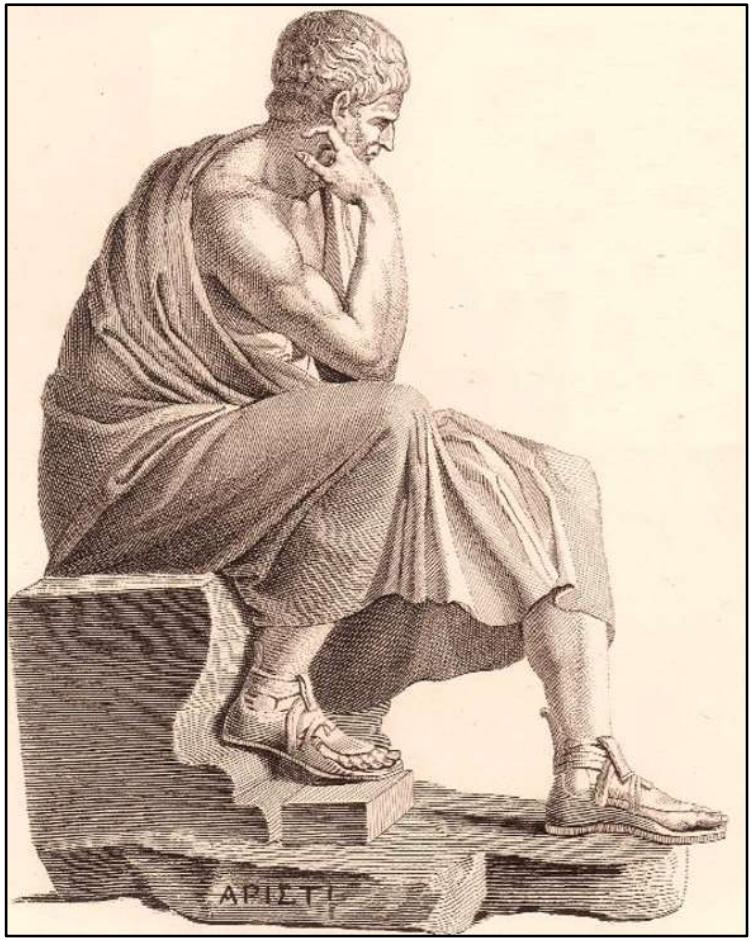
UNIWERSYTET OPOLSKI
WYDZIAŁ PRZYRODNICZO-TECHNICZNY UNIWERSYTET OPOLSKI
INSTYTUT INŻYNIERII ŚRODOWISKA I BIOTECHNOLOGII UNIWERSYTET OPOLSKI

Bioluminescencja grzybów

Radosław Pytlarz
dr hab. Ewa Moliszewska prof. UO

Aristotle

(384-322 BC)



Ἀριστοτέλης, Greek philosopher of the Classical period, founder of the Lyceum and the Peripatetic school of philosophy. (Image source: Visconti, 1817.)

From mythology to science: the development of scientific hydrological concepts in the Greek antiquity and its relevance to modern hydrology.

Pliny the Elder

(23-79 CE)

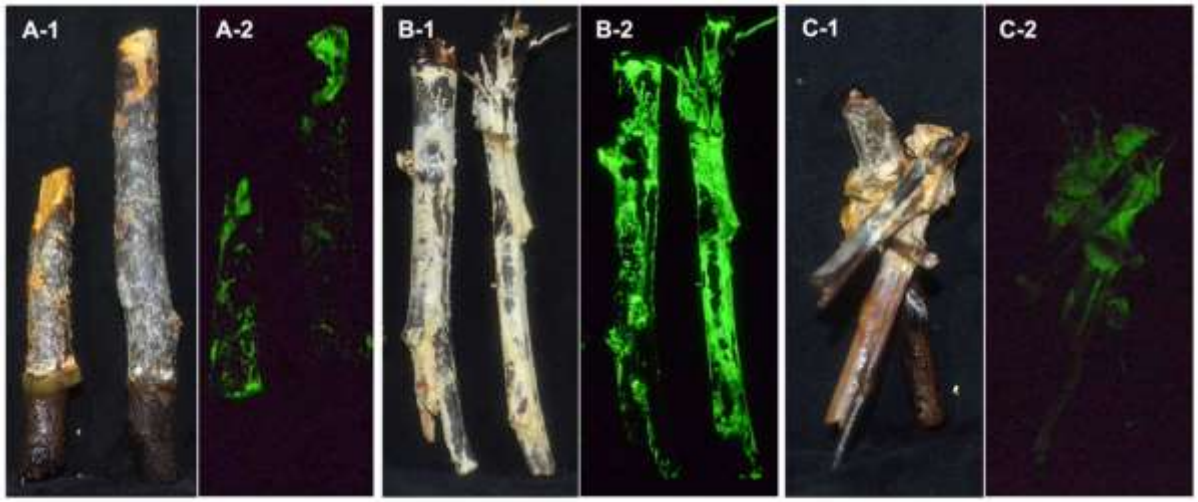
Roman savant and author of the celebrated *Natural History,* an encyclopedic work of uneven accuracy that was an authority on scientific matters up to the Middle Ages.

