
Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Environmental Research 188 (2020) 109916

Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

# Massive use of disinfectants against COVID-19 poses potential risks to urban wildlife

Coronavirus Disease 2019 (COVID-19) was first reported in Wuhan, China, at the end of December 2019. The disease then rapidly spread around the world and declared as a public health emergency of international concern (PHEIC) on 30th January 2020, and as a pandemic on 11th March 2020 (World Health Organization, 2020). The high transmissibility of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) makes the spread of the disease virtually impossible to stop within a short period, resulting in both a global health emergency and widespread public fear (Cohen and Kupferschmidt, 2020). As of June 22, SARS-CoV-2 has infected more than 8.9 million individuals and caused over 466,500 fatalities globally (Walker, 2020).

Disinfection is a commonly used practice for preventing SARS-CoV-2 infection in households and community settings. In an attempt to contain the outbreak in most parts of the world, fleets of trucks, drones, and mini-tankers have been deployed to spray vast quantities of disinfectants in urban public areas (Fig. 1; Palmer et al., 2020; You, 2020; Service, 2020). The active components of the majority of the disinfectants used are harmful and corrosive chemical compounds, including chlorine-releasing agents, oxidizing agents, and quaternary ammonium cations (Emmanuel et al., 2004; Dumas et al., 2019; Bonin et al., 2020). Although some human residents of cities can avoid contact with these chemicals by remaining at home, urban organisms are directly or indirectly exposed to these chemicals. Furthermore, with cities on lockdown, animals in urban areas go deeper into the cities, and frequently explore the emptied streets, parks, and waterways (BBC, 2020). This temporary boom in urban wildlife and massive disinfection during lockdown could affect a large amount of biodiversity.

Urban ecosystems, including natural, semi-natural, and artificial ecological systems, provide a range of habitats essential for urban biodiversity (McDonnell and Hahs, 2015; Beninde et al., 2015; Aronson et al., 2017; Johnson and Munshi-South, 2017). There are a variety of human commensal organisms in urban areas (Johnson and Munshi-South, 2017) that hold aesthetic value and represent identity of culture and community (Michelfelder, 2003). According to the "One Health" concept, human health is linked to environmental and animal health; therefore, urban wildlife could have positive effects on human physical and mental health, societal and cultural health, and economic health and stability (Zari, 2018; Mackenzie and Jeggo, 2019). Unfortunately, urban wildlife is exposed to toxic anthropogenic chemicals (McDonnell and Hahs, 2015; Giraudeau et al., 2018; Sepp et al., 2019). For example, chlorine disinfectants are acutely toxic to both terrestrial (birds and mammals) (Omer, 1970; Barghi et al., 2018) and aquatic animals (Panseri et al., 2019), causing respiratory and digestive lesions or even death (Wilson et al., 2001; Emmanuel et al., 2004). On the other hand, the bioaccumulation of chlorine disinfectants can also occur in the food chain (Barghi et al., 2018). Recently, hundreds of free-living animals belonging to 17 different species (e.g., common blackbird, *Turdus merula;* and Siberian weasel, *Mustela sibirica*) were found to have died due to the overuse of disinfectants in Chongqing, China (You, 2020). Considering that the majority of disinfectants (e.g., sodium hypochlorite, NaClO) are irritative and corrosive to the mucous membranes of the respiratory and digestive tracts (Dumas et al., 2019), the practice of indiscriminate application of vast quantities of such chemicals in urban environments could directly or indirectly pose a significant threat to urban wildlife.

Disinfection is an efficient way to kill pathogenic microorganisms that cause infectious diseases. There are scientifically based guidelines for judicious selection and proper use of disinfectants in hospitals, laboratories, and homes that take into consideration their efficiency, convenience, and health risks (Rutala and Weber, 2008). However, there are no comparable guidelines or monitoring mechanisms for the large-scale application of disinfectants currently being used to control infectious diseases such as the recent COVID-19 in urban environments. Considering the toxicological effects of disinfectants on both terrestrial and aquatic animals (El-Nahhal and El-Nahhal, 2020), this practice is likely to pose a serious threat to the urban environment, wildlife, and biodiversity, in general. For example, the application of such high volumes of disinfectants could contaminate food and water resources (Zhang et al., 2020) or roosting habitats of free-living animals (Giraudeau et al., 2018; Sepp et al., 2019). Therefore, it is important that disinfectants used to control COVID-19 in urban environments are selected and applied in ways that avoid unnecessary environmental pollution (El-Nahhal and El-Nahhal, 2020; World Health Organization, 2020).

