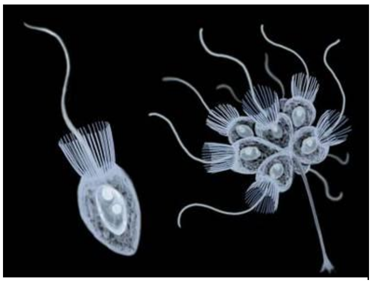
The Origins of Multicellularity

- Multicellularity is seen throughout the animal and fungal lineages of the Obazoa, but several closely related species also display multicellular forms.
- Multicellularity-related genes are encoded within the genome of close relatives of the Opisthokonts.
- These species are important for understanding the early stages of multicellularity.

Thecamonas trahens is a biflagellate heterotroph found in marine environments. Belonging to the group Apusomonadida, phylogenetics have revealed that they are closely related to the Opisthokonts. Components of systems associated with multicellularity have been found in *Thecamonas,* suggesting these genes were found in a common ancestor of both groups (Handbook of the Protists, 2017).

T. trahens, image courtesy of

Integrins are receptors that activate signal transduction upon binding, form a complex (IMAC) which mediates cell physiological processes (Kang et al, 2021), and are therefore required for multicellularity in animals. These proteins and other IMAC components have been found in both *T. trahens* and the closely related breviate *Pygsuia biforma* (Kang et al, 2021). Perhaps these innovations are not animal-specific, but predate the evolution of both the Holozoa and the Apusomonadida. Another important component of multicellular function is calcium signalling, required for cell-cell communication. This machinery is found in a primitive form in *T. trahens* and the related amoeba *Capsaspora owczarzaki* (Cai and Clapham, 2012), and so this system was present in some form in the ancestor of the Amorphea. Cyclins, responsible for cell cycle regulation among other processes, are proposed to be crucial to the evolution of metazoan multicellularity (Cao et al, 2014). Through evolutionary analysis, it was found that the cyclin D subfamily is present in *T. trahens*, and is linked to the emergence of eumetazoans.



Choanoflagellates, image courtesy of Warren Kelley's Weebly

Choanoflagellates are heterotrophic flagellates with around 150 described species, and are closely related to the Metazoans (Microbial Eukaryotes, 2024). They form colonies when in the presence of particular signalling molecules produced by bacteria in order to increase feeding efficiency. Bacteria may therefore have played a role in the development of multicellularity. This morphological similarity alongside molecular phylogenetic data has led to the hypothesis that animals evolved from a choanoflagellate-like ancestor (Ros-Rocher et al, 2021).

The transition to multicellularity was "likely gradual" and involved different gene regulation mechanisms and protein complexes as described to result in early body plans.

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