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RECONSTRUCTING THE FLIGHT APPARATUS OF *EUDIMORPHODON*

Eudimorphodon is the commonest and best known pterosaur from the Upper Triassic. A long-tailed form that reached about one metre in wingspan, it has been reported from Italy (Wild, 1978, 1994; Dalla Vecchia, 1995, 2003), Austria (Wellnhofer, 2003), Greenland (Jenkins *et al.*, 2001) and possibly also from Switzerland, Belgium, Luxembourg and the USA (Dalla Vecchia, 2003). Older systematic (Wild, 1978) and newer phylogenetic analyses (Unwin, 2003) both support a close relationship between *Eudimorphodon* and *Campylognathoides* which form the Campylognathoididae, a relatively derived clade of basal pterosaurs.

The skeletal anatomy of *Eudimorphodon* is more completely known than for any other early pterosaur, and it is the only Triassic form in which soft tissues have been reported so far (Wild, 1994; Dalla Vecchia, 1995). Published restorations of the flight membranes indicate a small propatagium anterior to the fore limb and a cheiropatagium attached to the rear margin of the fore limb and the body as far as the hip (Wild 1978), or extending to just beyond the knee (Wellnhofer, 1991). There is no cruropatagium (= uropatagium) shown in the reconstructions by Wild (1978; tafs 10, 16) or Wellnhofer (1991; p. 63), but small, crescentic membranes stretched between the leg and the base of the tail are indicated in a painting in the 'Encyclopedia of Pterosaurs' (Wellnhofer, 1991; p. 61). Preservation of parts of the wing membranes in a juvenile example of *Eudimorphodon* (MCSNB 8950; Fig. 1) led Wild (1994) to suggest that the cheiropatagium may have attached to the fifth toe and, by inference, to the hind limb.

Combining published details of the disposition of the skeletons of *Eudimorphodon*, and the distribution of impressions of the wing membranes in MCSNB 8950 (Wild, 1994) with understanding of wing membrane distribution in *Sordes pilosus* (Sharov, 1971; Unwin & Bakhurina, 1994) permits a new restoration of the flight apparatus of *Eudimorphodon*.

Sordes pilosus is represented by eight individuals, several exhibiting exceptionally well preserved soft tissues (Bakhurina & Unwin, 1995) from the Upper Jurassic Karabastau Svita (Oxfordian-Kimmeridgian) of the Karatau Ridge in Kazakhstan (Sharov, 1971; Bakhurina & Unwin, 1995; Unwin & Bakhurina, 2000). Evidence of the wing membranes is more completely preserved in *Sordes* than in any other pterosaur and demonstrates that there was a small propatagium, a cheiropatagium that attached to the fore limb, body and hind limb as far as the distal end of the crus, and a cruropatagium stretched between the hind limbs and supported along its rear edge by the fifth toes (Unwin & Bakhurina 1994; Fig. 2).

In MCSNB 8950 the hind limbs, foot and fifth toe show an almost identical disposition to that seen in the holotype of *Sordes* (PIN 2585/3, Sharov, 1971; Unwin & Bakhurina, 1994) as do the preserved portions of the wing membrane. In particular,

