In one of the most celebrated examples of the theory of universal critical phenomena, the phase transition to the superfluid state of $^4$He belongs to the same three dimensional O(2) universality class as the onset of ferromagnetism in a lattice of classical spins with $XY$ symmetry. Below the transition, the superfluid density $\rho_s$ and superfluid velocity $v_s$ increase as powerlaws of temperature described by a universal critical exponent constrained to be equal by scale invariance. As the dimensionality is reduced towards one dimension (1D), it is expected that enhanced thermal and quantum fluctuations preclude long-range order, thereby inhibiting superfluidity. We have measured the flow rate of liquid helium and deduced its superfluid velocity in a capillary flow experiment occurring in single 30 nm long nanopores with radii ranging down from 20 nm to 3 nm. As the pore size is reduced towards the 1D limit, we observe: i) a suppression of the pressure dependence of the superfluid velocity; ii) a temperature dependence of $v_s$ that surprisingly can be well-fitted by a powerlaw with a single exponent over a broad range of temperatures; and iii) decreasing critical velocities as a function of decreasing radius for channel sizes below $R \simeq 20$ nm, in stark contrast with what is observed in micron sized channels. We interpret these deviations from bulk behavior as signaling the crossover to a quasi-1D state whereby the size of a critical topological defect is cut off by the channel radius.