Given that there are no scientific guidelines for the large-scale use of disinfectants in outdoor urban environments, it is crucial to develop strategies to minimize the environmental pollution caused by this practice. To respond to public health challenges such as COVID-19 without harming the urban environment and wildlife, we propose three possible strategies. First, decisions on when, where, and how to disinfect, and what disinfectant to use, should fully consider both public health and environmental safety (Curran et al., 2019; El-Nahhal and El-Nahhal, 2020; Iyiola et al., 2020; Zhang et al., 2020). For example, rather than indiscriminately spraying high volumes of disinfectants in biodiversity-rich areas such as urban parks, wetlands, and green spaces, it would be preferable to suspend human activities in such places. Second, because information on the ecological consequences of applying massive quantities of disinfectants in the urban environment is limited, more research on the toxic effects on urban organisms and the potential threats to the urban environment and biodiversity of this practice is urgently required. Third, there is also an urgent need to develop low-risk, or nontoxic, but effective disinfectants that are suitable for being widely applied in outdoor urban environments to cope with a sudden and unexpected pandemic. To summarize, an effective biological and environmental safety evaluation and prevention system is required to be put forward for facilitating healthy environments for organisms and biodiversity, especially for managing the future global public health challenges.

https://doi.org/10.1016/j.envres.2020.109916
Received 24 May 2020; Received in revised form 3 July 2020; Accepted 5 July 2020
Available online 9 July 2020
0013-9351/


**Fig. 1.** Rampant use of disinfectants. The spraying of disinfectants in public areas to prevent the spread of the Coronavirus Disease 2019 (COVID-19), which inevitably poses a series of deleterious threats to urban environments and wildlife.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

We thank Ron Moorhouse for valuable comments on the original manuscript. This study was supported by the National Natural Science Foundation of China (NSFC, 31672292), and the biodiversity investigation, observation, and assessment program (2019–2023) of the Ministry of Ecology and Environment of China to D.M.L., and NSFC (31800338) to Y.Wang.

## References

Aronson, M.F.J., Lepczyk, C.A., Evans, K.L., Goddard, M.A., Lerman, S.B., MacIvor, J.S., Nilon, C.H., Vargo, T., 2017. Biodiversity in the city: key challenges for urban green space management. Front. Ecol. Environ. 15, 189–196.

Barghi, M., Jin, X., Lee, S., Jeong, Y., Yu, J.-P., Paek, W.-K., Moon, H.B., 2018. Accumulation and exposure assessment of persistent chlorinated and fluorinated contaminants in Korean birds. Sci. Total Environ. 645, 220–228.

BBC, 2020. Coronavirus: Wild Animals Enjoy Freedom of a Quieter World. https://www.bbc.com/news/world-52459487. (Accessed 21 June 2020).

Beninde, J., Veith, M., Hochkirch, A., 2015. Biodiversity in cities needs space: a meta-analysis of factors determining intra-urban biodiversity variation. Ecol. Lett. 18, 581–592.

Bonin, L., Vitry, V., Olivier, M.G., Bertolucci-Coelho, L., 2020. Covid-19: effect of disinfection on corrosion of surfaces. Corrosion Eng. Sci. Technol. https://doi.org/10.1080/1478422X.2020.1777022.

Cohen, J., Kupferschmidt, K., 2020. Strategies shift as coronavirus pandemic looms. Science 367, 962–963.

Curran, E.T., Wilkinson, M., Bradley, T., 2019. Chemical disinfectants: controversies regarding their use in low risk healthcare environments (part 1). J. Infect. Prev. 20, 76–82.

Dumas, O., Varraso, R., Boggs, K.M., Quinot, C., Zock, J.-P., Henneberger, P.K., Speizer, F.E., Le Moual, N., Camargo Jr., C.A., 2019. Association of occupational exposure to disinfectants with incidence of chronic obstructive pulmonary disease among US female nurses. JAMA Network Open 2, e1913563.

El-Nahhal, I., El-Nahhal, Y., 2020. Ecological consequences of COVID-19 outbreak. J. Water Sci. Eng. 1, 1–5.

Emmanuel, E., Keck, G., Blanchard, J.M., Vermande, P., Perrodin, Y., 2004. Toxicological effects of disinfections using sodium hypochlorite on aquatic organisms and its contribution to AOX formation in hospital wastewater. Environ. Int. 30, 891–900.

Giraudeau, M., Sepp, T., Ujvari, B., Ewald, P.W., Thomas, F., 2018. Human activities might influence oncogenic processes in wild animal populations. Nat. Ecol. Evol. 2, 1065–1070.