From Encyclopædia Britannica.
https://www.britannica.com/biography/Pliny-the-Elder/Legacy#/media/1/464822/234312

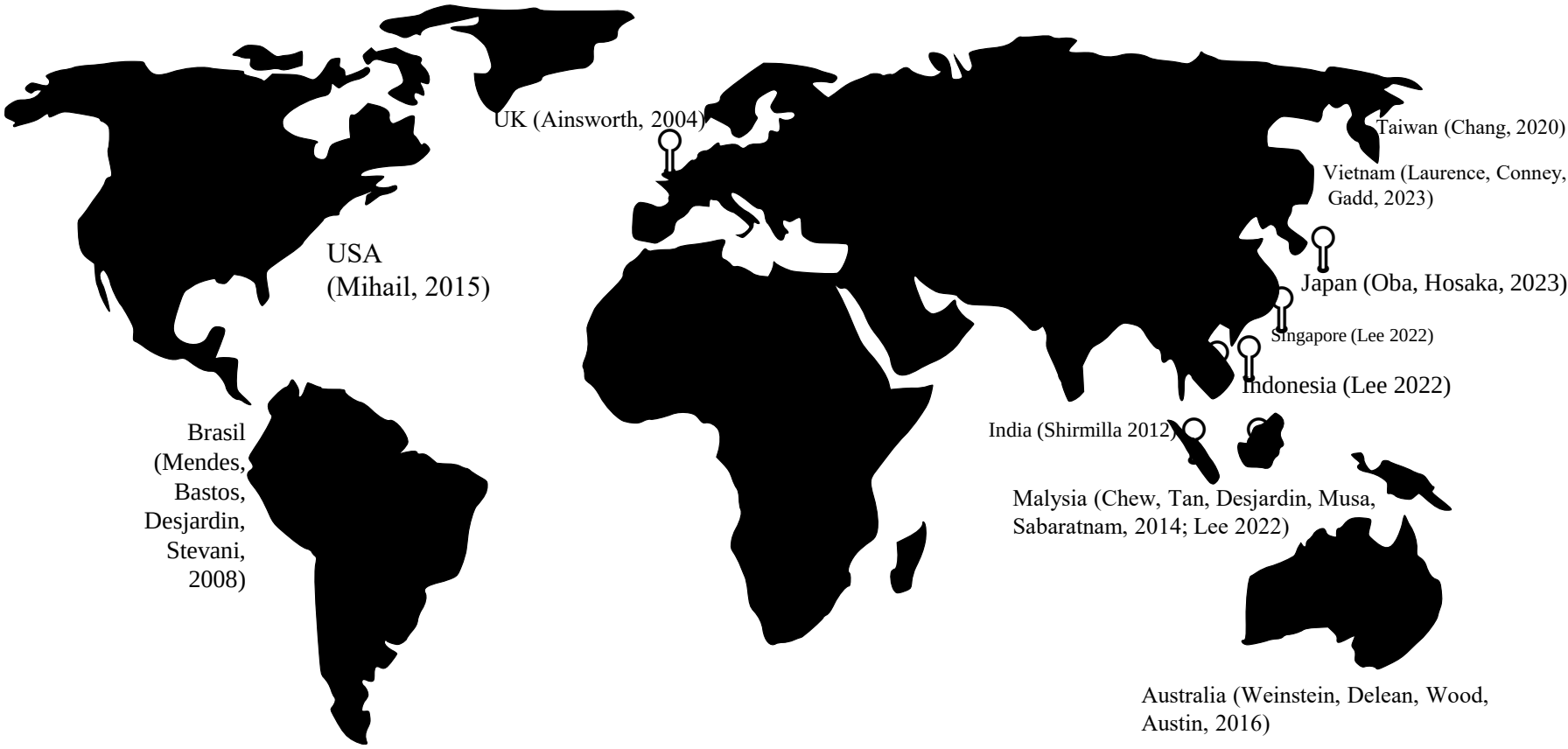
Natural History
Page from *Natural History* by Pliny the Elder, 12th century; in the British Library.

