Bridging the Evolutionary Divide: Gastrovascular Flows in Polyclad Flatworms

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Polyclad flatworms have a highly branched digestive system combining features of the gastrovascular cavity and the gastrointestinal tract. However, the exact function of this system remains unconfirmed due to a lack of observation methods. Here we developed a staining method and used static image processing to observe the highly branched digestive system of the flatworm. Sequentially bidirectional gastrovascular flows were first revealed in polyclad flatworms through video recordings of the tract during the ingestion period. Post-stain active tracking confirmed consistent contractions that hint at another driving force other than pharyngeal contractions within the tracts. Serial sections further reveal radial muscles that enable contractions of the tracts. The mechanism of sequentially bidirectional flow is a novel discovery that bridges the evolutionary gap of the digestive system. Regulated by a diffuse nerve net, bidirectional flows and sequential peristalsis enhances the flatworm's digestion efficiency. This enables a diverse diet and a more efficient nutrient distribution compared to gastrovascular cavity organisms, providing survival advantages for polyclad flatworms. The staining technique used in this experiment also opens up possibilities for future research on the digestive behavior of lower organisms.