Iyiola, A.O., Asiedu, B., Fawole, F.J., 2020. Possible effects of COVID-19 on sustainability of aquatic ecosystems: an overview. Aquat. Res. 3, 177–187.

Johnson, M.T., Munshi-South, J., 2017. Evolution of life in urban environments. Science 358 (6363), eaam8327.

Mackenzie, J.S., Jeggo, M., 2019. The One Health approach-why is it so important? Trop. Med. Infect. Dis. 4, 88.

McDonnell, M.J., Hahs, A.K., 2015. Adaptation and adaptedness of organisms to urban environments. Annu. Rev. Ecol. Evol. Syst. 46, 261–280.

Michelfelder, D.P., 2003. Valuing wildlife populations in urban environments. J. Soc. Philos. 34, 79–90.

Omer, St VV., 1970. Chronic and acute toxicity of the chlorinated hydrocarbon insecticides in mammals and birds. Can. Vet. J. 11, 215–226.

Palmer, M., Barth, D., Barth, D., 2020. Chinese Cities Are Rolling Out Disinfectant Tunnels and Spray Trucks to Ward off the Coronavirus - but Experts Don't Think it Will Work. Business Insider. https://www.businessinsider.in/science/news/chinese-cities-are-rolling-out-disinfectant-tunnels-and-spray-trucks-to-ward-off-the-coronavirus-160but-experts-dont-think-it-will-work/articleshow/74305925.cms. (Accessed 28 February 2020).

Panseri, S., Chiesa, L., Ghisleni, G., Marano, G., Boracchi, P., Ranghieri, V., Malandra, R.M., Roccabianca, P., Tecilla, M., 2019. Persistent organic pollutants in fish: biomonitoring and cocktail effect with implications for food safety. Food Addit. Contam. Part A Chemistry, Analysis, Control, Exposure and Risk Assessment 36, 601–611.

Rutala, W.A., Weber, D.J., the Healthcare Infection Control Practices Advisory Committee, 2008. Guideline for Disinfection and Sterilization in Healthcare Facilities. Centers for Disease Control and Prevention, US. https://www.cdc.gov/infectioncontrol/guidelines/disinfection/.

Sepp, T., Ujvari, B., Ewald, P.W., Thomas, F., Giraudeau, M., 2019. Urban environment and cancer in wildlife: available evidence and future research avenues. Proc. Biol. Sci. 286, 20182434.

Service, R.F., 2020. Does disinfecting surfaces really prevent the spread of coronavirus? Science. https://doi.org/10.1126/science.abb7058.

Walker, M., 2020. Track the Coronavirus Outbreak on Johns Hopkins Live Dashboard. Medpage Today. https://www.medpagetoday.com/infectiousdisease/publichealth/84698. (Accessed 22 June 2020).

Wilson, H., Brown, C.A., Greenacre, C.B., Fontenot, D., Carmichael, K.P., 2001. Suspected sodium hypochlorite toxicosis in a group of psittacine birds. J. Avian Med. Surg. 15, 209–215.

World Health Organization, 2020. WHO Characterizes COVID-19 as a Pandemic. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen.

You, T., 2020. More than 100 Wild Animals Drop Dead Near Coronavirus Epicentre in China after Workers 'sprayed Too Much Disinfectant' to Prevent Coronavirus. Mail Online. https://www.dailymail.co.uk/news/article-8029271/100-wild-animals-drop-dead-near-coronavirus-epicentre.html. (Accessed 27 February 2020).
Zari, M.P., 2018. The importance of urban biodiversity–an ecosystem services approach. Biodivers. Int. J. 2, 357–360.
Zhang, H., Tang, W., Chen, Y., Yin, W., 2020. Disinfection threatens aquatic ecosystems. Science 368, 146–147.

Ghulam Nabi[a], Yang Wang[a], Yujiang Hao[b], Suliman Khan[c], Yuefeng Wu[a], Dongming Li[a,*]

[a] *Key Laboratory of Animal Physiology, Biochemistry and Molecular Biology of Hebei Province, College of Life Sciences, Hebei Normal University, Shijiazhuang, 050024, Hebei Province, China*

[b] *Key Laboratory of Aquatic Biodiversity and Conservation of the Chinese Academy of Sciences, Institute of Hydrobiology, The Chinese Academy of Sciences, Wuhan, 430072, Hubei Province, China*

[c] *Department of Cerebrovascular Diseases, The Second Affiliated Hospital of Zhengzhou University, Zhengzhou, 450001, Henan Province, China*

[*] Corresponding author.
*E-mail addresses:* lidngmng@gmail.com, lidongming@hebtu.edu.cn (D. Li).