The saprobe *Panellus Stipticus* displaying bioluminescence. From https://en.wikipedia.org/wiki/Foxfire#/media/File:PanellusStipticusAug12_2009_Animated.gif

Mycena jingyinga *Mycena luguensis* *Mycena venus*



Chang, C., Chen, C., Lin, W., & Kao, H. (2020). Mycena jingyinga, Mycena luguensis, and Mycena venus: three new species of bioluminescent fungi from Taiwan.


UK (Ainsworth, 2004)
Taiwan (Chang, 2020)
Vietnam (Laurence, Conney, Gadd, 2023)
USA
(Mihail, 2015)
Japan (Oba, Hosaka, 2023)
Singapore (Lee 2022)
Indonesia (Lee 2022)
India (Shirmilla 2012)
Brasil
(Mendes, Bastos, Desjardin, Stevani, 2008)
Malysia (Chew, Tan, Desjardin, Musa, Sabaratnam, 2014; Lee 2022)
Australia (Weinstein, Delean, Wood, Austin, 2016)

Osamu Shimomura

(1928-2018)

Osamu Shimomura with Green Fluorescent Protein.

From https://www.the-scientist.com/news-opinion/marine-biologist-osamu-shimomura-dies-64982

Panellus stipticus

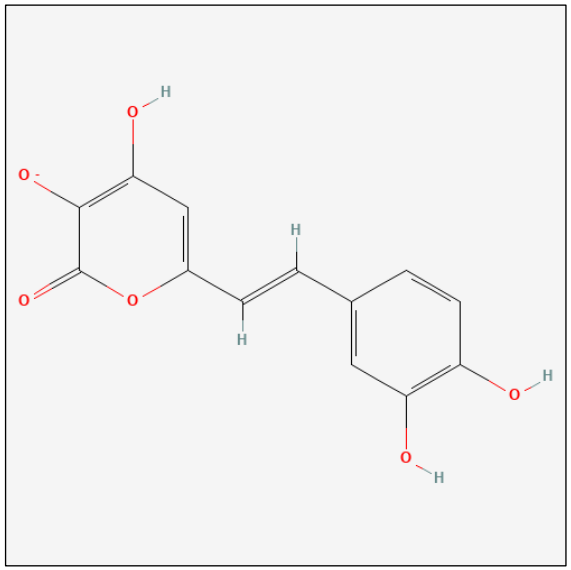
Kushwaha Vinodkumar and Hajirnis Sarita (2016) A Review on Bioluminescent fungi: A Torch of Curiosity , Int. J.of. Life Sciences, Special Issue, A7:107-110.

Łycznik Ochrowy, Bitter Oyster - *Panellus stipticus*.

From https://www.flickr.com/photos/40948266@N04/37162668243/

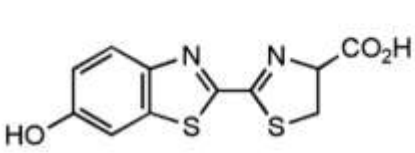
Fungal luciferin

3-hydroxyhispidin

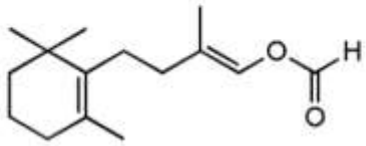


National Center for Biotechnology Information (2023). PubChem Compound Summary for CID 131841536, 3-Hydroxyhispidin. Retrieved October 23, 2023 From https://pubchem.ncbi.nlm.nih.gov/compound/3-Hydroxyhispidin.

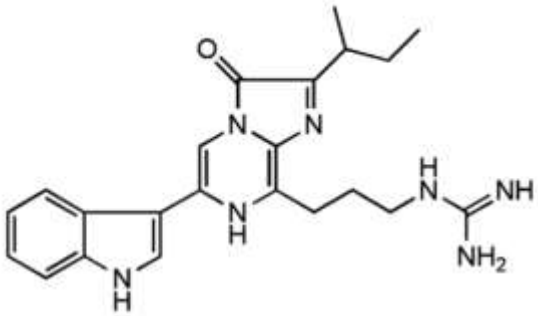
Desjardin, D.E., Oliveira, A.G. & Stevani, C.V. Fungi bioluminescence revisited. *Photochem Photobiol Sci*7, 170–182 (2008). https://doi.org/10.1039/b713328f



