed by a cerulean exoskeleton, the development of pelvic girdle limbs, an elongated tail, the development of frontal planar fins, three pairs of frontal planar wings, ocular rings, dorsal spikes, an opercular expansion, a hinged jaw, and the presence of mandibular teeth [Figure 1].The timing of the fusion of the dorsoventral craniocaudal lateromedial phalanges remains unknown.ORBMNMM 113 was identified as the youngest specimen, and ORBMNMM 404 was identified as the oldest specimen.

One tree was recovered for K. maximus, with a consistency index of 1.00 (excluding uninformative characters 1.00), a homoplasy index of 1.00 (excluding uninformative characters 1.00), a retention index of 1.00, a rescaled consistency index of 1.00, an HP of 60.00, an AT of 115.00, a DE of 105.00, an SA of 65.00, an SD of 70.00, and an SP of 80.00.

Three growth stages were recovered, and are termed Basic, Stage 1, and Stage 2. Stage 1 is exemplified by ORBMNMM 140 (commonly referred to as Kabuto) and is diagnosed by a brown exoskeleton, a black ventral torso, an unsegmented thorax, pectoral and pelvic claws, and compound eyes. Stage 2 is exemplified by ORBMNMM 141 (commonly referred to as Kabutops) and is diagnosed by a grey ventral torso, a segmented torso, the development of pelvic girdle limbs, an elongated tail, the development of pectoral claws, 3 pairs of frontal planar spikes, a three lobed cranium, refractive corneal eyes, a hinged jaw, and a laterodorsal cranial expansion [Figure 2].The timing of the fusion of the dorsoventral craniocaudal lateromedial phalanges remains unknown.ORBMNMM N-00-B was identified as the youngest specimen, and ORBMNMM 141 was identified as the oldest specimen.

While both juvenile and adultS. laminam have caudal forks, adult tails are significantly longer. As studies suggest that caudal forks increase agility significantly more than longer tails, it is possible that the longer tails are a display of sexual maturity [14]. Tails may also serve as a counterweight while on land, as adults are likely amphibious while juveniles are completely aquatic [1]. Changes in coloration (from grey to cerulean) and the expansion of the opercular region are also likely related to sexual maturation, although the enlarged opercular region may also allow for increased bite forces.

Specimens with unusual coloration of both species have been found, including a specimen of the same growth stage as ORBMNMM 111 with a tan exoskeleton, a specimen of the same growth stage as ORBMNMM 404 with a reddish hue, and specimens of the same growth stages as ORBMNMM 140 and 141 [9]. These alternate colorings (popularly referred to as “shinies” due to their unique sparkling coloration) appear to be quite rare, with estimates of their occurrence ranging from one of every thousand specimens to one of every eight thousand specimens, and their appearance has been documented in nearly all members of Monstrasinu [2,6,7].

Their rarity may be due to “shininess” being a trait passed on by multiple interacting recessive genes, although given that the incidence of these “shinies” does not vary between sexes, the genes involved are unlikely to be carried on sex chromosomes [8]. Resolution of this question requires genetic analysis and controlled breeding experiments of Monstrasinu. Evolutionarily,

