UNIVERSITAS
GADJAH MADA
EKSPLORASI LUMUT KERAK SEBAGAI BIOINDIKATOR KUALITAS UDARA DI KAWASAN SUB-PESISIR PARANGTRITISâ€“DEPOK, BANTUL, DAERAH ISTIMEWA YOGYAKARTA
Herawati Nugrahayu, Prof. Dr. rer. nat. Andhika Puspito Nugroho
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

DAFTAR PUSTAKA

Abas, N., Wahid, N., and Abdul, L.N. 2021. A systematic review on biomonitoring using lumut kerak as the biological indicator: A decade of practices, progress, and challenges. *Ecological indicators*, 132, 108281.

Adeniran, J. A., Aremu, A. S., Saadu, Y. O., and Yusuf, R. O. 2018. Particulate matter concentration levels during intense haze event in an urban environment. *Environmental Monitoring and Assessment*, 190, 41.

Arino, X., & Saiz-Jimenez, C. 2023. Selecting the species to be used in lichen transplant surveys of air pollution in Tunisia. *Environmental Monitoring and Assessment*, 195, 570.

Australian Biological Resources Study. *Flora of Australia Volume 54*. 1992. Flora of Australia.

Brunialti, G., and Giordani, P. 2022. Lumut keraks As ecological indicators in coastal gradients. *Diversity*, 14(3), 215.

Chappuis, E., Terradas, M., Cefali, M. E., and Mariani, S. 2014. Vertical zonation is the main distribution pattern of littoral assemblages on rocky shores at a regional scale. *Estuarine, Coastal, and Shelf Science*, 147:113-122.

Chiang-Ming, C., Yo-Long, L., & Chien-Lung, H. 2017. Does air pollution drive away tourists? A case study of the Sun Moon Lake National Scenic Area, Taiwan. *Transportation Research Part D Transport and Environment*, 53, 398-402.

Consortium of North American Lichen Herbaria. 2022. https://lichenportal.org/ (Diakses 10 April 2026).

Dabson, F. S. 1992. *Lumut keraks: An Illustrated Guide to The British and Irish Species (3RD enlarged ed.).* The Richmond Publishing Co. Ltd.

Das, A. K., Sharma, A., Kathuria, D., Ansari, M.J., and Bhardwajy, G. 2024. Chemistry, Biology and Pharmacology of Lichen. John Wiley & Sons Ltd.

Faroqi, A., Hadisantoso, E.K., Halim, D.K., dan Mada Sanjaya. 2016. Perancangan Alat Pendeteksi Kadar Polusi Udara Menggunakan Sensor Gas MQ-7 dengan Teknologi Wireless HC-50. *Journal UIN SGD*, 10(2): 33-48.

Fryday, A. M., and Coppins, B. 2017. Lumut kerak Identification Using Chemical Spot Tests and Microscopy. *The Lumut kerakologist*, 49(1): 1-15.

Galloway, D. J. 1991. *Tropical Lumut keraks: Their Systematics, Conservation, and Ecology*. The Systematics Association Special Volume No. 43. Oxford University Press.

Garcia, G. G., Diaz, R. S., and Holst, I. 2015. Lumut kerak community structure and richness in three mid-elevation secondary forest in Costa Rica. *Revista de Biologia Tropical,* 63(2): 429-446.

UNIVERSITAS GADJAH MADA
EKSPLORASI LUMUT KERAK SEBAGAI BIOINDIKATOR KUALITAS UDARA DI KAWASAN SUB-PESISIR PARANGTRITISâ€“DEPOK, BANTUL, DAERAH ISTIMEWA YOGYAKARTA
Herawati Nugrahayu, Prof. Dr. rer. nat. Andhika Puspito Nugroho
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Garty, J. 2011. *Environmental Stress and Lumut kerak Ecology*. In: Current Advances in Lumut kerakology. Springer.

Gasulla, F., Guera, A., Rios, A.D.L., and Ortega, S. P. 2019. Differential responses to salt concentrations of lumut kerak photobiont strains isolated from lumut keraks occurring in different littoral zones. *Plant and Fungal Systematics*, 64(2): 149–162.

Gauslaa, Y. 2026. Trait- and environment-based determinants of reproduction in the old forest indicator lichen *Lobaria pulmonaria. Oecologia*, 208(60).

Gbif, "*The Global Biodiversity Information Facility*", diakses pada tanggal 15 April 2026 dari situs: www.gbif.org

Harahap, U. R., Wibisono, G., Zaenudin, A., Susanti, J. K. 2025. Pengaruh Pertumbuhan Wisatawan terhadap Kualitas Udara di Kota Yogyakarta (Sebuah Kajian Literatur). *Jurnal Masyarakat dan Desa*, 5(1).

