One-flavor QCD – a gauge theory with SU(3) colour gauge group and a fermion in the fundamental representation – is studied by Monte Carlo simulations. The Symanzik tree-level-improved Wilson action is used for the gauge field and the (unimproved) Wilson action for the fermion. The theory is simulated by a polynomial hybrid Monte Carlo algorithm (PHMC). The mass spectrum of hadronic bound states is investigated at two different lattice spacings: $a \simeq 0.37 \ell_0$ and $a \simeq 0.27 \ell_0$, corresponding to $\simeq 0.19\text{ fm}$ and $\simeq 0.13\text{ fm}$ in ordinary QCD. The lattice extension is fixed to $L \simeq 4.4 \ell_0$ ($\simeq 2.2\text{ fm}$). The lightest simulated quark mass corresponds to a pion lighter than 300 MeV.