Survival has been put down to optical illusions, writes ***Lewis Dartnell***

The cuttlefish makes a killing with colour

The sleek animal glides effortlessly above the ground. The skin of her bullet-shaped body can smoothly change colour and pattern to match the surroundings, providing an almost perfect camouflage.

The animal is on the hunt, and scans ahead with her acute vision. She spies her prey in the murky distance and banks gently towards it. As she approaches, the hunter slows and then hovers, the skirt-like fin along her flanks rippling gently to provide lift. The design on her back morphs into an all-together different pattern, this one a vivid, dynamic display. The whole animal appears to be pulsating as thick black and white stripes race across her surface, from the base of her body to the tip of her tentacles.

The predator carefully edges nearer to its quarry and then suddenly jets forward, her tentacles exploding outwards to envelop the hapless prey in their clutches. It is quickly dragged in towards the beak, which crushes through the prey's exoskeleton and gulps down its flesh. After this burst of ferocity the hunter switches back into perfect camouflage, and slips away unseen.

This is not a fantastical description of an alien hunter from a science fiction novel – it actually exists in our own oceans. The predator is *Sepia officianalis*, perhaps inappropriately dubbed the common cuttlefish as this creature is anything but ordinary.

The cuttlefish is truly a master of disguise. Its skin contains more than two million special cells, each filled with one of three pigments. Each cell can independently shrink or expand in under a second, acting much like the pixels on a television to give the cuttlefish unbelievable control over its appearance. They can produce hundreds of distinct patterns, which they use for camouflaging, courting or startling predators.

It is the dynamic pattern described above that is most intriguing, however. Thick black and white bands flow rapidly over the skin of the cuttlefish towards the shrimp in front. This display, named Passing Cloud, is somewhat of a mystery. Why, just as the cuttlefish approaches an unsuspecting prey, should it switch from camouflage to a highly conspicuous display?

It is widely thought that Passing Cloud operates by somehow "mesmerising" the prey. My research has focused on exactly how this spectacular display functions, and has come to a startling conclusion. It is possible that the cuttlefish is generating a specific kind of optical illusion, effectively jamming the prey's visual system just before it strikes.

Even a well-camouflaged animal becomes obvious if it moves quickly. This is why tigers stalk their prey painstakingly slowly and only attack when very close. As the cuttlefish pounces on a shrimp, then, camouflage is of little value. What would be more useful is a way of hindering the shrimp's escape, by confusing it about which direction the cuttlefish is moving in, for example. Psychologists are aware of a type of illusion that would have precisely this effect.

The "motion after-effect" was known to the ancient Greeks, but was rediscovered by Robert Adamms in 1834 as a "peculiar optical phænomenon". He was watching the Foyers waterfall in Scotland, and noticed that when he looked away to a stationary scene it appeared to drift upwards. We now believe that this illusion is caused by the nerve cells sensitive to downwards motion becoming fatigued, and remaining suppressed for some time afterwards. Nerve cells sensitive to motion in other directions remain unaffected, and so we perceive an upwards drift.

A similar illusion is the sense that you are driving particularly slowly after coming off a motorway. The motion after-effect is known to disrupt the accurate judging of speed and direction of moving objects. This is exactly the sort of information a shrimp would need to successfully dodge an attacking predator.

Passing Cloud, with its highly-conspicuous and rapidly moving stripes, would seem an ideal display to generate such an optical illusion. If the shrimp does experience a motion after-effect from this display its ability to calculate the best escape route would be disrupted, making it easy prey for the attacking cuttlefish. This is just like modern warfare, where the radar on a fighter jet can be jammed so that it is unable to tell which direction a missile is coming from.

Thanks to this article, Lewis Dartnell of University College London came second in the older age group of the latest BASF/*Daily Telegraph *science writer competition. The competition will be launched again later this year