

Description of Additional Supplementary Files

File Name: Supplementary Data 1

Description: Close up images of the longitudinal muscle bands of *Megasiphon thylakos*, indicated by white arrowheads.

File Name: Supplementary Data 2

Description: Bayesian phylogenetic tree including *Megasiphon thylakos*, placing it in a polytomy with the stolidobranchs and the majority of a paraphyletic “phlebobranch” clade. Refer to Methods for details of the analytical parameters.

File Name: Supplementary Code 1

Description: Character matrix used in the phylogenetic analysis of *Megasiphon thylakos*, adapted from Braun et al. 2020.