龙形类：为三趾生物提出的基础四足动物新分类群

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摘要

本文提出设立一个新的分类群——龙形类，用于归类在秘鲁纳斯卡地区发现的三趾生物。形态学、发育学与矿物学证据表明，这些标本展现出与原始两栖类或基础四足动物形态一致的特征。其特征包括三趾性、融合锁骨（叉骨）、腹肋、类似尾骨融合的荐骨、融合的四肢骨骼、气腔化骨骼结构，以及适应皮肤呼吸的特征。矿物学分析揭示了嵌入的海洋沉积物，提示这些生物源于半水生或两栖环境。综合这些证据（卡萨斯，未发表手稿，2025年），支持将龙形类确立为一个独特的基础四足动物谱系。

引言

纳斯卡三趾生物标本已通过多学科手段进行了分析，包括CT成像、形态测量断层扫描、组织学以及矿物学研究（科罗特科夫 2019；埃尔南德斯-乌阿里保卡尔等 2024）。"J型"与"昆虫型"形态表明，存在与早期四足动物演化相关的形态创新（克拉克 2012；苏斯 2019；迈尔斯 2022）。作者最初提出了原始两栖类与基础四足动物假说，基于对这些标本的早期分析（卡萨斯，未发表手稿，2025年）。

原始两栖类与基础四足动物假说

该假说认为，这些三趾标本源自早期两栖类祖先，保留了皮肤呼吸、变态发育以及气腔化骨骼适应特征。为容纳这一谱系，作者提出了新的分类群：龙形类，代表具有原始两栖特征的基础四足动物。

地质时间线与系统发育背景

关键形态特征对应于泥盆纪（公元前4.19亿至3.59亿年）和石炭纪早期（公元前3.59亿至3.23亿年）的演化节点：

- **腹肋：出现于早期四足形态鱼类（约3.85亿年前）（克拉克 2012）。**
- **叉骨：在基干四足动物中已出现，至石炭纪早期变得明显。**
- **气腔化骨骼：出现在早期半水生四足动物（约3.75亿年前）（苏斯 2019）。**
- **类尾骨融合：由作者根据标本分析提出（卡萨斯，未发表手稿，2025年），类似于棘螈类动物（约3.65亿年前）中的特征。**
- **三趾性：提示生态适应的特殊化。**

尽管这些特征在早期四足动物中各自出现，但尚无已知谱系同时保留完整的祖先特征。随着泥盆纪至石炭纪的过渡，羊膜动物与现生两栖类各自失去了关键特征。因此，三趾标本所保留的腹肋、叉骨、气腔结构、荐骨融合、三趾性及皮肤呼吸，代表了独特的进化状态。

形态学特征

标本展示出的关键特征包括：

- **所有个体均具有三趾手和足。**
- **四肢骨骼融合（尺桡骨、胫骨结构融合）。**
- **存在融合锁骨（叉骨）。**
- **腹肋结构表明原始呼吸适应。**
- **骨骼气腔化（通过成像观察）。**
- **推荐骨融合，形成类似尾骨的结构。**

- **缺乏尾骨，与变态发育中的尾部缩短一致。**
- **存在皮肤呼吸与排泄适应特征。**
- **缺乏牙齿，取而代之的是前齿板，暗示以柔软或流体食物为主的饮食专化。**

形态多样性与谱系推测

所谓的"昆虫型"形态表现出明显的脊柱突起。"昆虫型"的称呼在此被视为误用，因为这些结构与节肢动物无关。更合适的称呼是三趾纳吉型，代表一种缺乏眶上弓的可能祖型。

眶上弓的缺失暗示，J型标本的眶上弓可能来源于与灵长类祖先（如类黑猩猩）的杂交。因此，J型可能代表两条不同进化线路之间的中间杂交形态。

观察到的三趾纳吉型脊柱突起不太可能是退化的翅膀或气动结构。考虑到气腔化和半水生适应，这些脊柱突起可能具有以下功能：辅助浮力调节、通过增加表面积促进皮肤呼吸、或协助体温调节。但其确切生物学功能仍有待进一步研究。