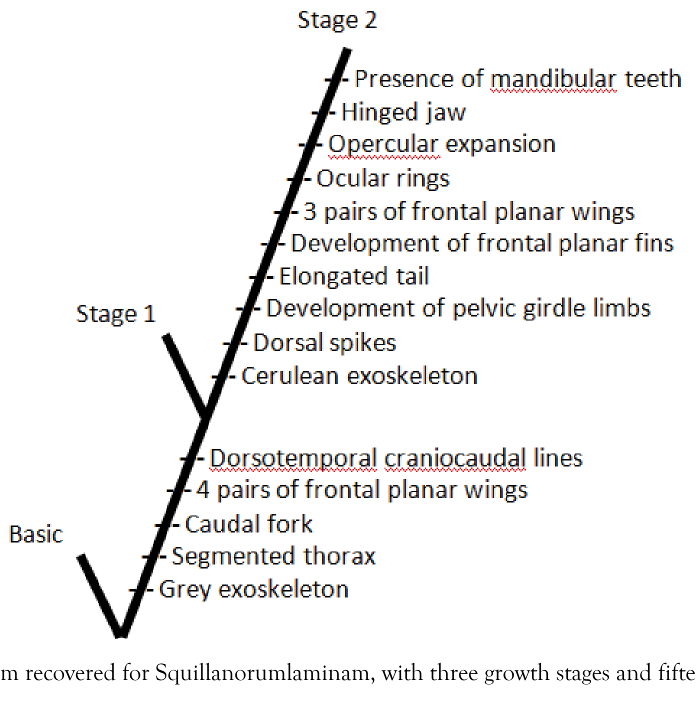

Figure 1: The ontogram recovered for Squillanorumlaminam, with three growth stages and fifteen growth characters.

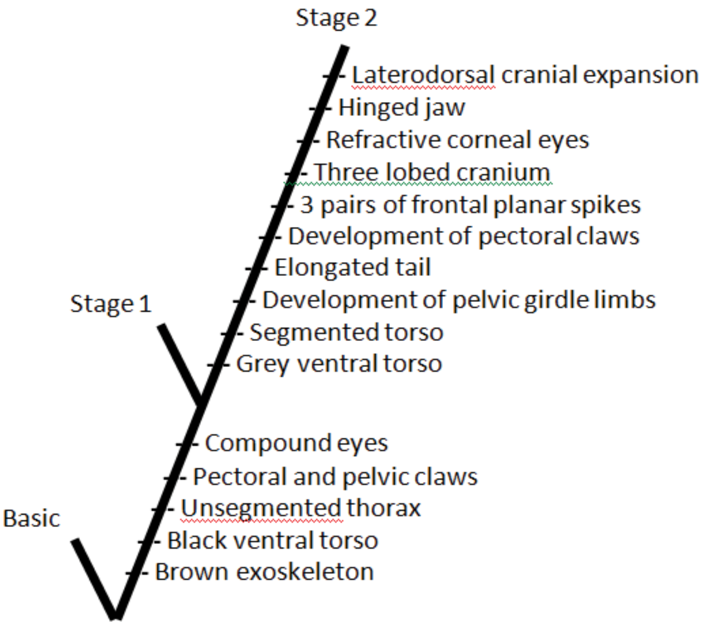

Figure 2: The ontogram recovered for Kabutops maximus, with three growth stages and fifteen growth characters.

their coloration may be maladaptive, putting these “shiny” S. *laminam*and.

K. maximus at a reproductive disadvantage and further explaining their rarity among wild Monstrasinu, although their uniqueness results in many living examples of “shinies” being captured by wild Monstrasinu trainers [12-14]. Indeed, it is through the actions of these trainers that the existence of “shinies” has been brought to the attention of science [14].

Development of the pelvic girdle limbs shortly before becoming an adult helps to segregate adult and juvenile S. *laminam* in a manner similar to dragonflies [7,13-15]. While adult S. *laminam* hunted in the shallow waters near the shore, juvenile S. *laminam* would hunt their prey further away from the shore, where they would avoid competing for prey with the previous generation. This may also explain the differences in coloration between juveniles and adults. The ocular rings of adults would have limited their cone of vision but increased the range of their binocular vision [16,17]. As adults were likely apex predators, they would not have needed a wider cone of vision to look for potential predators (like Carvanhadae sharks) but would have benefitted from improved binocular vision for hunting prey items such as *Omanyte* spp. [18].

Fewer frontal planar wings in adult S. *laminam* further suggests that adults were less agile than juveniles and adapted to hunt different prey. Hinged, homodont jaws would also allow adult S. *laminam* to eat different prey items than juveniles, although it is unusual that only mandibular teeth are present [19,20]. More unusual is that an uneven number of mandibular teeth are present, with two molars and a single premaxillary tooth shared between both premaxillae, with two roots, one anchored in each premaxilla. It should be noted that since S. *laminam* and *K. maximus* are fictional pocket monsters, real-life biological principles are unlikely to always apply. Specimens at an age between ORBMNMM 111 and ORBMNMM 404 are needed to learn more of this highly derived tridonty. Regardless of dental abnormalities, juveniles would eat small, swift-moving prey in open waters, while adults would hunt larger, slower prey in the shallows.

