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Systematic Morphology in the Age of Phylogenomics: New Methods and Their Possible Application for Hexapod Embryological Research*

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With the advent of DNA and RNA sequence analysis, new data sources were available to infer the phylogenetic relationships of insects. Vast amounts of sequence data could be gathered in a comparably short time and new software tools were developed to aid the effective handling and analysis of these data amounts. High rates of data acquisition and tool development led to a diversity of hypotheses on insect relationships and the origin of insects within Arthropoda. These hypotheses have to be checked carefully with other types of data in order to test the robustness of theories. One of these data types is the anatomy of species in different life stages. Comparison of the anatomy between species and the homologization of structures (=systematic morphology) can help to develop realistic scenarios of character evolution in order to explain the evolution of insects. Systematic morphological researches on adult specimens profited to a great extend from the availability of new methods in recent years. Synchrotron-radiation micro computer tomography (SR-microCT) and serial block face scanning electron microscopy (SBF-SEM) allow us to study the outer and inner anatomy especially focused on muscles, skeleton and membranes. Depending on the device or facility even different brain tissue types can be analyzed. While SR-microCT allows for a resolution of down to 1μm, SBF-SEM even allows for resolutions below 15nm.

One key characteristic of SBF-SEM and SR-microCT is the rapid data acquisition. One CT scan of a specimen can be done in 15 minutes, the serial cuts at an SBF-SEM can require days depending on the amount of serial sections and their thickness, but the sections are produced automatically without further assistance required by the investigator. This rapid high quality data acquisition in systematic morphology finally meets the data acquisition speed of molecular systematics. New types of studies with high taxon coverage and reduced quantities of missing data are possible.

The technical capabilities of SR-microCT and SBF-SEM also allow us to study the embryology of specimens in a new way. This talk will give an overview of these two techniques, including requirements for specimen preparation, and the specifications of selected European and Japanese facilities. Current research on adult specimens as well as possible future applications for embryological studies will be presented.

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