幼体发育、变态与胃育现象

作者在成体标本内部检测到了幼体存在，观察到四颗含有胚胎的卵。在成像之前，作者根据比较形态学推测前肢发育优先，后续成像证实了这一预测。

胚胎的内部存在表明一种卵胎生或兼性胎生的繁殖方式，可能包括胃育现象，即胚胎在消化道或体腔内发育。

不同发育阶段的胚胎分布，暗示了异步发育（分批孵化）。此外，缺乏明显的交配结构也提出了孤雌生殖的可能性，尽管仍需更多证据加以证实。

矿物学证据与环境推断

骨骼分析揭示了海洋矿物质的沉积，支持了半水生或河口环境的假设（延森等 2024；格罗夫斯与帕莱尼克 2017）。

这种半水生联系与古代神话传说中将蛇形生物与水体相联的观念相呼应。在南亚与东亚的语言传统中，“龙”常用来指代与湖泊、河流及地下水域有关的神灵或蛇形生物。

气腔结构与功能形态

CT成像显示头骨与长骨中存在广泛的气腔化现象（埃尔南德斯-乌阿里保卡尔等 2024），表明具备浮力适应。作者正式命名眶上弓后方的独特凹陷为卡帕结构。

卡帕得名于日本民间传说中的妖怪，其头部拥有可盛水的凹槽。卡帕的存在挑战了如骆驼类等哺乳动物改造假设。"约瑟芬娜"标本清晰展示了卡帕特征，进一步支持三趾生物为非哺乳类独特形态。

卡帕的解剖学位置暗示其可能具有感知或调节功能，类似于现存两栖动物中的顶眼或松果体结构。

文化附录：太平洋西北地区青蛙人传统

太平洋西北地区的多个原住民群体，如海达族、特林吉特族、海岸萨利希族及夸夸卡瓦克族，保存着关于类蛙生物的神话。在这些传统中，青蛙常被视为能够在水陆之间穿梭、具备变形能力与处于界限状态的存在。

在海达族神话中，青蛙（k'úust'áan）充当物质世界与精神世界之间的信使，反映出两栖性与变态发育的特征（博厄斯 1916）。类似地，海岸萨利希族传统将青蛙视为标志从神话时代过渡到人类时代的原始存在。

图腾柱、面具及仪式用具中广泛描绘了具有宽口、扁平头和蹲伏半水生姿态的拟人化青蛙，与三趾生物所展现的适应特征高度一致。

这些反复出现的青蛙生物形象可能反映了对古代半水生或两栖生物的文化记忆，与龙形类生物学证据产生共鸣。

结论

虽然理论上存在三趾生物在保持基础形态特征的同时与其他陆地生命形式并行演化的可能性，但综合形态学、发育学与矿物学证据，更加支持将龙形类作为独立分类群，甚至可能作为新巨纲的解释。

作者在本研究中的原创贡献，包括发现幼体存在、识别荐骨融合、提出卡帕结构、预测前肢发育优先性，以及确立原始两栖类与基础四足动物假说，体现了科学自下而上的发展过程，预示着秘鲁纳斯卡三趾生物作为曾经存在生命体的正式确认。

鉴于生物学与文化记忆之间的重要交集，未来研究应进一步探索世界各地原住民关于两栖生物的传统，以发掘人类祖先可能与这些半水生存在接触的历史证据。

Nagalomorpha: Proposed Clade of Basal Tetrapods for the Tridactyls

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Abstract

This paper proposes the establishment of a new clade, Nagalomorpha, to categorize the tridactyl beings recovered near Nazca, Peru. Morphological, developmental, and mineralogical evidence indicates that these specimens exhibit traits consistent with proto-amphibian/basal tetrapod forms. Traits include tridactyly, fused clavicles (furcula), gastralia, a urostyle-like sacral fusion, fused limb bones, pneumatic skeletal structures, and adaptations for cutaneous respiration. Mineralogical analyses reveal embedded marine sediments, suggesting a semi-aquatic or amphibious origin. Recognition of these combined traits, as originally proposed by the author (Casas, unpublished manuscript, 2025), supports Nagalomorpha as a distinct basal tetrapod lineage.

