Desmosomal connectomics of all somatic muscles in an annelid larva

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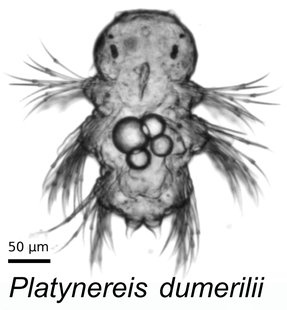
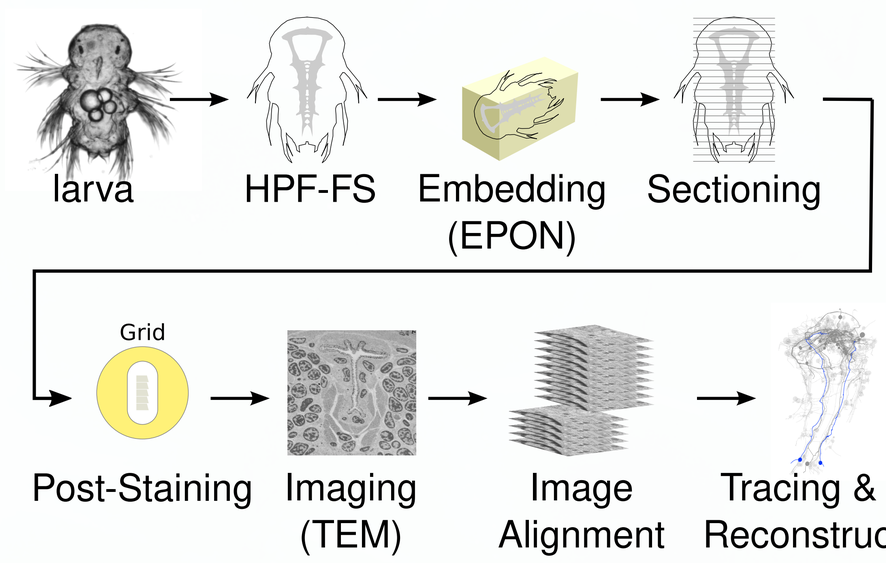
Introduction



Animals use somatic muscles to rapidly change body shape. In many animals, muscle-force coupling is provided by desmosomes – stable adhesive junctions anchored by intermediate filaments. To better understand which muscles attach to which cell types, and how the forces are propagated, we analyze the desmosomal connectome of the three-day-old *Platynereis dumerilii* larva. We combine these data with the synaptic connectome of the same individual to determine which motoneurons innervate which muscles, and which tissues those muscles attach to. This enables us to infer which movements a particular motoneruon is likely to elicit.

