学位論文　（要約）

Osteological and myological evolutionary sequences of the pes in Archosauria, with an emphasis on Theropoda (Dinosauria: Saurischia)

（獣脚類（恐竜類：竜盤類）をはじめとする
主竜類における足の筋骨格系の進化シークエンス）

平成 28 年 2 月博士（理学）申請

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ABSTRACT

Archosauria is the least inclusive clade containing living crocodiles and birds and radiated extraordinarily during the Mesozoic. This clade consists of highly diverse extinct species, many of which differed substantially from their extant relatives in morphology. In their evolutionary history, archosaurs display a trend toward increasing bipedalism, that is, the forelimbs tend to be reduced in contrast to the development of the hindlimbs becoming major weight-bearing and locomotor appendages. The limb morphology is the most informative in understanding the locomotor modes. Since Romer's pioneering work on the limb anatomy and myology, archosaur locomotion has been extensively discussed in paleontology and comparative biomechanics. In addition, the recognition of extant birds as the direct descendants of Mesozoic theropod dinosaurs has led to further understanding of major evolutionary changes in the limb morphology and function in the entire evolutionary history of Archosauria. Despite numerous attempts of reconstructing the hindlimb musculature in archosaurs, the most distal portion, the pes, has often been neglected.

In order to infer evolutionary changes in the pedal muscles, their detailed homologies among reptilian taxa, as well as osteological correlates of their attachments on the skeleton, were established based on dissections and literature reviews. As a result, the homologies of m. tibialis cranialis and m. extensor digitorum longus between non-avian and avian reptiles were revised, challenging the classical interpretations. The new hypothesis in which the avian m. tibialis cranialis and non-avian m. extensor digitorum longus, as well as the avian M. extensor digitorum longus and non-avian M. tibialis anterior, are homologized is more plausible because it requires no difference in the attachment sites between the avian and non-avian homologues unlike the classical hypothesis. In addition, many dorsal and plantar interosseous muscles that have previously been regarded as a part of the short digital extensors or flexors were divided into multiple distinct muscles in non-avian reptiles as a result of the present study. These subdivisions previously unknown for non-archosaurian reptiles have enabled the comparison of short pedal muscles between non-avian reptiles and avians.

To reveal the evolutionary history of the musculoskeletal complex of the pes, the morphology of the hindlimb skeleton was examined in a broad range of fossil archosaurs with a particular emphasis on the osteological correlates of the musculature.

As a result, many osteological correlates were recognized, and most of them present in basal archosaurs appeared to have been displaced or disappeared in their evolutionary history toward extant birds over the past 250 million years.

Based on osteological correlates, the evolutionary sequences of the pedal musculature among archosaur lineage were inferred with a focus on theropod dinosaurs, with the ancestral state successfully reconstructed on each node on the line to birds. The transition of the pedal muscle morphology from the ancestral to derived conditions was revealed to have occurred sequentially along the lineage of bird-line archosaurs. However, the acquisition of erect, digitigrade and bipedal posture in basal ornithodirans was inferred to have been associated with the reduction of the plesiomorphic device for reducing the bending moment of the pes. In contrast, although the 'knee-driven' locomotion would have been aided by the lightened distal limb, the reduction of the muscle mass in the pedal region appears to have occurred as a further optimization of the plesiomorphic, hip-driven locomotion through reduction of the energy required for the stride cycle. Although the present study was focused on the anatomy of the pes as a clue for tracing the evolution of the pedal locomotor function in Archosauria, the pedal muscle reconstructed here will also contribute to refining the kinematic analyses. Moreover, further study on the reconstruction of other soft tissues of the pes will contribute to connecting skeletal and ichnological data and revealing the evolution of locomotor traits in Archosauria.

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CHAPTER 2 – Homology and Osteological Correlates of Pedal Muscles among Extant Reptiles

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FIGURES

TABLES

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APPENDIX 1 – Institutional abbreviations

AMNH: American Museum of Natural History, New York, USA

FMNH: Field Museum of Natural History, Chicago, USA

IGM: former abbreviation of MPC-D (Geological Institute of the Mongolian Academy of Sciences), Mongolia

IVPP: Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Science, Beijing, China

MACN: Museo Argentino de Ciencias Naturales 'Bernardino Rivadavia', Buenos Aires, Argentina

MCF-PVPH: Museo Carmen Funes, Plaza Huincul, Neuquén Province, Argentina

MPC: Paleontological Center of the Mongolian Academy of Sciences, Ulaan Baatar, Mongolia

NHMUK: Natural History Museum, London, UK

PVL: Paleontología de Vertebrados, Instituto Miguel Lillo, Tucumán, Argentina

PVSJ: Division of Paleontology of the Museo de Ciencias Naturales de la Universidad Nacional de San Juan, Argentina

SMNS: Staatliches Museum für Naturkunde, Stuttgart, Germany

UCMP: University of California Museum of Paleontology, Berkeley, USA

UMNH: Utah Museum of Natural History, Salt Lake City, USA

YPM: Yale Peabody Museum, New Heaven, Connecticut, USA

APPENDIX 2 – Character Matrix

[redacted]

[redacted]

APPENDIX 3 – Details of the results of ancestral state reconstructions

[redacted]

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