Inaku, A. H. R., dan Novianus, C. 2020. Pengaruh Pencemaran Udara $PM_{2,5}$ dan PM_{10} Terhadap Keluhan Pernapasan Anak di Ruang Terbuka Anak di DKI Jakarta. *ARKESMAS*, 5(2):9-17.

ICP Forest. 2016. *Assessment of epiphytic lumut kerak diversity: Manual Part X*. https://www.icp-forests.org

Jannah, M., dan Hudayah. 2019. Keanekaragaman Lumut kerak Sebagai Biomonitoring Kualitas Hutan Lereng Selatan Gunung Merapi Yogyakarta 1. *ResearchGate*, 1-14.

Jason Hollinger. 2022. *Enlichenment*. www.waysofenlichenment.net (Diakses: 13 April 2026).

Keputusan Menteri Negara Lingkungan Hidup No. KEP-45/MENLH/10/1997 *Indeks Standar Pencemar Udara*. 13 Oktober 1997. Menteri Negara Lingkungan Hidup. Jakarta.

Lisowska, M. 2011. Lichen recolonisation in an urban-industrial area of southern Poland as a result of air quality improvement. *Environmental Monitoring and Assessment*, 179, 177–190.

Lumbsch, H. T. 2012. Chemical Ecology and Chemotaxonomy of Lumut keraks. *Annals of the Missouri Botanical Garden*, 99(3): 359-379.

Manisalidis, I., Stavropoulou, E., Stavropoulou, A., and Bezirtzoglou, E. 2020. Environmental and health impacts of air pollution: a review. *Frontiers in Public Health*, 8: 1–13.

Monteiro, A., Eusébio, C., Carneiro, M. J., Madaleno, M., Robaina, M., Rodrigues, V., Gama, C., Relvas, H., Russo, M., Oliveira, K., Lopes, M., and Borrego, C. 2021. Tourism and Air Quality during COVID-19 Pandemic: Lessons for the Future. *Sustainability*, 13(7), 3906.

Mudahka, G.A., Shehab, M., Gasana, J., and Zoughool, M.A. 2025. Levels of Indoor $PM_{2.5}$ and PM_{10} in Public High Schools in Kuwait. *Aerosol and Air Quality Research*, 25 (70).

UNIVERSITAS GADJAH MADA
EKSPLORASI LUMUT KERAK SEBAGAI BIOINDIKATOR KUALITAS UDARA DI KAWASAN SUB-PESISIR PARANGTRITISâ€“DEPOK, BANTUL, DAERAH ISTIMEWA YOGYAKARTA
Herawati Nugrahayu, Prof. Dr. rer. nat. Andhika Puspito Nugroho
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Munzi, S., Ravera, S., Ricciardi, C., & Caneva, G. 2010. Lumut keraks as bioindikators of environmental quality: A review. *Environmental Pollution*, 158(9): 2099–2109.

Namcome, T., and Tansuchat, R. 2021. The Impact of Fine Particulate Matter ($PM_{2.5}$) Pollution on the Number of Foreign Tourists in Chiang Mai and Bangkok. *Community and Social Development Journal*, 22 (3).

Nash, T.H., Ryan, B.D., Gries, C., Bungartz, F., (eds.) 2004. *Lichen Flora of the Greater Sonoran Desert Region*. Vol 2.

Nebore, I. D. Y. 2017. Lumut kerak Corticolous Sebagai Bioindikator Pencemaran Udara di Manokwari, Papua Barat. Tesis. Fakultas Biologi. Universitas Gadjah Mada.

Niepsch, D., Clarke, L. J., Jones, R. G., Tzoulas K., and Cavan, G. 2024. Lichen biomonitoring to assess spatial variability, potential sources and human health risks of polycyclic aromatic hydrocarbons (PAHs) and airborne metal concentrations in Manchester (UK). *Environmental Monitoring and Assessment*, 196(379).

Nugrahayu, H. 2023. Kemelimpahan Lumut kerak Sebagai Bioindikator Pencemaran Udara di Sleman, Daerah Istimewa Yogyakarta. Skripsi. Fakultas Biologi. Universitas Gadjah Mada.

Peraturan Menteri Lingkungan Hidup dan Kehutanan Republik Indonesia No 14 Tahun 2020 Indeks Standar Pencemar Udara. 15 Juli 2020. Berita Negara Republik Indonesia Tahun 2020 Nomor 774. Jakarta.

Rasyidah. 2018. Kelimpahan Lumut Kerak (Lumut keraks) Sebagai Bioindikator Kualitas Udara di Kawasan Perkotaan Kota Medan. *Klorofil*, 1(2), 88–92.

Roziaty, E. 2016. Lumut kerak: Karakteristik Anatomis dan Reproduksi Vegetativenya. *Jurnal Pena Sains*, 3(1): 44-54.

