Presence of SARS-CoV-2 in waste water in Antarctica and risk assessment.

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***Summary***

The first outbreak of Covid-19 was reported at a Chilean base during the December 2020 Antarctic expedition. This season, the Antarctic continent reported some positive cases of Covid-19 and the measures taken to prevent the entry of this virus with the National Antarctic Programmes (NAP) seem to be working, in addition to the successful vaccination programmes and quarantine measures. The main concern of this global pandemic is limited to the health facilities available in the Antarctic bases to manage the disease, but the impact that the presence of the virus could have on the Antarctic fauna must be considered. The monitoring carried out by our programme on samples obtained from the Frei, Escudero and O’Higgins Base waste management plants indicated the presence of genetic material of the SARS-CoV2 virus, subsequent environmental monitoring shows the non-presence of the virus in the Antarctic fauna.

***Context***

Following the Covid-19 outbreaks detected at the Chilean station, our programme immediately implemented surveillance for the presence of the virus in the waste management plants. The presence of SARS-CoV-2 in waste water is predictable because it can infect the gastrointestinal tract and is shed through the faeces of patients (Kitajima *et al.*, 2020; Kumar *et al.*, 2020). For the most part, research on the destination of viruses in the aquatic environment has focused on enteric viruses, as these viruses are characterised by high resistance under various environmental conditions. The number of studies on the destination of enveloped viruses in aquatic compartments, such as SARS-CoV-2, is quite limited, because enveloped viruses are predisposed to inactivation in water. Virus persistence can be affected by environmental conditions (eg, surface, water, sewage) and by physical and chemical factors (eg, temperature, pH, humidity, exposure to sunlight and the type of surface). Coronaviruses are not quantitatively significant components of marine virioplankton. Members of the Nidovirales infect marine mammals, fish, and possibly invertebrates, and human coronaviruses can persist in marine plankton receiving sewage effluents. However, virions are likely to experience a significant decrease in particle number and infectivity rate in seawater, similar to other enveloped RNA viruses.

As suggested by Barbosa *et al.* (2020), the lack of information on susceptibility to SARS-CoV-2 is a significant knowledge gap for a risk assessment of the potential impacts of this virus on Antarctic fauna. On the other hand, Damas *et al.* (2020) report that in six species of pinnipeds the binding affinity of the ACE2 receptor is “very low”, suggesting that Antarctic pinnipeds might also have low susceptibility to SARS-CoV-2 infection. However, it is important to note that the surviving virions can potentially infect cetaceans such as the Antarctic whale (Balaenoptera bonaerensis) and orca (Orcinus orca) because they share receptor-binding domains similar to the ACE2 protein, which in humans is the receptor that interacts with the virus and allows entry into tissues.

***Response and monitoring***

For this reason, our programme began monitoring the presence of SARS-CoV-2 in the waste water of the research stations (Escudero, Frei and O’Higgins) that had the Covid 19 outbreak event. Waste water samples were taken from both the influent (inlet) and effluent (outlet). To concentrate the virus from the waste water samples, the sample was flocculated using skimmed milk and NaCl. After flocculation, RNA extractions were performed. Viral RNA was detected by RT-qPCR, targeting the N1 and N2 genomic regions (nucleocapsid protein), E protein, and RdRP. In addition, reaction inhibition tests were performed and the presence of a positive control corresponding to the human RNaseP gene was detected, which is an indicator of the presence of faecal material.

The presence of the virus was detected in all waste water samples, which was consistent with the presence of positive cases for Covid-19, confirmed by PCR. At the Escudero and O’Higgins stations, a viral material signal for SARS-Cov2 was detected in the outlet pipe. In contrast, this release was not detected at the Frei Base, perhaps due to the type of management, which is based on worms that act as biofilters. In addition, the environmental sampling carried out during this Antarctic summer, from different environmental sources in the vicinity of the O’Higgins station, did not detect the presence of the SARS-Cov-2 virus.

During this season, environmental samples were collected in the vicinity of the O’Higgins base, the samples analysed did not detect the presence of SARS-Cov 2; on the contrary generic coronaviruses were detected.

***Recommendations***

Based on the various literature reviews and scientific evidence obtained to date, it is important to try to optimise water treatment plant systems to make them more efficient and incorporate state-of-the-art technologies. Consideration may be given to adding a final disinfection step to further reduce the risk posed by viral pathogens, such as SARS-CoV-2, prior to discharge into the sea, such as a water ozoniser.

Continue surveillance for the presence of SARS-CoV-2 in waste water from cruise ships, research stations and research ships.

It is also recommended to continue monitoring the presence of SARS-CoV-2 in the ecosystem at different levels of the Antarctic food web.

***References***

Barbosa, A., A. Varsani, V. Morandini, *et al.*, (2020) Risk assessment of SARS-CoV-2 in Antarctic wildlife, Science of the Total Environment, https://doi.org/10.1016/j.scitotenv.2020.143352

Damas, J., Hughes, G.M., Keough, K.C., Painter, C.A., Persky, N.S., Corbo, M., Hiller, M., Koepfli, K.-P., Pfenning, A.R., Zhao, H., Genereux, D.P., Swofford, R., Pollard, K.S., Ryder, O.A., Nweeia, M.T., Lindblad-Toh, K., Teeling, E.C., Karlsson, E.K., Lewin, H.A. (2020). Broad host range of SARS-CoV-2 predicted by comparative and structural analysis of ACE2 in vertebrates. Proc. Natl. Acad. Sci. U.S.A. 8 (117(36)), 22311–22322. https://doi.org/10.1073/pnas.2010146117.

Kitajima, M., Ahmed, W., Bibby, K., Carducci, A., Gerba, C.P., Hamilton, K.A., Haramoto, E., & Rose, J.B. (2020). SARS-CoV-2 in waste water: State of the knowledge and research needs. The Science of the total environment, 739, 139076. https://doi.org/10.1016/j.scitotenv.2020.139076

Kumar, M., Alamin, M., Kuroda, K., Dhangar, K., Hata, A., Yamaguchi, H., *et al.* (2021). Potential discharge, attenuation and exposure risk of SARS-CoV-2 in natural water bodies receiving treated waste water. NPJ Clean Water 4:8. doi: 10.1038/s41545-021-00098-2