Abstract We compute for the first time very highly damped quasinormal modes of the (rotating) Kerr black hole. Our numerical technique is based on a decoupling of the radial and angular equations, performed using a large-frequency expansion for the angular separation constant $sA_{lm}$. This allows us to go much further in overtone number than ever before. We find that the real part of the quasinormal frequencies approaches a non-zero constant value which does not depend on the spin $s$ of the perturbing field and on the angular index $l$: $\omega_R = m\varpi(a)$. We numerically compute $\varpi(a)$. Leading-order corrections to the asymptotic frequency are likely to be $\sim 1/\omega_I$. The imaginary part grows without bound, the spacing between consecutive modes being a monotonic function of $a$. 