



Short communication

Homology of the muscles within the uropatagium membrane in *Leschenault's rousette* (*Rousettus leschenaultii*)

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ARTICLE INFO

Article history:

Received 13 February 2017

Accepted 24 July 2017

Handled by Daisuke Koyabu

Available online 29 July 2017

Keywords:

Rousettus leschenaultii

Uropatagium

Homology

Musculus uropatagialis

Musculus depressor ossis styliiformis

ABSTRACT

Pteropodidae possess unique muscles in the uropatagium called Musculus uropatagialis and M. depressor ossis styliiformis. The homology of these muscles is important for the phylogenetic analysis of bats because the wing membrane is a characteristic feature for them. Here, I discuss the homology of M. uropatagialis and M. depressor ossis styliiformis in *Rousettus leschenaultii* by tracing their innervations. I found that the dominant nerve for the M. uropatagialis contains the components of the sciatic nerve associated with the dominant nerve of the flexor muscles of the thigh. This result shows that M. uropatagialis is homologous to the flexor muscles of the thigh. The dominant nerve of M. depressor ossis styliiformis is the lateral plantar nerve derived from the tibial nerve. Thus, this innervation pattern proposes the hypothesis that M. depressor ossis styliiformis is homologous to one of the muscles of the foot sole.

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Bats (Chiroptera) are the only mammals capable of powered flight and possess wing membranes (propatagium, plagiopatagium, uropatagium, and dactylopatagium) associated with flight control (Norberg, 1972) (Fig. 1A). These wing membranes contain the wing muscles, which is a characteristic feature. The wing muscles are considered to play essential roles in controlling the shape of the wing and allowing the bats to fly (Neuweiler, 2000). On the basis of an anatomical and developmental study, the precursor of each wing muscle is reported to have a different ontogenetic origin (Tokita et al., 2012).

The specialized muscle within the propatagium of Yinpterochiropteran *Pteropus* sp. and Yangochiropteran *Myotis lucifugus* and *Tadarida brasiliensis*, that is, Musculus occipito-pollicalis, receives double innervation by both the facial and cervical spinal nerves (Thewissen and Babcock, 1991, 1992). Such a double innervation that occurs in bat muscles does not occur in any other mammalian muscle including Dermoptera with propatagial muscle, suggesting that all bats are monophyletic (Thewissen and Babcock, 1991, 1992). Regarding the homology of the dactylopatagium brevis involved in the distal segment of the M. occipito-pollicalis, Amador et al. (2015) suggested that the dactylopatagium brevis is a part of the propatagium, and this assertion is also supported by developmental evidence. Although the homologies of the wing muscle and membrane in the propatagium have been revealed, knowledge of

the homology of the wing muscles involved in the uropatagium is currently quite poor.

M. uropatagialis and M. depressor ossis styliiformis are embedded within the uropatagium in Pteropodidae (Yinpterochiroptera), and are muscles involved in the control of the uropatagium membrane (Schutt and Simmons, 1998). M. uropatagialis has been known to be present only in the species of Pteropodidae (Norberg, 1972). The morphology of the M. uropatagialis was described by Humphry (1869), MacAlister (1872), Schumacher (1932), Mori (1960), and Norberg (1972). M. depressor ossis styliiformis of several species of bats has been reported (Humphry, 1869; MacAlister, 1872; Vaughan, 1959, 1970; Simmons, 1998). M. depressor ossis styliiformis, which controls the position of the calcar relative to the tibia and ankle, is a unique muscle in bats, and the presence of a calcar and M. depressor ossis styliiformis can be interpreted as a synapomorphy of bats (Simmons, 1994).

Tracing the innervation of muscle is critical in determining muscle homologies (e.g., Edgeworth, 1935; Romer and Parsons, 1986). Schumacher (1932) reported that M. uropatagialis in *Pteropus* sp. is supplied by a branch from "Plexus coccygeus," although the components of the "Plexus coccygeus" have not been described. According to Tokita et al. (2012), M. uropatagialis is innervated by the nerve branch that topologically corresponds to the branch innervating the anteromedial part of the semitendinosus in mouse embryos. From this study, it is suggested that the dominant nerve of M. uropatagialis is strongly related to the nerve belonging to the lumbosacral plexus, but tracing the innervation in bats was not carried out. As far