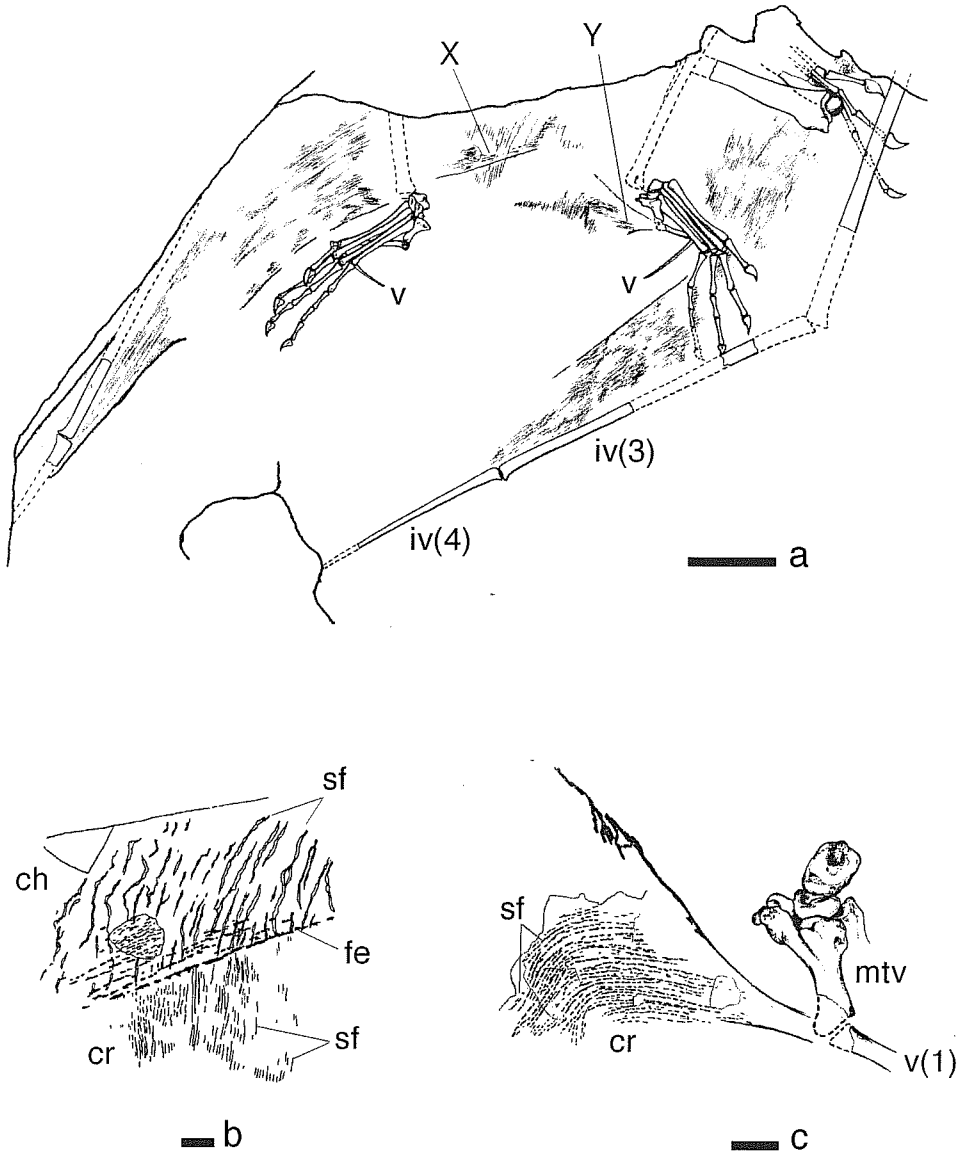


Fig. 1. *Eudimorphodon* sp. (MCSNB 8950) details of the hind limbs and associated soft tissues redrawn from Wild (1994). (a) Hind limbs and wing membranes showing locations "X" and "Y". (b) Details of membranes at "X" showing distal part of the right cheiropatagium overlying the cruropatagium. (c) Detail of the patagium at "Y" showing the cruropatagium attaching to the fifth toe. Abbreviations: ch, cheiropatagium; cr, cruropatagium; iv(3), phalange three of wing finger; iv(4), phalange four of wing finger; fe, free edge of cheiropatagium; mtv, metatarsal five; sf, structural fibre; v, fifth toe of pes; v(1), phalange one of fifth toe. Scale bar = 10 mm (a) and 1 mm (b), (c).

patches of soft tissue located between the ankles (Fig. 1b, c), with a lineation that has been interpreted as ‘hair-like structures’ (Wild, 1994; fig. 9) and ‘structural fibres’ (Wild, 1994; fig. 11), form part of the cruropatagium. In our opinion, the lineation represents patagial fibres and has the same orientation and spacing as in the cruropatagium of *Sordes* (cf. Bakhurina & Unwin, 1995; fig. 7). We argue, therefore, that our reconstruction of the wing membranes in *Eudimorphodon* corresponds to that evident in *Sordes* and is generally applicable to other basal (‘rhamphorhynchoid’) pterosaurs especially in regard to the hind limbs, with attachment of the cheiropatagium to the femur and crus and the presence of a cruropatagium stretched between the hind limbs that was supported and manipulated by the fifth toes.

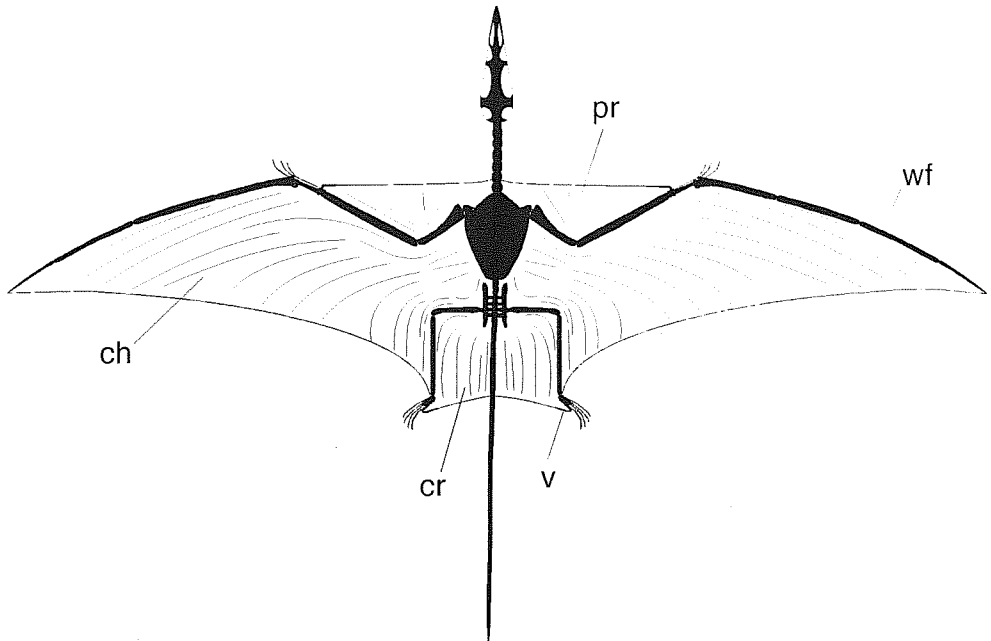


Fig. 2. Reconstruction of *Sordes pilosus* indicating the extent of the flight membranes. Lineation within the patagia indicates general orientation of wing fibres, but not their true size (more slender) or spacing (more closely packed). Abbreviations: ch, cheiropatagium; cr, cruropatagium; pr, propatagium; v, fifth toe of pes; wf, wing finger.

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