

Research

Ecological consequences of COVID-19 surgical mask pollution: Evidence from field surveys in Pakistan

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Abstract

Since its emergence in 2019, the COVID-19 pandemic has rapidly spread worldwide, prompting widespread use of personal protective equipment (PPE), particularly surgical masks, to reduce viral transmission. However, the improper disposal and mismanagement of these single-use masks have introduced a new environmental concern. This study aims to assess the environmental impact of discarded surgical masks through field surveys conducted in four major Pakistani cities—Chiniot, Islamabad, Faisalabad, and Bahawalpur. Data were collected in the form of photographic evidence documenting mask litter in public spaces and natural habitats. The captured images reveal significant environmental contamination, including the accumulation of mask waste in water bodies and interaction with wildlife. The findings underscore the urgent need for public awareness, effective waste management practices, and the adoption of environmentally sustainable alternatives to mitigate the ecological consequences of COVID-19-related mask pollution.

Keywords: Surgical masks; pollution; health hazards; COVID-19; Environment

Introduction

The COVID-19 pandemic has profoundly affected global health and society, with far-reaching consequences that

extend beyond human health (Ciotti et al., 2020). As the world faces the challenges posed by this unprecedented crisis, it becomes imperative to examine the environmental impact of various mitigation measures,

including the widespread use and disposal of surgical masks (Yang et al., 2020). The purpose of this paper is to provide a comprehensive analysis of the environmental implications associated with COVID-19 surgical masks. Specifically, we aim to investigate the adverse effects of surgical masks on urbanized and natural environments, the impact on wildlife, and the potential consequences of their improper disposal.

Prior research has investigated the effectiveness of face masks in preventing the transmission of respiratory diseases, including COVID-19 (Deng et al., 2022). However, while numerous studies (Wang et al., 2021; Eikenberry et al., 2020) have examined the filtration efficiency and protective capabilities of different mask types, there remains a significant gap in our understanding of the environmental consequences of their use and disposal. In reviewing existing literature, we find that previous studies have primarily focused on the medical efficacy and public health aspects of face masks (Desai and Aronoff, 2020). However, few studies have systematically examined the ecological repercussions and environmental impacts associated with increased production, consumption, and disposal of surgical masks during the COVID-19 pandemic.

To address this gap, we will draw on a range of sources, including both older and more recent scholarly works, to establish the current state of knowledge on the subject. By doing so, we aim to provide a comprehensive overview of the environmental impact of COVID-19 surgical masks, integrating insights from diverse disciplines such as environmental science, ecology, public health, and waste management. The timing of this research is particularly pertinent given the ongoing COVID-19 pandemic and its sustained impact on mask use worldwide (Esposito and Principi, 2020). It is essential to shed light on the environmental consequences of this rapid increase in surgical mask production and consumption, especially in light of the urgent need for sustainable solutions to address the waste management and pollution challenges associated with the pandemic.

By addressing these research gaps and highlighting the importance of understanding the environmental impact of surgical masks, this paper seeks to contribute to the broader discourse on the sustainability of pandemic response strategies. Furthermore, it aims to inform policymakers, public health officials, and the general public about the potential environmental risks associated with the use and disposal of surgical masks, with the ultimate goal of fostering more environmentally

conscious practices in the face of health crises.

Materials and Methods

Study Locations

A short field survey was conducted from 6th July 2021 to 20th December 2021 in selected cities of Pakistan, including Islamabad (Rawal Lake), Faisalabad (Canal Road Pond), Chiniot (Chenab River and near Rao Bagh village), and Bahawalpur (Lalsuhanara National Park). These locations were chosen for their distinct urban and natural settings, enabling a comprehensive assessment of the environmental impact of COVID-19 surgical masks.

Data Collection

The direct observational approach was employed to collect data on the contamination of river water and public places with COVID-19 surgical masks. Field visits were conducted at the study locations, equipped with high-resolution cameras capable of capturing detailed images. The data collection focused on systematically documenting instances where surgical masks were found in close proximity to water bodies and public areas.

Image Collection

A systematic sampling strategy was used to capture images spanning a wide range of locations and scenarios. Researchers followed a predetermined transect design to ensure adequate coverage of the study sites. Images were captured in a standardized format, including relevant metadata such as date, time, and precise geolocation information, to enable accurate analysis and interpretation.