The purpose of the dorsal spikes in adult S. *laminam* is unclear. While they protect a natural blind spot, they would not protect from other S. *laminam***,** as they would be more likely to use their claws offensively than their teeth, and their hard carapace would be a suitable deterrent against Carvanhadae sharks found in the Stwarzac Pozory Formation [11,14]. Dorsal spikes could be a signal of reproductive fitness to prospective mates, or may indicate a yet to be discovered predator of S. *laminam***.** This hypothetical predator could be a large Carvanhadae shark or another large member of Ferrumaquidae, but could also be a member of a terrestrial clade like Carnivora or Tyrannosauridae. Like many amphibious species, S. *laminam* would have been faster in the water than on land, and would have benefitted from additional defenses against potential predators on dry land [21,22].

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REFERENCES

1. Birch J, Birch M. Paleontological discoveries in hoenn. J Route Analysis. 2003;3:111-113.
2. Shelomi M, Richards A, Li I, Okido Y. A phylogeny and evolutionary history of the Pokémon. Improbable Res. 2012;18:15.
3. Oak S. A Novel species of radiodont from the stwarzac pozory formation. Proceedings of the geological society of Kanto. 1995;1:140-141.
4. Mulder F, Scully D. Pseudo-insect proliferation threatens small towns. J Soc Sci. 1996;3:22.
5. Cobey KD, Lalu MM, Skidmore B, Ahmadzai N, Grudniewicz A, Moher D, et al. What is a predatory journal? A scoping review. *F1000Res.* 2008; 7:1001.
6. Duchovny D. The schizophrenic critique of pure reason in beckett’s early novels. Thesis, Princeton University. 1982.
7. Beall J. Dangerous predatory publishers threaten medical research. J Korean Med Sci. 2016;31:1511-1513.
8. Laurel A, Oak S. We don’t exist: Pseudonyms and fictional characters and institutions in this journal article. J Route Analysis. 2020;7:44-53.

9. Stone S, Cozmo T. Rocks of the Hoenn region. Hoenn Geological Bulletin. 2003;83:6.
10. Jones I. Nazi activities threaten old world archaeology. Spielbergia. 1937;3:1.
11. Simon A. Pitfalls of predatory journals: A personal account. Comprehensive Psychol. 2016;5:1-5.
12. Calvin J, Hobbes T. Capturing tigers (*Panthera tigris*) using common sandwiches. J Vis Art. 1985;9:85-95
13. Monster T. Evaluation of the letter of the day program as a means of imparting spelling knowledge. Public broadcasting system. 2004.
14. Beall J. What I learned from predatory publishers. Biochem Med. 2017;27:273-278.
15. Stone S, Cozmo T. Mirage towers in the sand: Temporary sand structures in northern hoenn. J Route Analysis. 2004;93:21-28.
16. Birch J. An overview of the stwarzacpozory formation. Hoenn Geological Bulletin. 2003;32:22-37.
17. Oak S, Elm J. New discoveries of *Omanyte* spp. in Kanto. Kanto J Paleontol. 1999;8:12.
18. Wandersee JH. Humor as a teaching strategy. Am Biol Teach.1982;44:212-218.
19. DeVito D. A robust phylogenetic analysis of extinct creepy crawlies. J Phylogeny Syst. 2020;65:8.
20. Pierce BF, McIntyre J, Burns F, Treating combat wounds in mobile army surgical hospitals. Columbia J Med. 1950;1:1-24.
21. Oak S, Rowan W. The masuda method as a means of increasing "shiny" encounter rate. J Biogeogr. 2007;1:4096-8192.
22. Tribbiani J. A quantitative analysis of the efficacy of "how you doin'" as an opposite sex attractant. New York J Rent Control Apart. 1995;8:1-22.