

How do Drugs Influence Marine Animal Behaviour?



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The story dates back to approximately 530 million years. Five hundred and thirty million years... a few short words, but an incomprehensibly long length of time. It is during this period of the Cambrian explosion that the first vertebrates appeared on the planet Earth in the form of the jawless fish, much like the hagfish and the lampreys we see today. Nearly 70 million years later, the first jawed fishes appeared in the Ordovician period. They later diverged into the thousands of species we know now. That level of diversity and physical adaptations leads to behavioural adaptations. Some live alone, while some others live in schools. Some migrate to breed, while others to eat. Some live in deep, dark and salty waters, while others in shallow, fresh waters. Just like the physical adaptations, the behavioural ones are also the evolutionary traits, which are essential for the survival of each species, as well as their continued coexistence with the other organisms. These behaviours are dependent on the proper functioning of the brain of these organisms down to the molecular level.

As an evolutionary adaptation, the brains got more and more complex as the organisms evolved and the most complex of them all is possessed by us, the humans. We have evolved to the point that we no longer need to adapt majorly to the surroundings, rather we “destroy and rebuild” our surroundings to suit our needs; a kind of like demolishing an old house and building a new one. The idea is not bad at the beginning; that is until we start to notice the caveats that come with it. There are too many stairs, for example, which is not suitable for, say, elders of the house. Eternally locked gates so the neighbours cannot enter (this is written partly because most of us tend to secretly hate our neighbours both anecdotally) (e.g. cockroaches, houseflies, mosquitoes and so on... Even with brains as complex as ours, it wouldn't be an overstatement if we mention that we failed to notice these caveats until recently.

Before get to the main point, it would like to expand a little more on the consequences of having a complex brain and body. It would still

not be enough if we say that the most brilliant of all innovations came forth from this very one-and-a-half-kilogram structure lazing around in our skulls and the remaining 70 kilogrammes of meat working to make them a reality. Everything from Paganini's violin caprices to the medium you are reading this article on to the fidget spinner we are playing with; everything is the physical manifestation of what that system can conjure up. With the most brilliant thoughts, come the most sad and depressing ones, the scary ones, the false ones and so on,, also make sure you do not forget about the headaches, the backaches and the squeaky joints; yes, it is about illnesses. But, like we learnt to hack every system in nature to solve “problems” that are a potential threat to our existence, we have adapted to “hack” our not-so-well brains and bodies and make them better; again, yes, about drugs to treat said illnesses. Indeed. Amazing discoveries in themselves. Now we can roam the streets without any of those pestering thoughts or screeching joints that are downright painful. (trust me we have been there; well, maybe not the joints yet, but we are sure we will get there eventually)

“All that is good, but why did you write this?” Now let us get to the point. The drugs that we use to treat mental illnesses are actually affecting fish behaviour. How? The drugs that we take us metabolized and excreted in our urine, down the drainage and into the rivers and seas. But that is a pretty small quantity considering the size of these water bodies. Or is it? from one person? Yes. Small quantity. From close to a billion people worldwide? Maybe not! The proof comes from several laboratory and field research experiments performed on different species of fish, both freshwater and seawater.

One such group of researchers experimented on a species commonly known as the Flathead Minnow (*Pimephales promelas*) in their

laboratory by exposing the different groups of the said fish to increasing concentrations of a drug called Oxazepam, which is an anxiolytic (anti-anxiety drug). What they found was rather interesting. The groups that were exposed to the highest and lowest concentrations showed no behavioural changes. But those who were exposed to 4.7 micrograms per litre concentration had statistically significant behavioural changes. This group had the plasma concentration of about one-third human plasma concentration. Another study published in the journal Nature found that the muscles of the fish had two to a thousand-fold higher concentration of Oxazepam as compared to the Fyris river. With this, the fish become more aggressive, faster feeders and even leave their school behaviours and become lone hunters. Why? This is all because the human brain evolved from the fish brain, which means we share similarities in how our neurons fire and these drugs are designed to intervene in that process.

Now to shock you all with a few familiar drug names, diclofenac, paracetamol and even caffeine! All of them have been shown to affect fish growth and development. The exact mechanism is not very clear. The majority of these drugs get there because of pharmaceutical effluents. But we consumers contribute almost equally.

This drastically affects their survivability due to their increased liability to be hunted in the process as they do not have the protection of their school. Don't believe? Google it for yourself! You will find several such studies. There is even a documentary on Netflix called “Connected” that talks about this in one of its episodes. This is important because fishes form almost everything from the base to the apex of the ecological pyramid of the aquatic ecosystem.

One imbalance could set off a chain reaction, which affects other species and ultimately humans.

Yes! Call it Karma or whatever, it comes back to us in the end. This should already serve as a motivation to those who do not want to care about the environment.

The reason for discussed the drugs used to treat mental illnesses is, when we observe changes in fish behaviour and come to a conclusion that it is drugs that are causing it, the first suspicion always goes to neuropsychopharmacological agents also known as drugs used to treat mental illnesses as they directly influence behaviour in humans. Therefore, this field has been extensively researched and research is still going on... However, this is not to say that effects of other drugs aren't being researched upon; they are, and research is taking off, as we develop better understanding of the problem.

Proposing a solution to this is a herculean task in itself. It may look like a one step problem, but trust this. There isn't a single step solution. Things aren't necessarily wrong, it's just that we did not account for this before because we did not have a clue. Now that we do, all we need to do is

adjust the existing systems in such a way as to account for this problem. What we need is a system that works to keep the drug concentrations in these water bodies as low as possible if not completely eliminate them. One way to do this is to adjust our sewage systems to chemically treat the drugs to harmless forms. But that may have other unknown side effects as we are using different reagents. Therefore, in order to increase the efficiency of our system, we need to develop drugs that are better metabolized. Of course, this is not the final solution. This in itself has many loopholes. It's a race! Whoever comes up with a workable solution to this problem, does humanity and all of the biosphere a favour that cannot be repaid!

Hyperlinks

- [https://www.nature.com/news/anti-anxiety-drug-found-in-rivers-makes-fish-more-aggressive-1.12434#:~:text=Perch%20can%20accumulate%20high%20levels, according%20to%20a%20new%20study.https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.3448](https://www.nature.com/news/anti-anxiety-drug-found-in-rivers-makes-fish-more-aggressive-1.12434#:~:text=Perch%20can%20accumulate%20high%20levels,according%20to%20a%20new%20study.https://setac.onlinelibrary.wiley.com/doi/full/10.1002/etc.3448)

