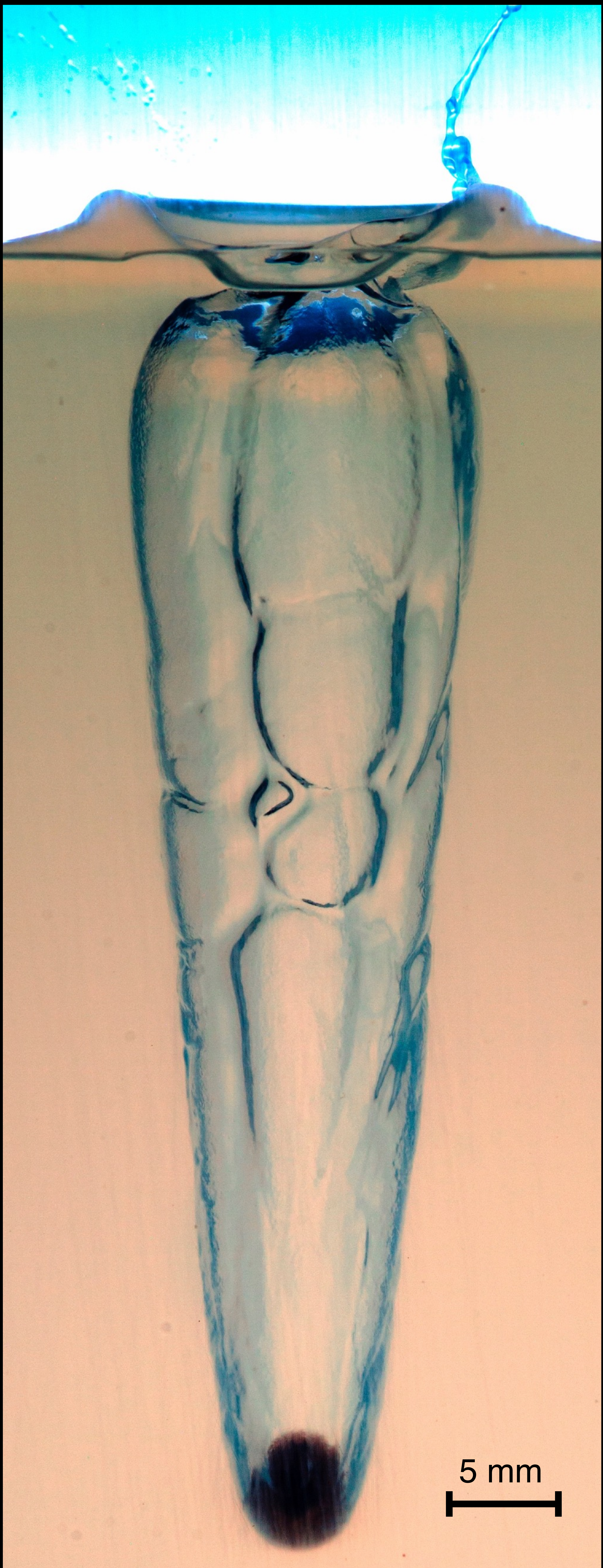
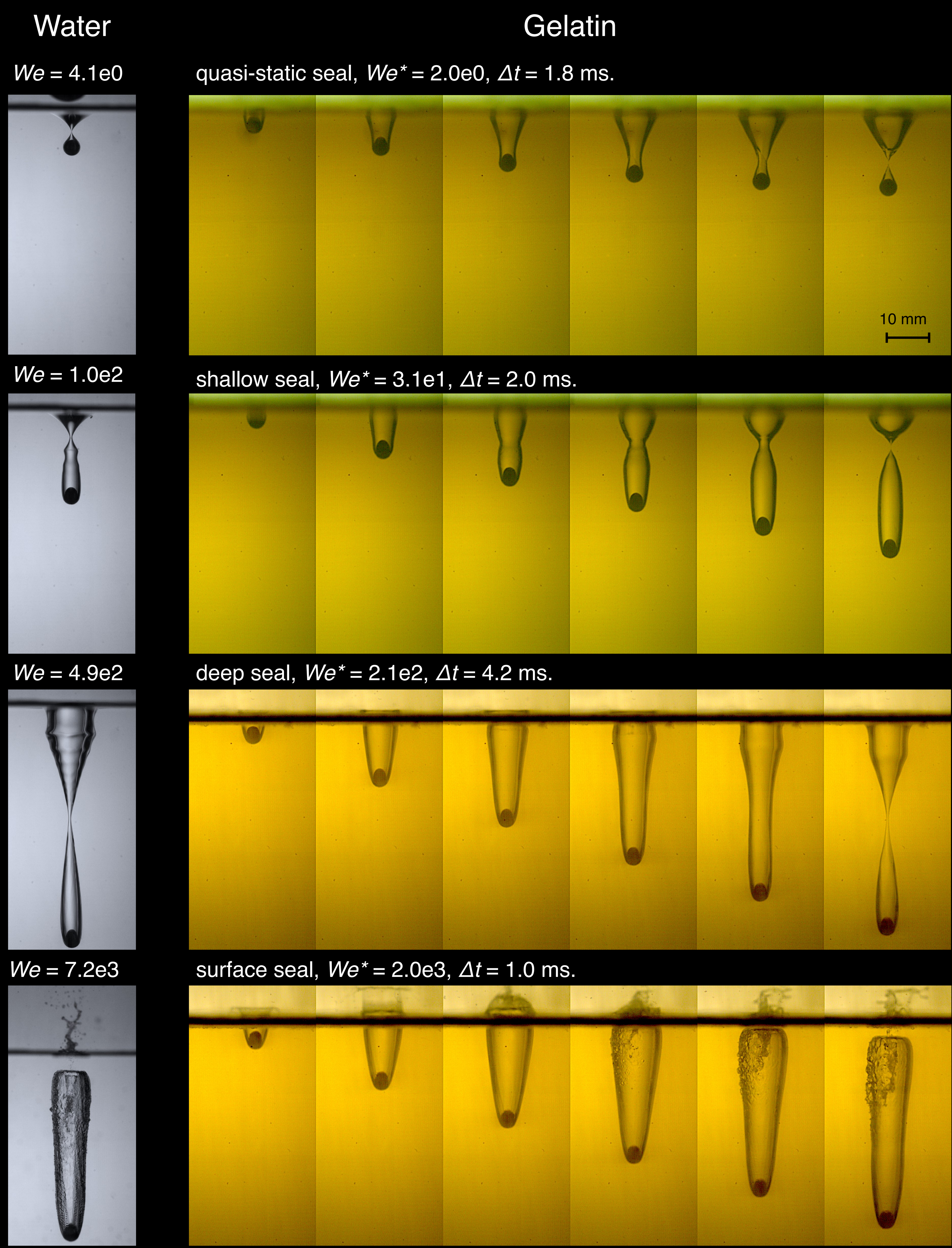
The liquid-like response of gels