Introduction

The Nazca tridactyl specimens have been subject to multidisciplinary analysis, including CT imaging, morphometric tomography, histology, and mineralogical studies (Korotkov 2019; Hernández-Huaripaucar et al. 2024). Common anatomical features across "J-type" and "insectoid" morphotypes highlight morphological innovations aligned with early tetrapod evolution (Clack 2012; Sues 2019; Miles 2022). The author originally proposed the Proto-Amphibian/Basal Tetrapod Hypothesis based on early analysis of these specimens (Casas, unpublished manuscript, 2025).

Proto-Amphibian/Basal Tetrapod Hypothesis

The Proto-Amphibian/Basal Tetrapod Hypothesis posits that the tridactyl specimens derive from early amphibian ancestors retaining cutaneous respiration, metamorphic development, and pneumatic skeletal adaptations. To accommodate this lineage, the author proposes the clade **Nagalomorpha**, representing basal tetrapods with proto-amphibian traits.

Geologic Timeline and Phylogenetic Context

The key morphological features correspond to evolutionary milestones during the Devonian (419–359 million years ago [Ma]) and early Carboniferous (359–323 million years ago):

- **Gastralia:** Appearing in early tetrapodomorph fishes (~385 million years ago) (Clack 2012).
- **Furcula:** Documented in stem tetrapods, prominent by the early Carboniferous.
- **Pneumatic bone structures:** Emerging in early semi-aquatic tetrapods (~375 million years ago) (Sues 2019).
- **Urostyle-like sacral fusion:** Identified by the author based on specimen analysis (Casas, unpublished manuscript, 2025), seen in amphibian-like tetrapods such as *Acanthostega* (~365 million years ago).
- **Tridactyly:** Suggestive of specialized ecological adaptations.

While these traits appeared separately among early tetrapods, no known lineage retains the full suite of ancestral characteristics. Following the Devonian-Carboniferous transition, clades such as amniotes and lissamphibians each lost key features. Thus, the tridactyl specimens' preservation of gastralia, furcula, pneumatic structures, urostyle fusion, tridactyly, and cutaneous respiration represents a uniquely conserved evolutionary state.

Morphological Characteristics

Key features identifying the tridactyl specimens as proto-amphibian/basal tetrapods include:

- Tridactyl hands and feet across all specimens.
- Fused limb bones (ulnius and tibial structures).
- Presence of a furcula (fused clavicle).

- Gastralia suggesting primitive respiratory adaptations.
- Pneumatic skeletal structures visible via tomography.
- Sacral urostyle-like fusion.
- Absence of coccyx, consistent with tail reduction through metamorphosis.
- Cutaneous respiration and waste removal adaptations.
- Absence of dentition, replaced by predentary plates suggesting a soft or fluid diet specialization.

Morphological Diversity and Proposed Lineages

Examination of the so-called "insectoid" morphotype reveals a pronounced spinal protrusion. The term "insectoid" is here considered a misnomer, as the morphology shows no true arthropod affinities. A more appropriate designation may be **Tridactyls nagi**, representing a likely antecedent type specimen lacking supraorbital arches.

The absence of these arches suggests that their presence in J-type specimens may derive from hybridization with a primate lineage, potentially chimpanzee-like ancestors. Thus, J-types could represent an intermediary hybrid form between two disparate evolutionary lines.