Limitations

Several limitations should be considered in interpreting the findings of this study. The observational nature of the data-collection method introduces inherent biases and may not capture the full extent of surgical mask contamination. The study was conducted over a specific timeframe and in selected locations, which may limit the generalizability of the results to other regions or time periods. By employing rigorous field survey methods and a direct observational approach, this study aimed to provide robust scientific evidence on contamination of river water and public spaces with COVID-19 surgical masks. The systematic analysis of collected images provides valuable insights into the environmental impact of improper mask disposal practices, facilitating the development of targeted waste management strategies and underscoring the importance of responsible mask use during the pandemic.

Results

To achieve the subsequent facts after an extensive survey of Pakistani cities following panel of images came in front. Overview of environmental interaction with surgical masks is presented in Fig.1. Gradually after every day in field survey, we found disturbingly a huge number of undisposed masks thrown directly in public and water places. Abandoned surgical masks were observed to pose a risk of water contamination (Fig. 2, 3, and 4). The fragments of these disposable masks will in long run slowly leech into the environment posing danger to every living creature Aragaw, (2020).

It was impossible to test every discarded mask for being positively contaminated with COVID-19 virus, but it is for sure sometimes we touch our masks with unwashed hands. This open dumping of masks is further creating panic about environmental pollution (Shruti et al., 2020).

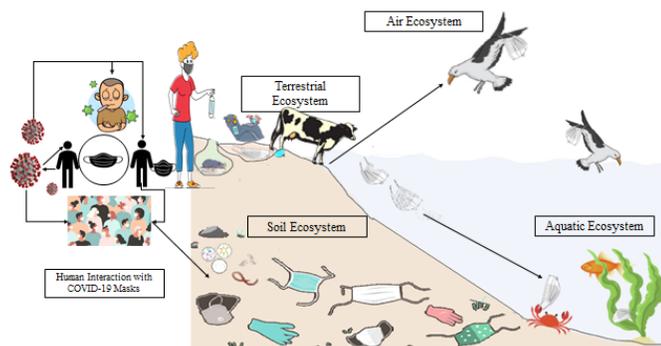


Figure 1 | Environmental interaction with COVID-19 face masks

In an open environment, we further found animals and birds entangled with disposable masks. Some of them have difficulty in feeding; they continued to drag with masks and pose unease movements. Further in a public place, Chiniot few dead crows (*Corvus splendens*) Fig. 5a, b, c and d entrapped with the surgical mask was also found suggesting masks as culprit Defina, 2020; Kaur, 2020; University of Glasgow, 2020; van Gerwen, 202; Hiemstra et al., 2021 also emphasized ingestion and entanglement of face masks can be detrimental and have negative effects on birds and animals' life. Survey results of Main Lalsuhanara Park, Bahawalpur Fig. 6a, b, and c show few dead crows (*Corvus splendens*) and pigeons entrapped with the surgical mask suggesting masks as the culprit.

The slow progression of microplastics is ecologically destroying the environment. Fig 7. (a) shows two hundred and fifty-six COVID-19 litter images collected from CA, USA. A recent study by Antwi et al., 2021 also assessed the severity of the disease at the global scale in the distribution chain. Some recent studies (Hiemstra et al.,

2021; Boyle, 2020; Ashworth, 2020; Edmond, 2020; Harris, 2020; Kassam, 2020 also mentioned the negative impact of COVID-19 masks on the environment, birds, and animals.



Figure 2 | Medical masks collected from the river Chenab and near Rao bagh village Punjab Pakistan – Photography by Saba Malik

Figure 3 at Faisalabad, Pakistan, shows an increased number of masks. This image shows environmental issues that are spread directly and indirectly by the COVID-19 masks. These masks interact with the aquatic species (e.g., partial submersion, entanglement with riparian vegetation). This serves as a representative visual evidence of point-source plastic pollution in urban water bodies. Photo credit: Hafiza Sadia.



Figure 3 | COVID-19 masks collected from Faisalabad Canal Road Pond – Photography by Hafiza Sadia

Figure 4. Surgical mask pollution in a critical freshwater reservoir. Photograph documenting the presence of discarded, surgical masks within the littoral zone of Rawal Lake, Islamabad. This lake serves as a primary drinking water source and an ecologically sensitive Important Bird Area (IBA). The image shows masks in varying states of degradation, integrated into shoreline debris and subject to hydrologic processes that promote leaching and fragmentation. This provides direct visual evidence of contamination in a high-value hydrological and ecological site. Photo credit: Maryam Riasat.



