Engineering Pterosaurs — Methods and perspectives of experimental palaeontology

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Pterosaurs are unique constructions among actively flying vertebrates. Their membranous wings are supported by an independently operating tandem wing spar system. The front spar is formed by the front limbs with a hypertrophied digit, the rear spar by the hind limbs. The wing membrane itself represents a smart multilayered, elastic structure with an internal mat of aktinofibrils that warrant the stability of the profile of the membrane and prevent fluttering. Muscle sheaths below this aktinofibril mat could increase the wing camber. Furthermore the wing membranes contained structural elements for insulation and thermoregulation. (overview: Frey et. al., 2003a) Other membranous areas of aerodynamic relevance comprise a propatagium along the cranial edge of the arms and the metacarpus, an uropatagium connecting the tip of the fifth pedal digit with the tail base and webbing between the toes (overview: Frey et al., 2003a,b). Long-tailed pterosaurs additionally had a terminal tail vane, short-tailed ones show large head crests that also are reported now from long-tailed pterosaurs (Czerkas & Ji, 2002). In most pterosaurs, the wing articulation lies level with the vertebral column, but in azhdarchoids the wings articulate level with the sternum. Thus, pterosaurs produced the only known bottom dekkers in the animal kingdom (Frey et al., 2003c).

Despite the profound knowledge about distribution and structure of the flight relevant surfaces, numerous attempts to apply aeronautical principles to pterosaurian constructions did not yield consistent results on their flight capabilities until today. With the discovery of new elastic and smart materials for experimental aircraft engineering, modern applications and wind tunnel experiments with life size pterosaur models made out of smart materials could result in a consistent concept of pterosaurian flight and mano euvring capabilities, a mechanical explanation why pterosaurs could reach wingspans of more than 10 metres, why they could already fly as post-hatchlings, and why only pterosaurs developed the bottom dekker construction. Intensive discussion between engineers, vertebrate palaeontologists and biologists resulted an increasing interest of aircraft engineers in aeroelastic wing solutions, simple and effective steering mechanisms and scale constructions based on one single constructional concept.

Here we present a research program for an interdisciplinary project for engineering pterosaurs with the aim, to understand the flight of pterosaurs and to make the results of pterosaur research applicable to modern aircraft engineering focussing on the extreme anatomical constraints of pterosaurian constructions.

References

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