The pronounced spinal protrusions observed in Tridactyls nagi are unlikely to represent vestigial wings or aerodynamic structures. Given their association with pneumaticity and the aquatic or semi-aquatic adaptations proposed for Nagalomorpha, several functional interpretations are plausible. The spines may have contributed to buoyancy control, aided in cutaneous respiration by increasing dermal surface area, or served thermoregulatory functions by facilitating heat exchange. However, the precise biological role of these structures remains uncertain.

Larval Development, Metamorphosis, and Gastrobrooding

The author detected evidence of larvae within adult specimens, observing four eggs containing embryos. Prior to imaging, the author hypothesized preferential front-limb development based on comparative morphology; subsequent imaging confirmed this prediction.

The internal presence of embryos suggests an ovoviviparous or facultatively viviparous reproductive strategy, possibly including gastrobrooding, wherein larvae develop internally within modified digestive or coelomic chambers.

The staggered embryonic stages observed imply asynchronous development (sequential hatching). In addition, the absence of mating structures raises the possibility of parthenogenesis, although further evidence is required to confirm this.

Mineralogical Evidence and Environmental Implications

Bone analysis revealed marine mineralization, supporting the hypothesis of a semi-aquatic or estuarine paleoenvironment (Jensen et al. 2024; Groves and Palenik 2017).

This semi-aquatic association resonates with ancient cosmological accounts that symbolically link serpentine beings to bodies of water. Linguistic traditions across South and East Asia preserve the term *Naga* as denoting water deities or serpentine beings associated with lakes, rivers, and subterranean aquatic realms.

Pneumatic Structures and Functional Morphology

CT imaging demonstrated extensive cranial and long bone pneumatization (Hernández-Huaripaucar et al. 2024), indicative of buoyancy adaptations. The author formally designates a distinctive concave depression posterior to the supraorbital arches as the **kappa**.

The *kappa* is named after the mythological Japanese *yōkai*, known for a head depression capable of retaining water. Its presence challenges terrestrial mammal modification hypotheses, such as those involving camelids. The specimen "Josefina" clearly exhibits the interruption associated with the kappa, supporting the tridactyl morphology as distinct and non-mammalian.

The kappa's anatomical positioning suggests a sensory or regulatory function akin to parietal or pineal-related structures seen in extant amphibians.

Cultural Addendum: Frog-People Traditions of the Pacific Northwest

Several Indigenous peoples of the Pacific Northwest, including the Haida, Tlingit, Coast Salish, and Kwakwaka'wakw, preserve myths of frog-like beings. In these traditions, frogs often represent beings capable of moving between water and land, transformation, and liminality.

In Haida mythology, the frog (*k'úust'áan*) serves as a messenger between the material and spiritual worlds, reflecting traits of amphibiousness and metamorphosis (Boas 1916). Similarly, Coast Salish traditions view the frog as a primordial figure marking the transition from the mythological to the human era.

Totem poles, masks, and ceremonial artifacts depict anthropomorphic frogs with wide mouths, flattened heads, and squat, semi-aquatic postures—morphological features broadly consistent with adaptations observed in the tridactyl specimens.

These recurring frog-beings in oral traditions may reflect an ancient cultural memory of amphibious or semi-aquatic entities, resonating with the biological evidence presented for the proposed Nagalomorpha clade.

Conclusion

While it remains theoretically possible that the Tridactyls evolved in parallel to other terrestrial life while retaining basal morphological traits, the preponderance of morphological, developmental, and mineralogical evidence favors the recognition of the Nagalomorpha clade—and possibly a distinct megaclass—as the more probable explanation.

The author's original contributions, including detection of larval forms, identification of the urostyle, suggestion of the kappa structure, prediction of front-limb superiority, and development of the Nagalomorpha Proto-Amphibian/Basal Tetrapod Hypothesis, demonstrate the grassroots movement of science as a precursor to formal recognition of the Tridactyls of Nazca, Peru as once living beings.

Given the significant intersections between biology and cultural memory, future research should further explore amphibian-associated traditions among Indigenous peoples as possible reflections of humanity’s ancestral encounters with amphibious beings.

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