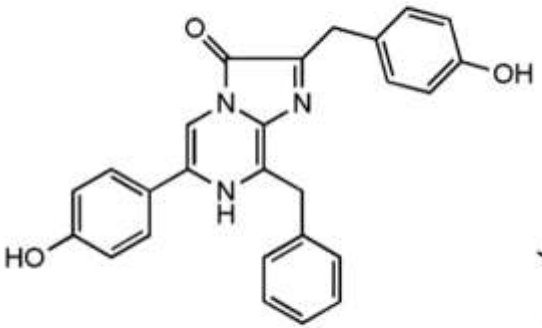
firefly luciferin



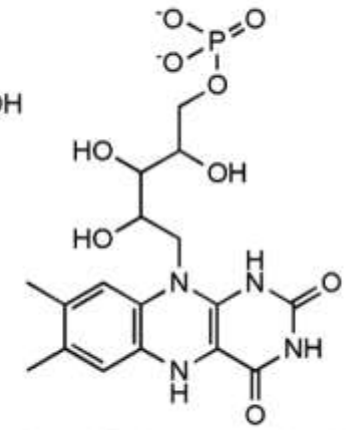
Latia neritoides luciferin



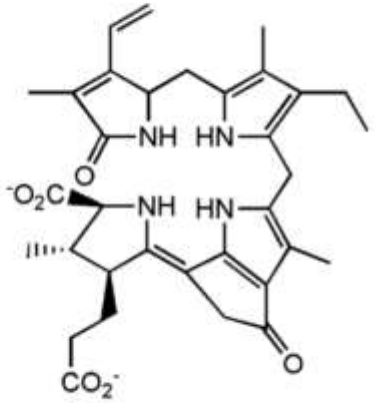
vargulin (Vargula luciferin)



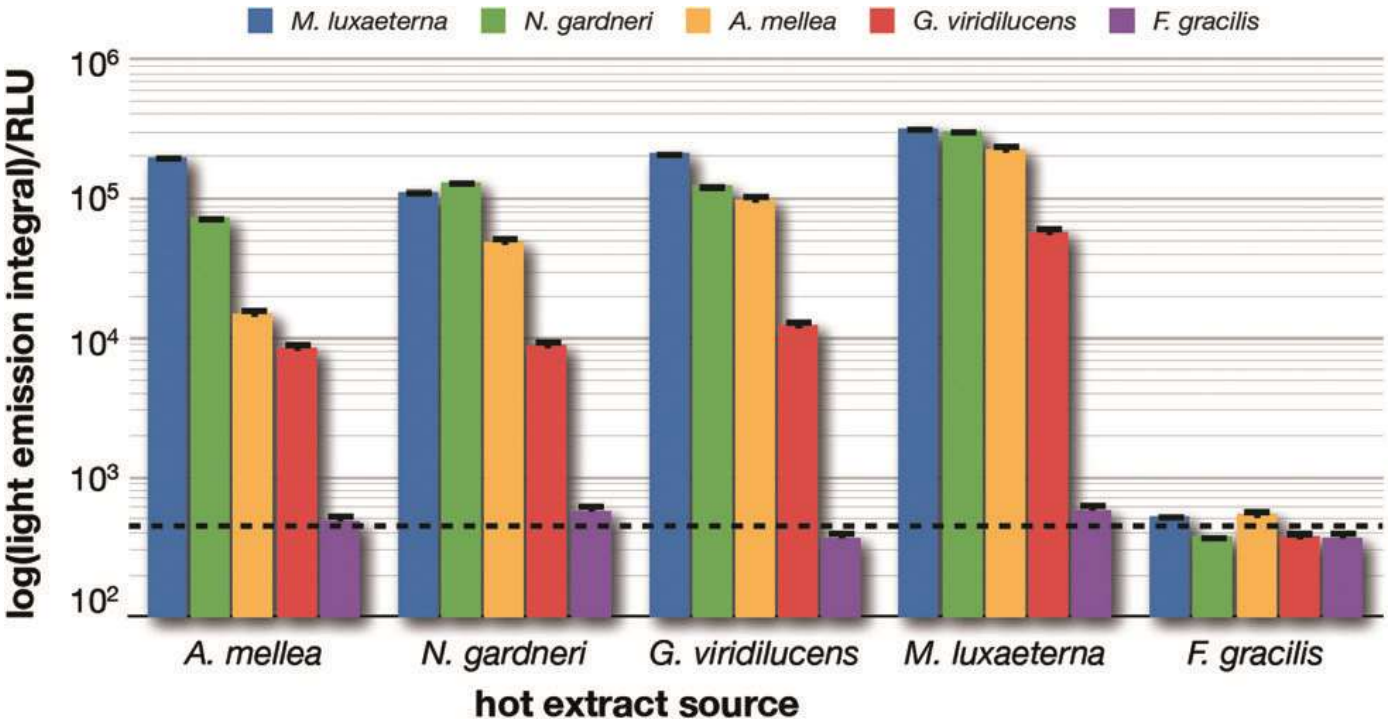
coelenterazine (Aequorea luciferin)