A. Kiyama[1], S. Kawamoto[1], M. Mansoor[2], N. Speirs[2], R. Hurd[2], T. Truscott[2] & Y. Tagawa[1]

[1]Tokyo University of Agriculture and Technology

[2]Splash Lab, Utah State University





A steel sphere (R=2.25 mm, for all images) shot from an air rifle passes through gelatin (of shear modulus G ~70 Pa) forming a shallow seal cavity reminiscent of a stained glass window (left image). The blue light cast by one of the flashes captures the contours of the cavity formed in the wake as the sphere rips the gelatin open and elasticity closes it quickly from behind. The emergence of the surface texture, which is not visible in the upper panels, is likely due to non-uniformities in the gelatin and surface features of the sphere.

The impact of a hydrophobic steel sphere into water is often classified into four regimes based on the type of cavity seal and the Weber number ($We=\rho RV^2/\sigma$) as shown in the black and white images (upper left).

Similarly, when the pool medium is changed to a viscoelastic gel, the same four regimes can occur (yellow images from natural gelatin coloring). A modified Weber number $We^*=\rho V^2/G$ can successfully classify the cavity dynamics similar to the classic Weber number. The four rows of images show the progression of the cavity regimes in gelatin compared to water (upper two rows: G ~400 Pa, lower two rows: G ~70 Pa) at an impact speed of V<15 ms^{-1}.