Figure 4 | Surgical face mask waste (litter) in Rawal Lake Islamabad - Photography by Maryam Riasat

Our surveys documented a range of behavioral disruptions caused by discarded surgical masks, illustrating both lethal and sub-lethal consequences (Figure 5). We recorded a second instance of avian mortality, where a House Crow (*Corvus splendens*) was found deceased with mask material tightly wound around its body (Figure 5a). Beyond lethality, masks were observed to cause significant physical impairment and behavioral interference. A domestic chicken (*Gallus gallus domesticus*) was documented with a mask loop snared around its leg, and foraging behavior (Figure 5b).

A more severe case of immobilization was observed in a free roaming dog (*Canis familiaris*), where a mask was entangled around its muzzle, potentially restricting breathing and feeding (Figure 5c). Finally, a recurrent pattern of beak entanglement was noted in avifauna, as shown by a Domestic Pigeon (*Columba livia domestica*) with its head trapped in a mask ear loop (Figure 5d). These cases, geographically dispersed across urban and rural transects in Punjab, confirm that the physical structure of masks specifically their elastic loops and fibrous sheets poses a multi-species threat through entanglement, restraint, and behavioral disruption.



Figure 5 | (a) Picture of a dead House Crow (*Corvus splendens*), (b) causing issue to the chicken walk (*Gallus gallus domesticus*) in Rao Bagh Village, Chiniot, Punjab, Pakistan, (c) Dog (*Canis familiaris*) entangled in a face mask (d) Domestic pigeon (*Columba livia domestica*) entangled with face Mask at Tehsil Chowk Chiniot, Punjab Pakistan – Photography by Saba Malik



Figure 6 | (a) Death of a House Crow (*Corvus splendens*) due to Mask (B) Domestic pigeon (*Columba livia domestica*) beak filled with mask at Main Lalsuhanara Park, Bahawalpur- Photograph by Iqra Bibi

Discussion

Our integrated findings, from quantified field surveys to documented wildlife interactions, establish a clear and concerning pathway of ecological impact. The widespread density and advanced degradation of masks in both terrestrial and aquatic environments (Figs. 1-4) confirm their role as a persistent source of complex polymer pollution.

Critically, this pervasive presence directly facilitates the physical harm mechanisms uniquely inherent to mask design. The elastic loops and fibrous sheets of these items function as anthropogenically derived snares, leading to the spectrum of wildlife entanglements we documented from lethal avian mortality in corvids (Figs. 5a, 6a) to debilitating sub-lethal impairments in domestic and synanthropic species (Figs. 5b-d, 6b). The contamination of a critical freshwater reservoir like Rawal Lake (Fig. 4) further worsens the risk. Therefore, surgical mask pollution poses a direct and multi-faceted threat to wildlife, disrupting ecosystems, and risking human health through water contamination.

The massive global consumption of single-use face masks during the COVID-19 pandemic has generated a novel and pervasive stream of plastic pollution, creating severe waste management challenges that offset any temporary environmental benefits from lockdowns (Wang et al., 2023). Discarded masks now pose a direct threat to wildlife, with documented cases of entanglement, ingestion, and contaminant exposure across multiple countries (Silva et al., 2021).

Surgical masks constitute a substantial and globally dispersed fraction of pandemic-associated plastic waste, with an estimated 1.56 billion masks entering oceans in 2020 alone (Li et al., 2020). As these masks weather, they release microplastics that act as vectors for adsorbed pathogens and toxic chemicals, posing risks of bioaccumulation. This pollution manifests in direct ecological harm, as evidenced by wildlife fatalities from

entanglement and ingestion, including seabirds and penguins (Matuschek et al., 2020).

The literature confirms that entanglement and ingestion events pose a significant risk of injury and mortality to fauna (Mikula et al., 2021). This evidence underscores that surgical mask pollution is a multi-vector stressor, threatening wildlife through physical, chemical, and microplastic pathways, with cascading ecological implications. Addressing this pervasive challenge therefore necessitates an integrated approach, combining improved waste management infrastructure, effective policy interventions, and the development of sustainable alternatives (Fabrero et al., 2023).