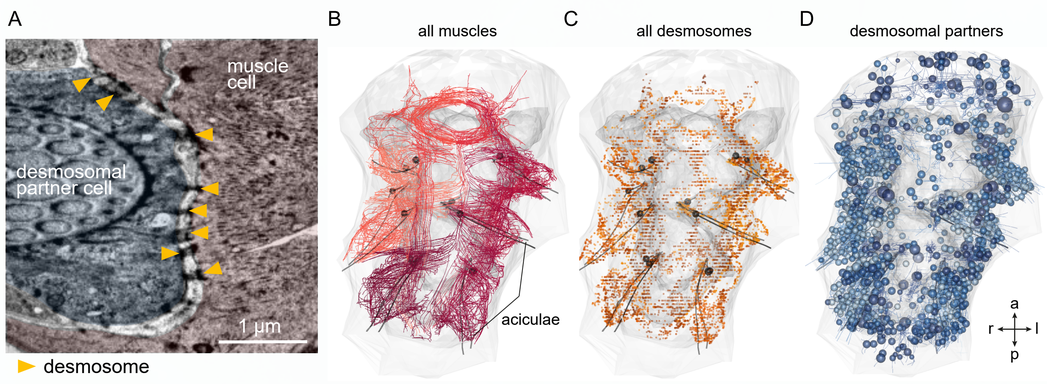
Methods

Full body serial section electron microscopy dataset

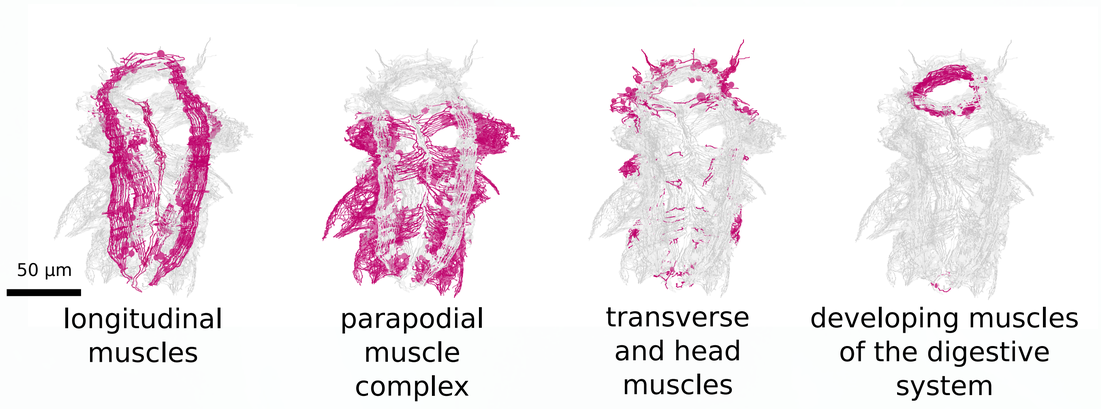


Results

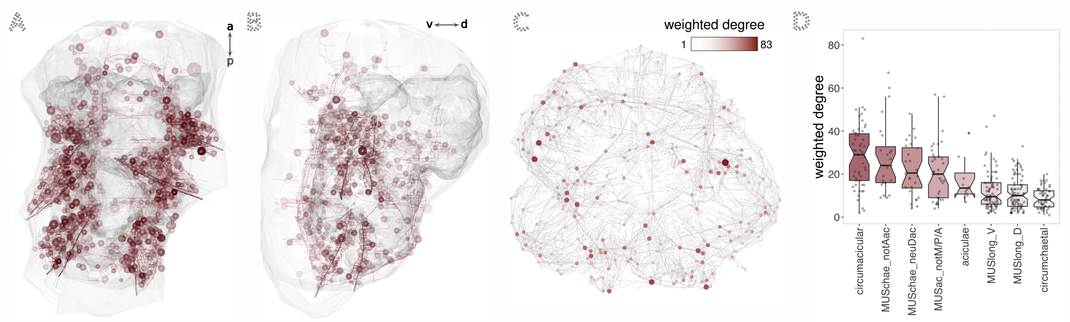
Cell reconstructions and desmosme annotations



