Burrowing Mayflies: Phylogeny of the Superfamily Ephemeroidae
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Introduction:
The superfamily ephemeroidae is a group of mayflies found throughout the world. They are commonly called the burrowing mayflies because as nymphs they live in the silt of marine environments and have adaptations for burrowing which often include strong legs, and mandibular tusks. One the exception of this is the Behningiidae family which burrows but lacks the mandibular tusk. This has lead people to propose that first the burrowing behavior evolved and was later followed by the development of tusks (McCafferty 1975 and 2004).

While morphological data has provided important insights into the evolution of mayflies, molecular phylogenetics has broadened our approach to resolving evolutionary relationships within this superfamily. For example, molecular analyses suggest that the Behningiidae family has evolved more recently than the burrowing lifestyle (Ogden et al. 2009). The objective of this project is designed to test three things. First, the relationships within the superfamily. Second, test monophyly of the families within this superfamily. Third, track the evolution of mandibular tusks among the burrowing mayflies.

Methods:
- PCR & sequencing of five genes: Mitochondrial 12S & 16S rDNA; Nuclear 18S & 28S rDNA, and Histone 3.
- Phylogenetic analyses were performed via MEGA (Tamura et al. 2007).
- Alignment in Muscle with default parameters (Edgar 2004a, 2004b).
- Tree reconstruction was performed under Parsimony and Likelihood (GTR+g model).
- Bootstrap analyses consisted of 500 reps in ML and MP.
- All five genes were analyzed separately and combined.

Results:
- 6329 aligned sites; 1080 were parsimony informative
- 5 most parsimonious trees with length 7237
- Likelihood tree with LogL score of -28998.04
- 24 taxa used with 11 different families

Evolution of Tusks Conclusion
It was concluded, as depicted above, that mayflies first evolved tusks (arrow 1), and then later in the family Behningiidae lost the tusks (arrow 2) even though it maintained the burrowing lifestyle as a nymph as does all of the superfamily ephemeroidae.

Monophyly Conclusions
Behningiidae monophyletic
Polymiricariidae monophyletic
Potamanthiidae monophyletic
Palingeniidae likely monophyletic
Euthyplociidae unlikely monophyletic
Ephemeridae non monophyletic

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References:
Edgar, R.C. (2004a) MUSCLE: multiple sequence alignment method with reduced space complexity. BMC Bioinformatics, 5, 179