Conclusions and Recommendations

The findings of this study highlight the alarming environmental repercussions of the widespread use and improper disposal of surgical masks during the COVID-19 pandemic. Field surveys conducted across several Pakistani cities revealed a significant accumulation of discarded masks in public spaces, water bodies, and natural habitats. These observations demonstrate how pandemic-related plastic waste has emerged as a new form of environmental pollution, posing serious threats to terrestrial and aquatic ecosystems. The entanglement of birds, domestic animals, and aquatic species in surgical masks, as documented in multiple photographs, underscores the immediate and visible ecological dangers posed by this form of litter.

Declarations

Ethics approval

Not applicable.

Consent to participate

Not applicable.

Consent for publication

Not applicable.

Conflict of interest

Author declares no conflict of interest.

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Data availability

Moreover, the long-term degradation of these disposable masks into microplastics adds an insidious dimension to the problem. Over time, these microplastic fragments can infiltrate soil and water systems, leading to bioaccumulation and potential entry into the food chain, thereby endangering both wildlife and human health. The evidence presented aligns with international studies, confirming that pandemic-related waste mismanagement is a global concern that requires urgent attention.

To mitigate these impacts, there is a pressing need for public awareness campaigns, the establishment of effective collection and disposal systems for personal protective equipment (PPE), and the promotion of environmentally sustainable alternatives such as biodegradable or reusable masks. Policymakers and environmental agencies must also enforce stricter regulations to ensure proper waste segregation and recycling practices. In conclusion, while surgical masks played a critical role in preventing the spread of COVID-19, their environmental aftermath serves as a reminder of the complex interplay between human health measures and ecological sustainability. A balanced approach—prioritizing both health safety and environmental responsibility—is essential to prevent future crises of a similar nature.

All the data generated are available in the manuscript.

Authors contribution

Saba Malik and Hafiza Sadia contributed equally to this work. Conceptualization, Saba Malik and Iqra Bibi; Methodology, Saba Malik, Hafiza Sadia, and Muhammad Naeem; Investigation, Saba Malik, Hafiza Sadia, Maryam Riasat, Iqra Bibi, and Muhammad Sikandar Majid; Data curation, Hafiza Sadia, Maryam Riasat, and Iqra Bibi; Formal analysis, Saba Malik and Hafiza Sadia; Visualization, Hafiza Sadia and Maryam Riasat; Writing original draft preparation, Saba Malik and Hafiza Sadia; Writing, review and editing, Muhammad Naeem and Sheeba Riaz; Supervision, Saba Malik.

References

- Ahmed, J., Malik, F., Arif, T. B., Majid, Z., Chaudhary, M. A., Ahmad, J., ... & Khalid, M. (2020). Availability of personal protective equipment (PPE) among US and Pakistani doctors in COVID-19 pandemic. *Cureus*, 12(6).
- Ammendolia, J., Saturno, J., Brooks, A. L., Jacobs, S., & Jambeck, J. R. (2021). An emerging source of plastic pollution: the environmental presence of plastic personal protective equipment (PPE) debris related

