Grasping the shape of belemnoid arm hooks – a quantitative approach

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Chitinous arm hooks (onychites) of belemnoid coleoids are widely distributed in Mesozoic sediments. Due to their relative abundance and variable morphology compared to the single, bullet-shaped belemnite rostrum, arm hooks came into the focus of micropalaeontologist as a promising index fossil group for the Jurassic–Cretaceous rock record and have been the target of functional, ecological, and phylogenetic interpretations in the past (e.g. Reitner & Engeser 1982; Fuchs et al. 2013; Hammer et al. 2013). Based on three well-preserved arm crowns of the Toarcian diplobelid *Chondroteuthis wunnenbergi*, we analyzed the shape of a total of 87 micro-hooks. The arm crown of *Chondroteuthis* is unique in having uniserial (rather than biserial) hooks. The first application of elliptic Fourier shape analysis to the arm weapons of belemnoid coleoids allows for the distinction of four micro-hook morphotypes and the quantification of shape variation within these morphotypes. Based on the best preserved arm crown, we reconstructed the distribution of morphotypes within the arm crown as well as along a single arm. Our quantitative data support former observations that smaller hooks were found close to the mouth and at the most distal arm parts, while the largest hooks were found in the central part of the arm crown. Furthermore, we found a distinct arm differentiation, as not every arm was equipped with the same hook-morphotypes. Here, we report the functional specialisation of the belemnoid arm crown for the first time and speculate about the potential function of the four morphotypes. Our analyses suggest a highly adapted functional morphology and intra-specimen individual distribution of belemnoid hooks, serving distinct purposes mainly during prey capture, prey digestion, as well as reproduction. In this regard, hooks at the distal end of the arms show stronger curvature to effectively catch and hold the prey, while hooks closer to the belemnoids mouth are more suitable for prey dissection and for transporting food to the mouth. We speculate that this highly specialised arrangement is an adaptation of *Chondroteuthis* towards its uniserial hook-arrangement. This is supported by the fact that belemnoids with biserial hook armament do not show inter-individual changes in micro-hook morphology (Engeser 1987).
Figure 1. Principal component analysis of *Chondroteuthis wunnenbergi* micro-hook morphology. Symbols represent the individual hooks, grey silhouettes represent the theoretical mean form of the respective 0.1 × 0.1 square. The positions of the four distinguished morphotypes are indicated.

REFERENCES