Muscle cell type classification

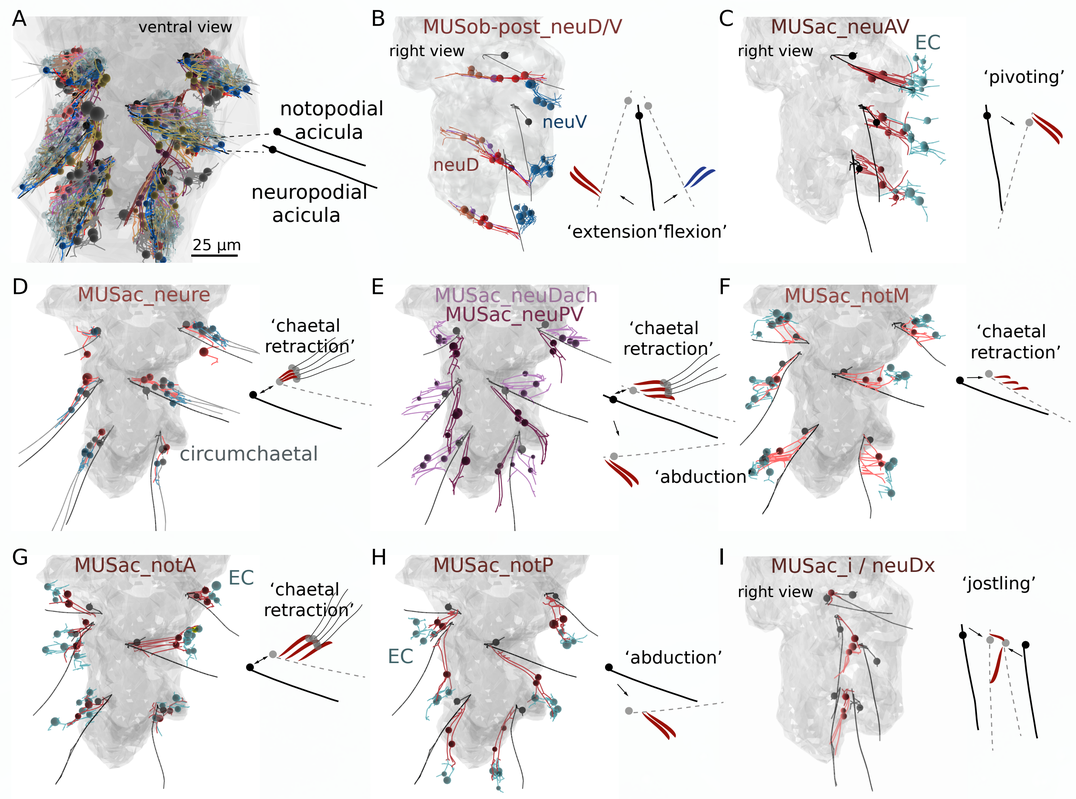


Cells in the parapodia are highly connected nodes in the desmosome network



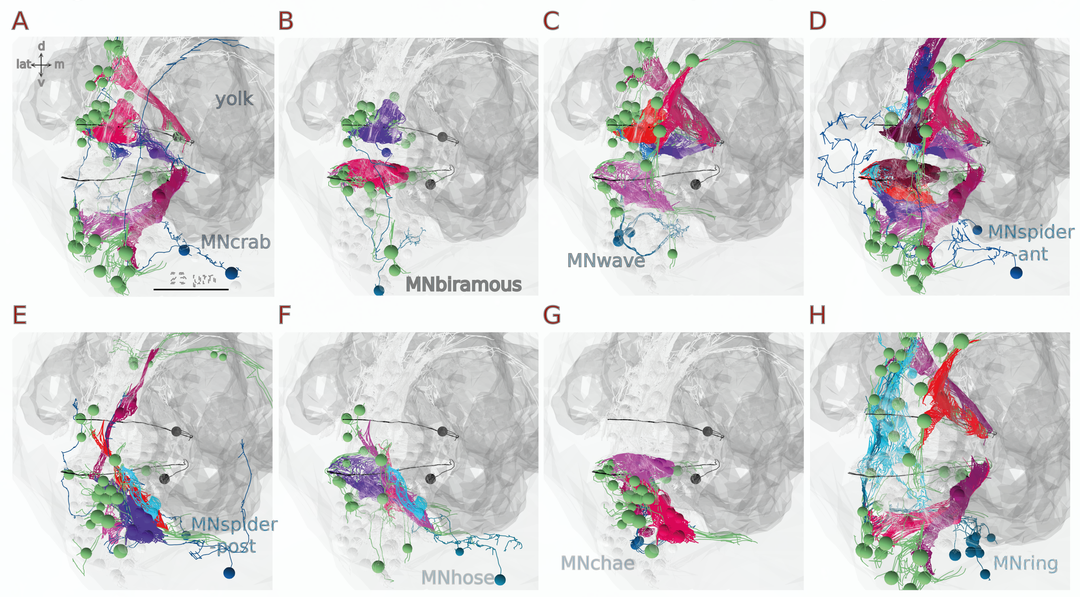
(A) Morphological rendering of all cells of the desmosomal connectome shown with a transparency inversely proportional to the cell's weighted degree, ventral and (B) lateral views. (C) The desmosomal connectome with node-colour intensity and node size proportional to node weighted degree. (D) Weighted degree of the most highly connected cells in the desmosomal connectome, arranged by cell-type.

Aciculae are stiff chitinous rods in the that function as an endoskeleton



Movements of the aciculae, and therefore the animal's limbs, caused by different muscle groups.

Targets of different motoneurons in the parapodia (limbs)



Posterior view of the second left parapodium. Different motoneurons are named and shown in dark blue. Postsynaptic muscle targets are in shades of red, purple, and cyan. Green are other cells (epidermal, chaetal sac...) which are connected to these muscles via desmosomes.

References

Shahidi, R. et al. (2015) A serial multiplex immunogold labeling method for identifying peptidergic neurons in connectomes. Elife 4, 1–24.

Jasek, S. et al. (2021) Desmosomal connectomics of all somatic muscles in an annelid larva. bioRxiv 2021.06.09.447732.

https://catmaid.jekelylab.ex.ac.uk

Conclusion

Desmosomes are the main adhesive junction type for muscles in annelids.
To our knowledge, this is the first desmosomal connectome described in any animal.
Aciculae act as an endoskeleton in annelids.
Aciculae and nearby cells are highly connected via desmosomes.
Parapodia have the highest diversity of muscle cell types.