Locomotion and chemotaxis of the nematode *Caenorhabditis elegans* in complex media

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Abstract

The one millimetre long nematode *Caenorhabditis elegans* is a model organism for research into the biological basis of behaviour. Its 302 neurons have been extensively studied, and their connectivity has been comprehensively mapped. Despite its small size and the apparent simplicity of the underlying nervous system, the worm is capable of a surprisingly rich repertoire of behaviours including navigation, foraging, mating, learning, interacting with others and adaptability. Its chemosensory neurons are highly developed which not only help the animal to detect bacteria but also distinguish between pathogenic and non-pathogenic species. This research on these organisms aimed at understanding their locomotion and behaviour in complex environment which will lead to better understandings in regard to drug screening and genetic applications involving the organism.

In this thesis, we thoroughly investigated the behavioural strategies adapted by *C.elgans* in response to change in temperature, substrate elasticity and chemical gradients. First, we studied the effect of temperature pre-exposure on locomotion and chemotaxis of the *C.elgans*. Animals showed increased levels of activity, speed, and chemotaxis, compared to control worms, immediately after pre-exposure to 30°C. The effect of pre-exposure was observed to be persistent for about 20 minutes and surprisingly, after 30 minutes of recovery, the behaviour of *C. elegans* continued to deteriorate further below that of control worms. Then, we studied the behaviour of *C. elegans* on surfaces with different stiffnesses. We observed that the animals are able to detect the rigidity of the underlying substrate and exhibit durotaxis toward stiffer surfaces. We also note that, unlike cells, *C.elgans* make a judicious decision to stay on the stiffer region by making U-turns or reversals when they cross the interface from stiffer to softer region.

We have explored more about *C. elegans* behaviour on substrates with different stiffness and studied the effect of grooves incised by the worms on their locomotion speed and efficiency. We measured the height of the groove that the animal incise on different gel surface by confocal microscopy and found that groove height decreases with rigidity of the substrate. Our results indicate that the kinematic properties of *C.elgans*, including amplitude (A), wavelength (λ), and frequency (f) of head turns depend strongly on surface properties and the groove height created by them. These deformations increase resistance to lateral slipping. Therefore the worms on softer gels crawl with a non-slipping undulatory wave in contrast to the backward slip over stiffer substrates.

Finally, we investigated *C.elegans* behaviour in gradients of chemical attractant. The results demonstrates that the worm directly approach the peak of the concentration gradient and roam around the peak before leaving the gradient. It was found that the short term memory of *C.elegans* about the peak concentration is constant over all the substrates and distance travelled by the worm from the peak is a function of its velocity and consequently a function of substrate stiffness. The worm with high velocity covers a large distance before it returns to the peak. On the other hand, the worm remains briefly at the centre of the gradient over the stiffer substrate where its velocity is less.