- to COVID-19 in a metropolitan city. *Environmental Pollution*, 269, 116160.
- Antwi, S. H., Getty, D., Linnane, S., & Rolston, A. (2021). COVID-19 water sector responses in Europe: A scoping review of preliminary governmental interventions. *Science of The Total Environment*, 762, 143068.
- Aragaw, T. A. (2020). Surgical face masks as a potential source of microplastic pollution in the COVID-19 scenario. *Marine Pollution Bulletin*, 159, 111517.
- Ashworth, C. (2020). More masks, more problems: Covid waste pollutes oceans. *The Thaiger*.
- Boyle, L. (2020). Bird dies after getting tangled in coronavirus face mask. *Independent New York*.
- Brandão, M. L., Braga, K. M., & Luque, J. L. (2011). Marine debris ingestion by Magellanic penguins, *Spheniscus magellanicus* (Aves: Sphenisciformes), from the Brazilian coastal zone. *Marine pollution bulletin*, 62(10), 2246-2249.
- Chua, M. H., Cheng, W., Goh, S. S., Kong, J., Li, B., Lim, J. Y., ... & Loh, X. J. (2020). Face masks in the new COVID-19 normal: materials, testing, and perspectives. *Research*, 2020.
- Ciotti, M., Ciccozzi, M., Terrinoni, A., Jiang, W. C., Wang, C. B., & Bernardini, S. (2020). The COVID-19 pandemic. *Critical reviews in clinical laboratory sciences*, 57(6), 365-388.
- Covid, C. D. C., Team, R., COVID, C., Team, R., COVID, C., Team, R., ... & Sauber-Schatz, E. (2020). Severe outcomes among patients with coronavirus disease 2019 (COVID-19)—United States, February 12–March 16, 2020. *Morbidity and mortality weekly report*, 69(12), 343.
- Defina, M. (2020, August 5) Press Release: ARL, MDAR, MVMA reminds public to properly dispose PPE. *Animal Rescue League of Boston*. <https://www.arlboston.org/press-release-arl-mdar-mvma-reminds-public-to-properly-dispose-ppe/>.
- Deng, W., Sun, Y., Yao, X., Subramanian, K., Ling, C., Wang, H., ... & Wang, S. (2022). Masks for COVID-19. *Advanced Science*, 9(3), 2102189.
- Desai, A. N., & Aronoff, D. M. (2020). Masks and coronavirus disease 2019 (COVID-19). *Jama*, 323(20), 2103-2103.
- Edmond, C. (2020). How Face Masks, Gloves and Other Coronavirus Waste are Polluting the Ocean. *GreenBiz* <https://www.greenbiz.com>.
- Eikenberry, S. E., Mancuso, M., Iboi, E., Phan, T., Eikenberry, K., Kuang, Y., ... & Gumel, A. B. (2020). To mask or not to mask: Modeling the potential for face mask use by the general public to curtail the COVID-19 pandemic. *Infectious Disease Modelling*, 5, 293-308.
- Esposito, S., & Principi, N. (2020). To mask or not to mask children to overcome COVID-19. *European journal of pediatrics*, 179(8), 1267-1270.
- Hakim, M., Khattak, F. A., Muhammad, S., Ismail, M., Ullah, N., Atiq Orakzai, M., ... & Ul-Haq, Z. (2021). Access and Use Experience of Personal Protective Equipment Among Frontline Healthcare Workers in Pakistan During the COVID-19 Emergency: A Cross-Sectional Study. *Health security*, 19(2), 140-149.
- Harris, K. (2020). RSPCA Alert: Fury as Discarded Face Mask Traps Baby Bird—Put in Bins. *Express*, UK <https://www.express.co.uk>.
- Hiemstra, A. F., Rambonnet, L., Gravendeel, B., & Schilthuisen, M. (2021). The effects of COVID-19 litter on animal life. *Animal Biology*, 71(2), 215-231.
- Hiemstra, A. F., Rambonnet, L., Gravendeel, B., & Schilthuisen, M. (2021). The effects of COVID-19 litter on animal life. *Animal Biology*, 71(2), 215-231.
- Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., ... & Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*, 395(10223), 497-506.
- Hussain, S., Cheema, M. J. M., Motahir, S., Iqbal, M. M., Arshad, A., Waqas, M. S., ... & Malik, S. (2020). Proposed design of walk-through gate (WTG): mitigating the effect of COVID-19. *Applied System Innovation*, 3(3), 41.
- Kassam, A. (2020). More masks than jellyfish': coronavirus waste ends up in ocean. *The Guardian*, 8.
- Kaur, J. (2020, November 24) COVID-19: discarded face masks posing deadly risk to dogs and other animals. *Sky news*. <https://news.sky.com/story/covid-19-discarded-face-masks-posing-deadly-risk-to-dogs-and-other-animals-12140467>.
- Leonard, S., Strasser, W., Whittle, J. S., Volakis, L. I., DeBellis, R. J., Prichard, R., ... & Dungan, G. C. (2020). Reducing aerosol dispersion by high flow therapy in COVID-19: High resolution computational fluid dynamics simulations of particle behavior during high velocity nasal insufflation with a simple surgical mask. *Journal of the American College of Emergency Physicians Open*, 1(4), 578-591.
