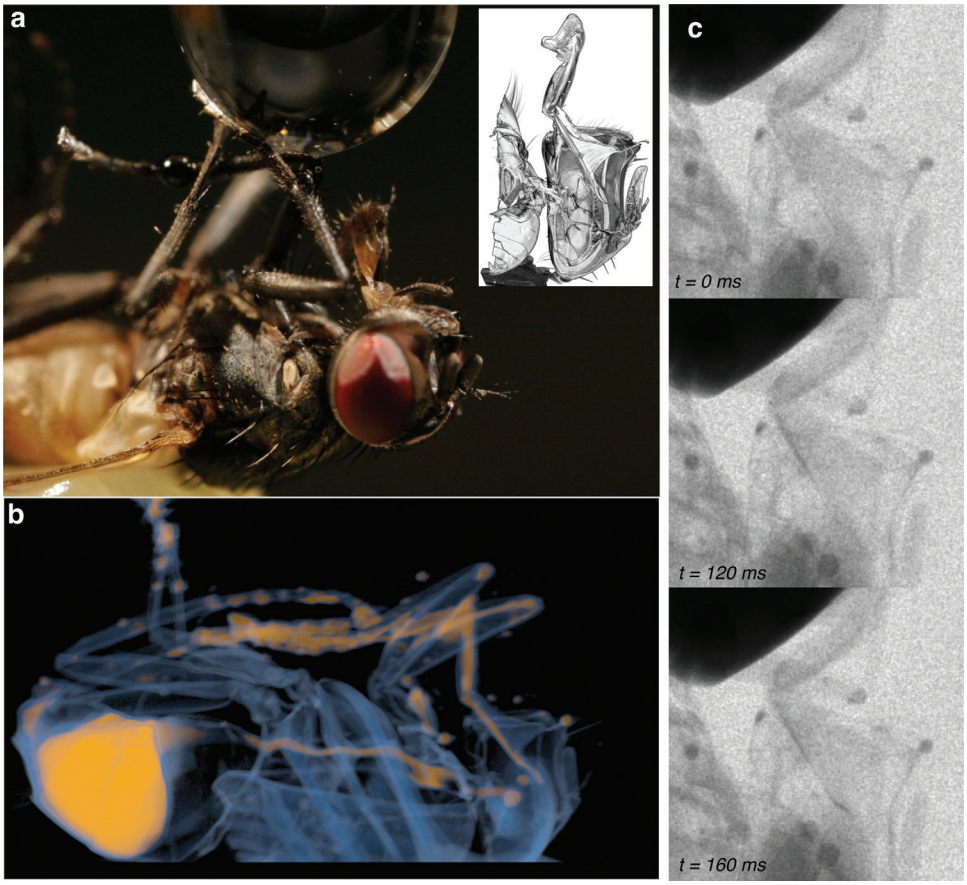

FIG. 1. (Color) (a) Hungry fly, *Musca domestica*. Inset depicts the entire feeding path and the fly gut highlighted in orange via an X-ray contrast agent (added to 0.1 M sucrose solution in water). (b) Cross section of X-ray micro-tomography depicting the cibarial pump and associated muscle groups. (c) In vivo feeding visualization with the average pump stroke cycle of 160 ms for a high viscosity solution (50% sucrose solution by weight) (enhanced online) [URL: http://dx.doi.org/10.1063/1.3640023.1].

The hungry fly: Hydrodynamics of feeding in the common house fly

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Many common insects including mosquitoes and flies primarily live on a liquid diet. Being small in size, pumping fluids poses a unique challenge insects need to solve. As the size of the creatures scales down to microscopic regimes, viscous forces dominate and it requires significant energy to pump fluids. For a given liquid diet such as nectar, viscosity of the fluid increases exponentially to the sugar concentration while the energy extracted from the solution only increases linearly with the amount of sugar present, presenting a severe constraint for pumping mechanism for insect feeding.[1]

Here, we directly visualize feeding in the common house fly, *Musca domestica* (Fig. 1(a)) via absorption X-ray microscopy. A starved fly is fed sugar solution of a known viscosity and sugar concentration, while fluid flow through the pump is observed in real time. A small amount of contrast agent is added to the feeding solution to provide a clear trace of fluid transport during a pumping cycle (Fig. 1(a) inset). Various X-ray imaging protocols were developed to allow for high resolution imaging using a simple table-top X-ray source. The pulsatile nature of the cibarial pump (Fig. 1(b)) in flies is depicted in Fig. 1(c). Via direct visualization of fluid flow during a single feeding stroke in flies, fluid-structure coupling of the pump geometry is revealed.

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