Can parasites use mind control to manipulate their hosts? - Alex T, 2-4

Introduction

My inquiry question was can parasites use mind control to manipulate their hosts? This idea sounds kind of far fetched, but there has actually been quite a lot of research done on this topic recently and there have been some amazing discoveries in these past few months.

Parasite #1 - *Euhaplorchis* and killifish

So I want to start off by referring to a short clip of some killifish, which are small fish that similar to guppies…

Now as a one can see, the killifish are displaying pretty strange behavior, jumping around, so when I was watching this, my first question was why are they doing this? This is kind of weird so is this just a fluke?

And the answer is yes it was a fluke. A liver fluke, actually, called *Euhaplorchis californiensis*, which is a parasite that resides in Southern California. Hehe hoho I'm pretty clever. Just kidding that wasn't funny.

So anyways, this fluke is heteroxenous, meaning it lives in multiple intermediate hosts before being able to reproduce in its final host. In *Euhaplorchis californiensis*' case, it first exists as an egg which is released into the ocean inside a sea bird's feces, and is subsequently eaten by a horn sea snail. The eggs in the snail hatch into larvae and to protect themselves while they develop, they castrate the snail by eating their gonads. After this stage, the larvae leave the snail and can either wait to be eaten or be proactive and latch on to a killifish's gill. From there, the fluke swims into the killifish's brain where it begins forming thousands of cysts. Now this is where the manipulation of the host's mind comes into play.

Cysts in the raphae nuclei and the hippocampus were found to inhibit serotonin while cysts in the hypothalamus significantly increased the dopamine activity. As we all know, according to the dopamine hypothesis, if there are higher levels of dopamine in the brain, then that organism will display Parkinsonian-type symptoms. These neurological adaptions caused by the flukes in the killifish are what cause the fish to display that unnatural behavior of flipping into the air. The shore birds that eat killifish are visual hunters and because of this conspicuous behavior of jumping up and staying relatively close to the surface, the infected fish are 10 to 30 times more likely to be eaten, which is exactly what the fluke wants.

Parasite and reproduction with killifish

If you can recall, I mentioned that this parasite can only reproduce in one final host, that final host being a shore bird. Once inside the bird's intestines, the fluke can reproduce and allow its eggs to be excreted to continue the life cycle. Now I just want to point out that flukes aren't very intelligent creatures, and yet they've managed to evolve into a species that gets what they want by modifying a much larger and more intelligent animal's actions, which is honestly pretty impressive. All right, so let's move on now to another example of a parasite that manipulates it's host's behavior.

Parasite #2 - *Jewel wasp* and the cockroach

So, this is a cockroach. I'm not really a fan of them to be honest, but when a jewel wasp decides it's time to reproduce, she forces the cockroach to help her in a way in which even I can't help but feeling sorry for the poor little fellow.

Once a wasp spots a suitable cockroach, she will first use her stinger to stab the brain of the cockroach, specifically in the subeosophageal ganglion. She then injects her venom, which causes the roach to enter into a hypokinetic, or decreased movement state.

Note that I said decreased movement, and not complete paralysis, because all the venom really does is reduce neuronal activity. Technically, the cockroach could run away or try to fight back, but it doesn't because the venom takes any motivation to move. The wasp then takes advantage of the situation by injecting it again in the supraeosophageal ganglion, which was discovered to increase spontaneous walking, and gently guides the cockroach by its antennae to her burrow. There she lays a single egg inside of it, which grows, feeding off the zombified cockroach's nutrients until one day a fully-grown wasp bursts out of the roach's body. So these cockroaches do not really know that the wasp is dominating them. Creepy, isn't it? They don't actually have freewill. Can you imagine living your life, blissfully unaware that every move you make was being controlled by a murderous parasite?

Parasite #3 - *Toxoplasma gondii* and the rat and the cat

I can imagine it pretty easily because it's most likely true. According to statistics, a third of this class is probably affected by an intracellular organism called toxoplasma gondii. T. gondii is another one of those heteroxenous parasites, with its final host being a cat.

If a T. gondii cell's life starts in a rat, it tweaks the rat's brain to supply more dopamine than what would normally be released, and actually causes the rat to be sexually attracted to cat urine. The rat then seeks out the cat and is promptly eaten, thus infecting the cat with the parasite. But where do people come into this?

Transfer of toxo to humans

Well, because many human households have pet cats, sometimes toxoplasma is accidentally transferred to us when dealing with fecal material while changing a cat's litter box. Here's little fun fact: around 35% or approximately 1 in 3 of all Canadian homes own a domestic cat. Coincidentally, 1 in 3 people around the world are infected with toxoplasma gondii. Obviously, saying owning a cat equals toxoplasma infection could just be correlational, however it just seems suspiciously convenient that a third of our population owns a cat and also has toxo. Anyways, toxoplasma in humans isn't exactly breaking news, however the effects of having T. gondii are less known.

A recent study done in Prague showed that those with toxoplasma have a higher chance of getting into car accidents and were reckless drivers. In addition to this study, there was more research done to conclude that those with T. gondii are more likely to commit suicide. Basically, this parasite is trying to kill humans. But why?

Evolutionary perspective of human behaviour with toxo

In a scientific article written earlier this year, it was explained that chimpanzees with toxo displayed an irrational lack of fear when confronted with signs of their most dangerous predators, leopards. How toxo does this is travel through the chimp's bloodstream by attaching itself to the white blood cells and then steer them towards the brain. There, they trick the brain into producing more of the neurotransmitter GABA, which is linked to lower levels of fear and anxiety. Evolution says that humans descended from monkeys, and making us also technically classified as an intermediate host for toxo. This means that toxo will do what it does to chimps and tries to get us killed so we can be eaten by a cat. Nowadays, it's unlikely for a house cat to eat us, however T. gondii is unaware of this and continues to push infected individuals to their death so that it can have a shot at reproducing.

Concluding discussion and thoughts

So now you've learned all about parasites and the possibilities of you even sacrificing your life for their survival, but some people may still be skeptical. The whole concept of animals, even humans not actually having free will sounds like something out of a crazy conspiracy theory, however the fact that it's backed up by cold hard science is even crazier. I definitely believe that some of our "personality traits" aren't actually our own, because in the words of science writer Ed Yong, "given the widespread nature of [parasitic] manipulations, it would be completely implausible for humans to be the only species that weren't similarly affected."

This really makes me question all of humanity's history because in the past our species has been known to die for what we believe in, whether that be for freedom, justice, communism, capitalism, religion, or whatever. What if these beliefs were just the byproducts of a parasite trying to pass on its genetics to the next generation? I'll probably never know, but in the mean time, I'm definitely staying far away from my cat's poop.