- Malik, S. (2021). Impact of 17beta-Estradiol (E2), in Increasing Immunity Against COVID-19 and Mitigating Severe COVID-19 Outcomes. *Technium BioChemMed*, 2(1), 12-22.
- Malik, S., Habib, M., Hashmi, M. A. H., Saeed, M. T., Zahra, S. A., Nisar, M., ... & Majid, M. S. (2021, January). Analysis of Covid-19 Impact on Gender (Male and Female) in South Asian Country Pakistan. In *International Conference on Digital Technologies and Applications* (pp. 925-937). Springer, Cham.
- Martínez Silva, P., Nanny, M.A., 2020. Impact of microplastic fibers from the degradation of nonwoven synthetic textiles to the Magdalena River water column and river sediments by the city of Neiva, Huila (Colombia). *Water* 12, 1210–1216. <https://doi.org/10.3390/w12041210>.
- Neto, H. G., Bantel, C. G., Browning, J., Della Fina, N., Ballabio, T. A., de Santana, F. T., ... & Barbosa, C. B. (2021). Mortality of a juvenile Magellanic penguin (*Spheniscus magellanicus*, Spheniscidae) associated with the ingestion of a PFF-2 protective mask during the Covid-19 pandemic. *Marine Pollution Bulletin*, 166, 112232.
- Prata, J. C., Silva, A. L., Walker, T. R., Duarte, A. C., & Rocha-Santos, T. (2020). COVID-19 pandemic repercussions on the use and management of plastics. *Environmental Science & Technology*, 54(13), 7760-7765.
- Shruti, V. C., Pérez-Guevara, F., Elizalde-Martínez, I., & Kutralam-Muniasamy, G. (2020). Reusable masks for COVID-19: A missing piece of the microplastic problem during the global health crisis. *Marine Pollution Bulletin*, 161, 111777.
- Silva, A. L. P., Prata, J. C., Walker, T. R., Campos, D., Duarte, A. C., Soares, A. M., ... & Rocha-Santos, T. (2020). Rethinking and optimising plastic waste management under COVID-19 pandemic: Policy solutions based on redesign and reduction of single-use plastics and personal protective equipment. *Science of the Total Environment*, 742, 140565.
- van Gerwen, J. (2021, January 3) Van mondkap naar 'lampenkap' Het is 03.00 uur in de nacht van zaterdag op zondag. Ik ben moe en klaarwakker [Image attached] [Status update]. Facebook. <https://www.facebook.com/janneke.vg.9/posts/2149505295184089>.
- Wang, Y., Deng, Z., & Shi, D. (2021). How effective is a mask in preventing COVID-19 infection?. *Medical devices & sensors*, 4(1), e10163.
- World Health Organization (2020, March 11) WHO Director-General's opening remarks at the media briefing on COVID-19. <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>.
- Wang, L., Li, S., Ahmad, I. M., Zhang, G., Sun, Y., Wang, Y., ... & Li, D. (2023). Global face mask pollution: threats to the environment and wildlife, and potential solutions. *Science of The Total Environment*, 887, 164055.
- Silva, A. L. P., Prata, J. C., Mouneyrac, C., Barcelò, D., Duarte, A. C., & Rocha-Santos, T. (2021). Risks of Covid-19 face masks to wildlife: present and future research needs. *Science of the Total Environment*, 792, 148505.
- Li, T., Liu, Y., Li, M., Qian, X., & Dai, S. Y. (2020). Mask or no mask for COVID-19: A public health and market study. *PLoS one*, 15(8), e0237691.
- Matuschek, C., Moll, F., Fangerau, H., Fischer, J. C., Zänker, K., van Griensven, M., ... & Haussmann, J. (2020). Face masks: benefits and risks during the COVID-19 crisis. *European Journal of Medical Research*, 25(1), 32.
- Mikula, P., Jokimäki, J., Kaisanlahti-Jokimäki, M. L., Markó, G., Morelli, F., Møller, A. P., ... & Tryjanowski, P. (2021). Face mask-wear did not affect large-scale patterns in escape and alertness of urban and rural birds during the COVID-19 pandemic. *Science of The Total Environment*, 793, 148672.
- Fabrero, G. V. N., Manceras, L. J. S., Agduma, A. R., & Tanalgo, K. C.

- (2023). Uncovering the effects of COVID-19 mask wearing on bird flight initiation distance in urbanized areas in the southern Philippines. *Animals*, 13(8), 1289.
- Xie, M., & Chen, Q. (2020). Insight into 2019 novel coronavirus—An updated interim review and lessons from SARS-CoV and MERS-CoV. *International Journal of Infectious Diseases*, 94, 119-124.
- Yang, L., Liu, S., Liu, J., Zhang, Z., Wan, X., Huang, B., ... & Zhang, Y. (2020). COVID-19: immunopathogenesis and Immunotherapeutics. *Signal Transduction and Targeted Therapy*, 5(1), 128.
- Zettler, E. R., Mincer, T. J., & Amaral-Zettler, L. A. (2013). Life in the "plastisphere": microbial communities on plastic marine debris. *Environmental Science & Technology*, 47(13), 7137-7146.

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