Nevrorthus apatelios - a Neuropteran of the old style?

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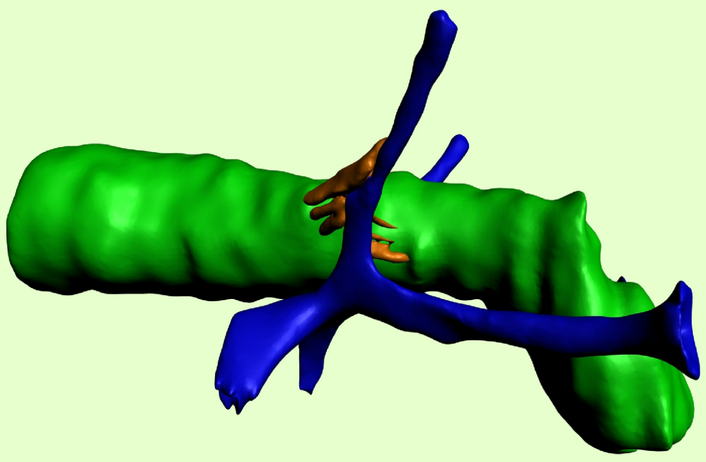
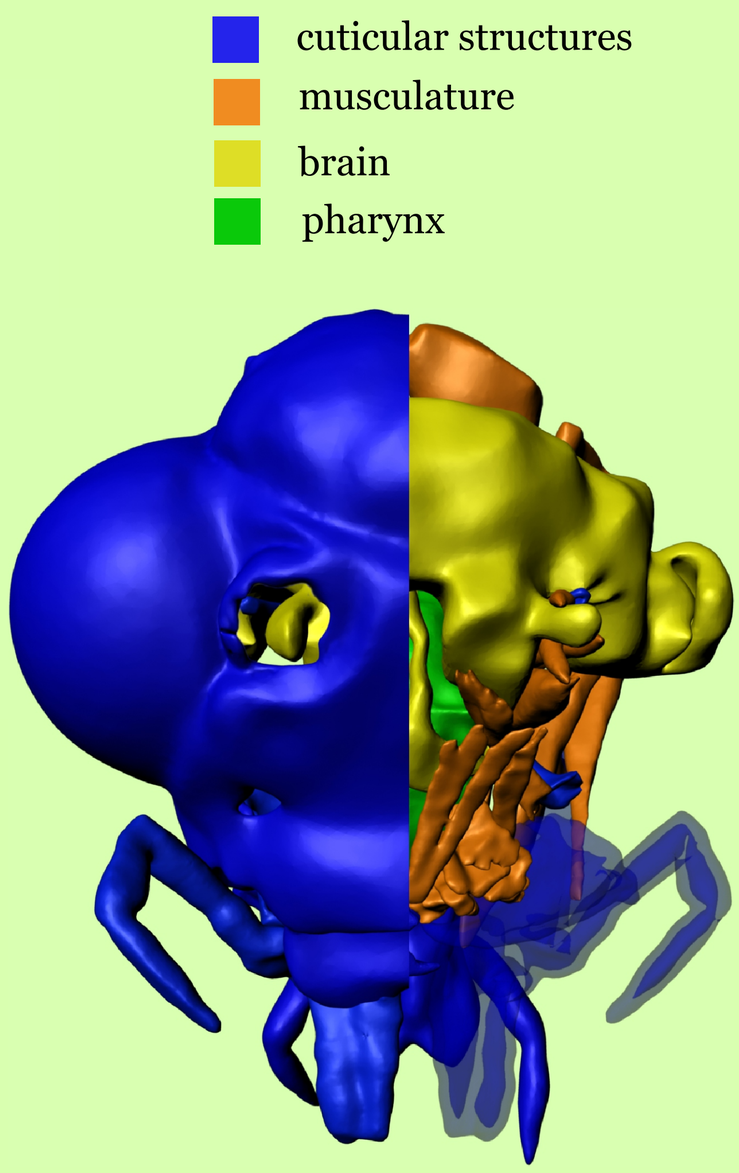
In most phylogenetic analyses the basal position of Nevrorthidae within the Neuroptera is undisputed. Therefore a profound knowledge of this family is essential for identifying ground patterns in the neuropteran head. In the present project we reconstructed the head anatomy of *Nevrorthus apatelios* and compared it with data of Neuroptera from literature.

We have imaged the head of *Nevrorthus apatelios* using X-ray microtomography (microCT) and semithin sections. For 3D-visualization and analysis of data we used the software Amira 5.1 and Autodesk® Maya® 2011. The classification of the musculature follows Kéler (1963).

ground pattern 1
pharyngeal muscle originating on dorsal tentorial arm



In most Neuropterans with weakly developed or completely reduced dorsal tentorial arms, the M. tentoriopharyngalis (M49) is reduced, whereas in *Nevrorthus* it is well developed.