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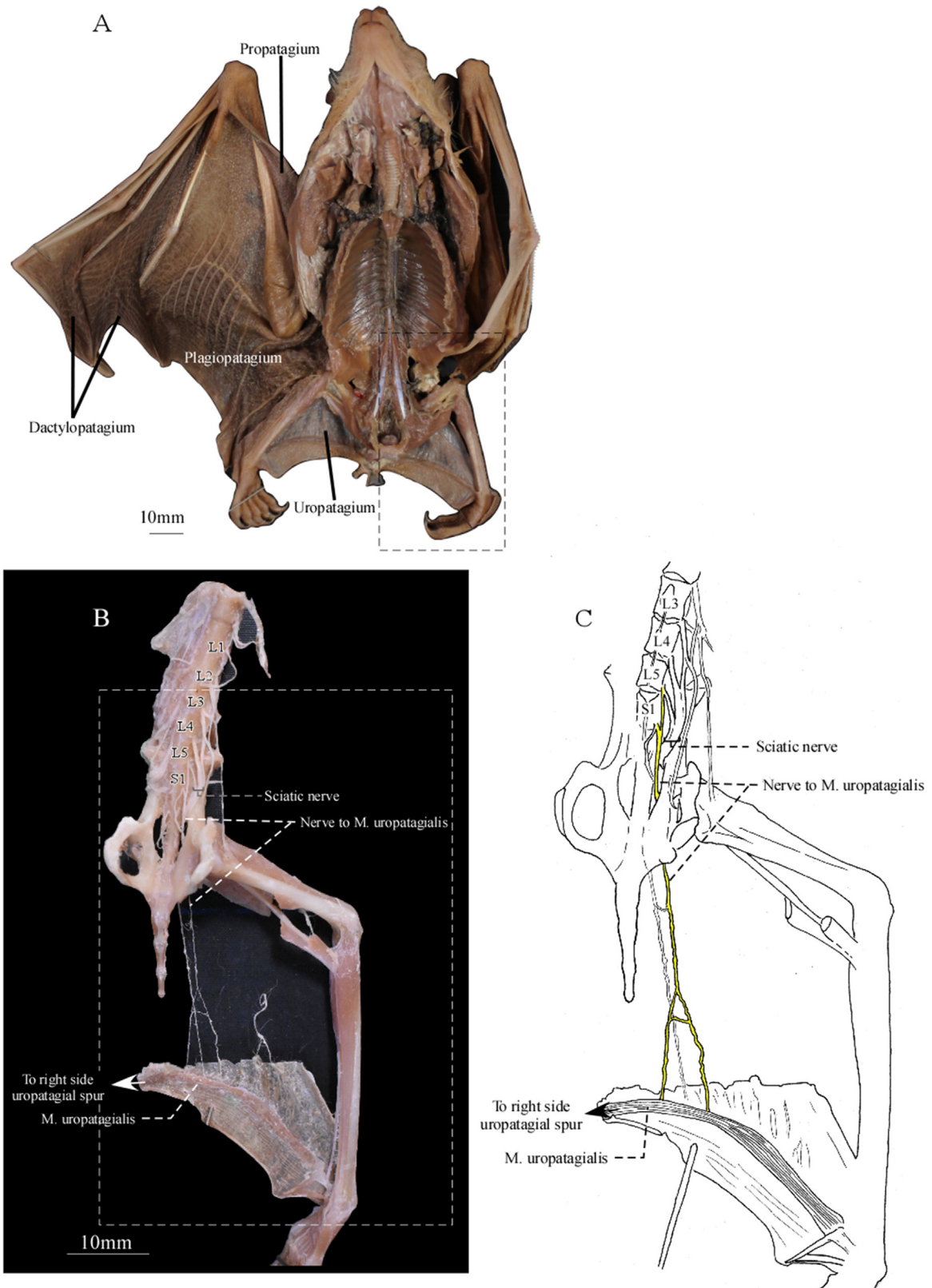


Fig. 1. (A) Ventral view of *Rousettus leschenaultii* (OUS-LCA 366) showing the patagial tracts; (B) Ventral view of the lumbar region and the left hind limb of *R. leschenaultii* (OUS-LCA 365) showing the Musculus uropatagialis and associated the dominant nerve; (C) Schematic representation of the square of (B). The dominant nerve of M. uropatagialis is shown in yellow. [abbreviations: M., musculus; L1, first lumbar nerve; L2, second lumbar nerve; L3, third lumbar nerve; L4, fourth lumbar nerve; L5, fifth lumbar nerve; S1, first sacral nerve].

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