Rushayati, S. B., Daulay, A. F. S., Herliyana, E. N., 2025. Lichen Diversity in Two Locations with Different Air Quality in Bogor Regency. *Journal of Tropical Silviculture*, 16 (03): 186-198.

Seed, L., Wolseley, P., Gosling, L., Davies, L., and Power, S. A. 2013. Modelling relationships between lichen bioindicators, air quality and climate on a national scale: Results from the UK OPAL air survey. *Environmental Pollution*, 182: 437-447.

Sonina, A. V., Rumjantseva, A. D., Tsunskaya, A. A., & Androsova, V. I. 2017. Adaptations of epilithic lumut keraks to the microclimate conditions of the White Sea coast. *Czech Polar Reports*, 7(2): 247–258.

Sonina, A. V., & Androsova, V. I. 2021. *Coastal Lumut keraks: Distribution Patterns and Adaptive Strategies.* In M. Hasanuzzaman (Ed.), Handbook of Halophytes: From Molecules to Ecosystems towards Biosaline Agriculture (pp. 1013-1034). Springer. Nature Switzerland AG.

UNIVERSITAS GADJAH MADA
EKSPLORASI LUMUT KERAK SEBAGAI BIOINDIKATOR KUALITAS UDARA DI KAWASAN SUB-PESISIR PARANGTRITISâ€“DEPOK, BANTUL, DAERAH ISTIMEWA YOGYAKARTA
Herawati Nugrahayu, Prof. Dr. rer. nat. Andhika Puspito Nugroho
Universitas Gadjah Mada, 2026 | Diunduh dari http://etd.repository.ugm.ac.id/

Styburski, J., and Skubata, K. 2023. Do urban air pollutants induce changes in the thallus anatomy and affect the photosynthetic efficiency of the nitrophilous lichen *Physcia adscendens*?. *Environmental Science and Pollution Research*, 30: 112336-112346.

Sun, Y.Y., Faturay, F., Lenzen, M., Grau, R., Wiedmann, T., and Guan, D. 2024. Drivers of global tourism carbon emissions. *Nature Communications*, 15, 10384.

Susilawati, R. S. 2013. Keanekaragaman corticolous lumut kerak dan preferensi inangnya dengan *Erythrina lithosperma* Miq., *Pinus merkusii* Jungh. & De Vr. dan *Engelhardtia spicta* Blume di Bukit Bibi, Taman Nasional Gunung Merapi. Tesis. Fakultas Biologi. Universitas Gadjah Mada.

Tangahu, B. V., Kartika, A.A.G., and Humaira, N.G. 2020. The Lichen Type Identification as a Bioindicator of Air Quality of Sukolilo District In Surabaya, Indonesia. *TAKU*, 62 (3): 743-750.

Tampang, B. L. 2018. Analisis Pencemaran Udara Dan Kebisingan Serta Persepsi Masyarakat Tentang Pembangkit Listrik Tenaga Diesel Kota Bitung. *Jurnal Frontiers*, 1(1): 119-133.

Wang, Y., Chen, L., and Kim, J. 2022. Image analysis for automatic measurement of crustose lumut keraks. *arXiv preprint arXiv:*2203.00787.

Weldon, J., and Grandin, U. 2021. Weak recovery of epiphytic lichen communities in Sweden over 20 years of rapid air pollution decline. *The Lichenologist*, 53 (2): 203-313.

West, N. J., Parrot, D., Fayet, C., Grube, M., Tomasi, S., and Suzuki, M. T. 2018. Marine cyanolumut keraks from different littoral zones are associated with distinct bacterial communities. *PeerJ*, 6 (5208): 1-29.

William, A. G., Ana, Z. C., and Zajch A. 2020. Sampling frequency of climate data for the determination of daily temperature and daily temperature extrema. *International Journal of Climatology*, 40 (13): 5451-5463.

World Health Organization (WHO). 2021. WHO Global Air Quality Guidelines: Particulate Matter ($PM_{2,5}$ and PM_{10}), Ozone, Nitrogen Dioxide, Sulfur Dioxide, and Carbon Monoxide. World Health Organization, Ganeva. https://www.who.int/publications/i/item/9789240034228

Yang, G., and Jia, L. 2022. Estimation of Carbon Emissions from Tourism Transport and Analysis of Its Influencing Factors in Dunhuang. *Sustainability*, 14(21), 14323.

Yuliani, R., Imaningsih, W., dan Yuwati, T.W. 2021. Lumut kerak Sebagai Bioindikator Kualitas Udara di Kawasan Penyangga Kota Banjarbaru. *Jurnal Galam*, 2(1): 54-65.

Zhou, J., Du, B., Qin, X., Tong, F., dan Li, G. 2020. Air pollution and its impacts on plant physiology: a review. *Journal of Environmental Sciences*, 96 : 298-314.