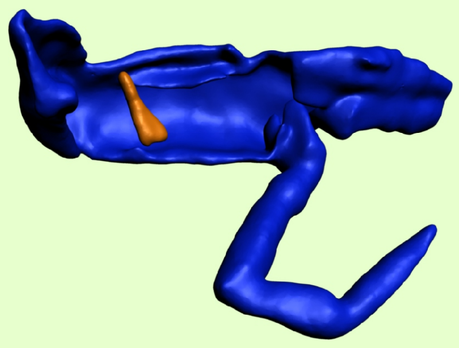


head of *Nevrorthus apatelios,* frontal view

ground pattern 5
antennal muscles originating on the dorsal tentorial arm

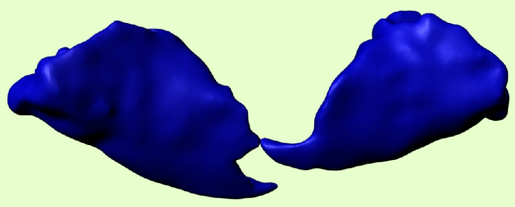
The origin of the M. tentorioscapalis medialis (M4) and of one component of the M. tentorioscapalis anterior (M1) on the dorsal tentorial arm is a plesiomorphic feature present in *Nevrorthus*. In the derived condition both muscles originate solely on the anterior tentorial arms.

ground pattern 2
presence of an ancient muscle of the stipes



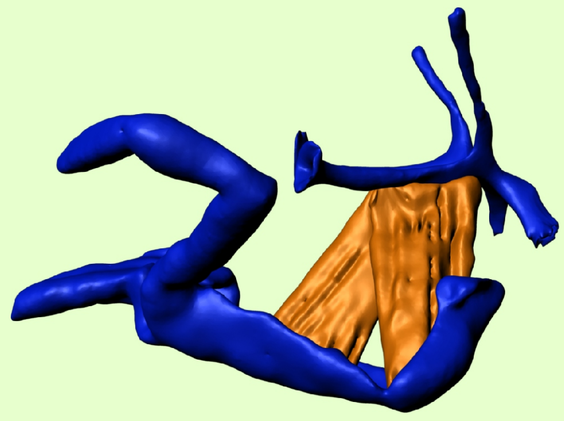
In *Nevrorthus* the M. stipitalis transversalis is shown to be present in Neuroptera for the first time. The loss of the M. stipitalis transversalis was hypothesized to be a synapomorphy of all Neoptera excluding Plecoptera (Kristensen 1991); meanwhile this muscle has been described for some Polyneoptera as well (Wipfler et al. 2011).

ground pattern 3
shape of the mandibles



We can confirm the mandibular asymmetry and the presence of blade-like projections being a ground pattern of Neuroptera as suggested by Beutel et al. (2010). A molar process is present only on one mandible in *Nevrorthus* and not on both mandibles as in *Osmylus* (Beutel et al. 2010) and *Myrmeleon* (Sundermaier 1940).

ground pattern 4
fan-shaped maxillary muscles



In *Nevrorthus* and *Sisyra* the maxillary muscles attach fan-shaped along a wide area of the anterior tentorial arms and not as compact roundish bundles on a laminatentorium as in other Neuroptera (Zimmermann et al. 2011).

Our results indicate that many anatomical characters of the head of *Nevrorthus* do reflect the neuropteran ground pattern and can thus be used to interpret differing characters in other neuropteran families. The presence of a M. stipitalis transversalis is interesting, not only with respect to evolutionary analyses of the Neuroptera but also in the larger context of Endopterygota.

Beutel, R.G., Zimmermann, D., Krauß, M., Randolf, S. and Wipfler, B., 2010. Head morphology of *Osmylus fulvicephalus* (Osmylidae, Neuroptera) and its phylogenetic implications. Org. Div. Evol. 10, 311-329. Kéler, S. von, 1963. Entomologisches Wörterbuch. Berlin: Akademie Verlag. Kristensen, N. P., 1991. Phylogeny of extant hexapods. Insects of Australia, Vol. 2 (ed. by J.D. Naumann, P.B. Carne and J.F. Lawrence) pp. 125-140. Melbourne University Press, Melbourne. Sundermeier, W., 1940. Der Hautpanzer des Kopfes und des Thorax von *Myrmeleon europaeus* und seine Metamorphose. Zool. Jahrb. Abt. Anat. Ontog. Tiere 66, 291 - 348. Wipfler, B., Machida, R., Müller, B. and Beutel, R. G., 2011. On the head morphology of Grylloblattodea (Insecta) and the systematic position of the order, with a new nomenclature for the head muscles of Dicondylia. Syst. Ent. 36, 241-266. Zimmermann, D., Randolf, S., Metscher, B. D. and Aspöck, U., 2011. The function and phylogenetic implications of the tentorium in adult Neuroptera (Insecta). Arthr. Struct. Dev., doi:10.1016/j.asd.2011.06.003.

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