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A model for insect tracheolar flow[1] ANNE STAPLES, Virginia Tech, KRISHNASHIS CHATTERJEE, Virgina Tech — Tracheoles are the terminal ends of the microscale tracheal channels present in most insect respiratory systems that transport air directly to the tissue. From a fluid dynamics perspective, tracheolar flow is notable because it lies at the intersection of several specialized fluid flow regimes. The flow through tracheoles is creeping, microscale gas flow in the rarefied regime. Here, we use lubrication theory to model the flow through a single microscale tracheole and take into account fluid-structure interactions through an imposed periodic wall deformation corresponding to the rhythmic abdominal compression found in insects, and rarefaction effects using slip boundary conditions. We compare the pressure, axial pressure gradient, and axial and radial velocities in the channel, and the volumetric flow rate through the channel for no-slip, low slip, and high slip conditions under two different channel deformation regimes. We find that the presence of slip tends to reduce the flow rate through the model tracheole and hypothesize that one of the mechanical functions of tracheoles is to act as a diffuser to decelerate the flow, enhance mixing, and increase the residency time of freshly oxygenated air at the surface of the tissue.

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