reduced flavin mononucleotide ($FMNH_2$, bacterial luciferin)



dinoflagellate luciferin

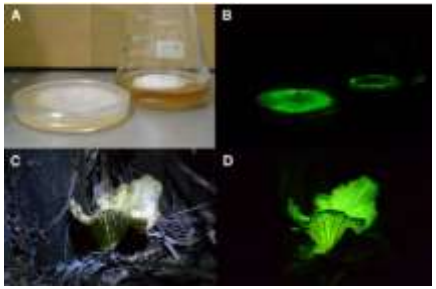


Oliveira, A.G., Desjardin, D.E., Perry, B.A. *et al.* Evidence that a single bioluminescent system is shared by all known bioluminescent fungal lineages. *Photochem Photobiol Sci* **11**, 848–852 (2012). https://doi.org/10.1039/c2pp25032b

Armillaria mellea

Malakauskiene, Asta. (2018). Reported and potential bioluminescent species in Lithuania. Biologija. 64. 10.6001/biologija.v64i3.3823.

Neonothopanus gardneri



Stevani, C.V., Oliveira, A.G., Mendes, L.F., Ventura, F.F., Waldenmaier, H.E., Carvalho, R.P. and Pereira, T.A. (2013), Current Status of Research on Fungal Bioluminescence: Biochemistry and Prospects for Ecotoxicological Application. Photochem Photobiol, 89: 1318-1326. https://doi.org/10.1111/php.12135

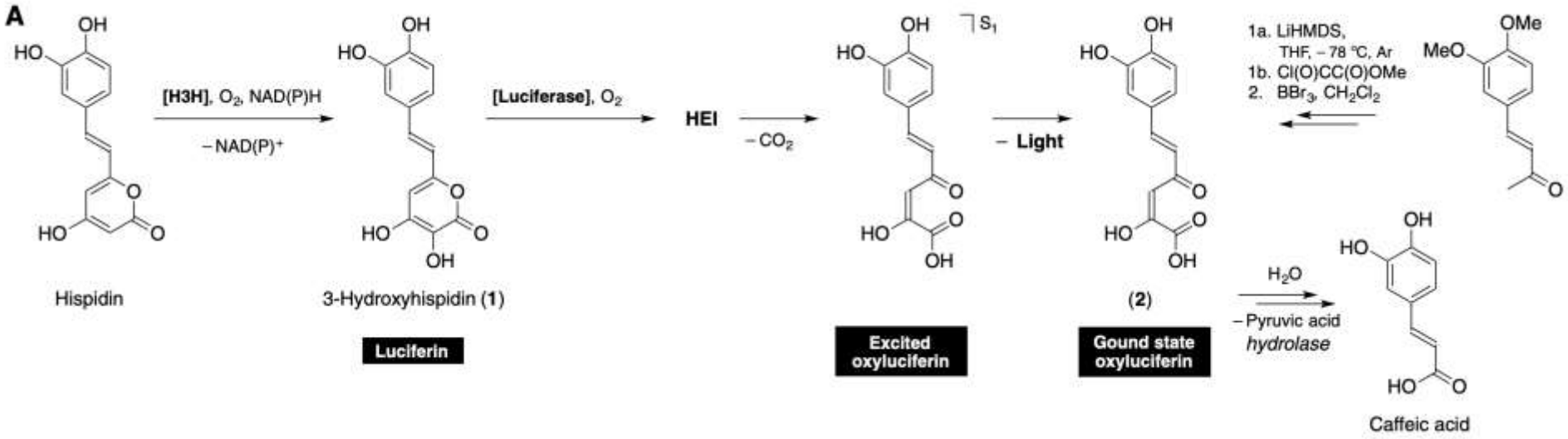
Gerronema viridilucens

Gerronema viridilucens. Photo: A.H.R Domingos.
From https://mindfunga.ufsc.br/gerronema-viridilucens/?lang=en

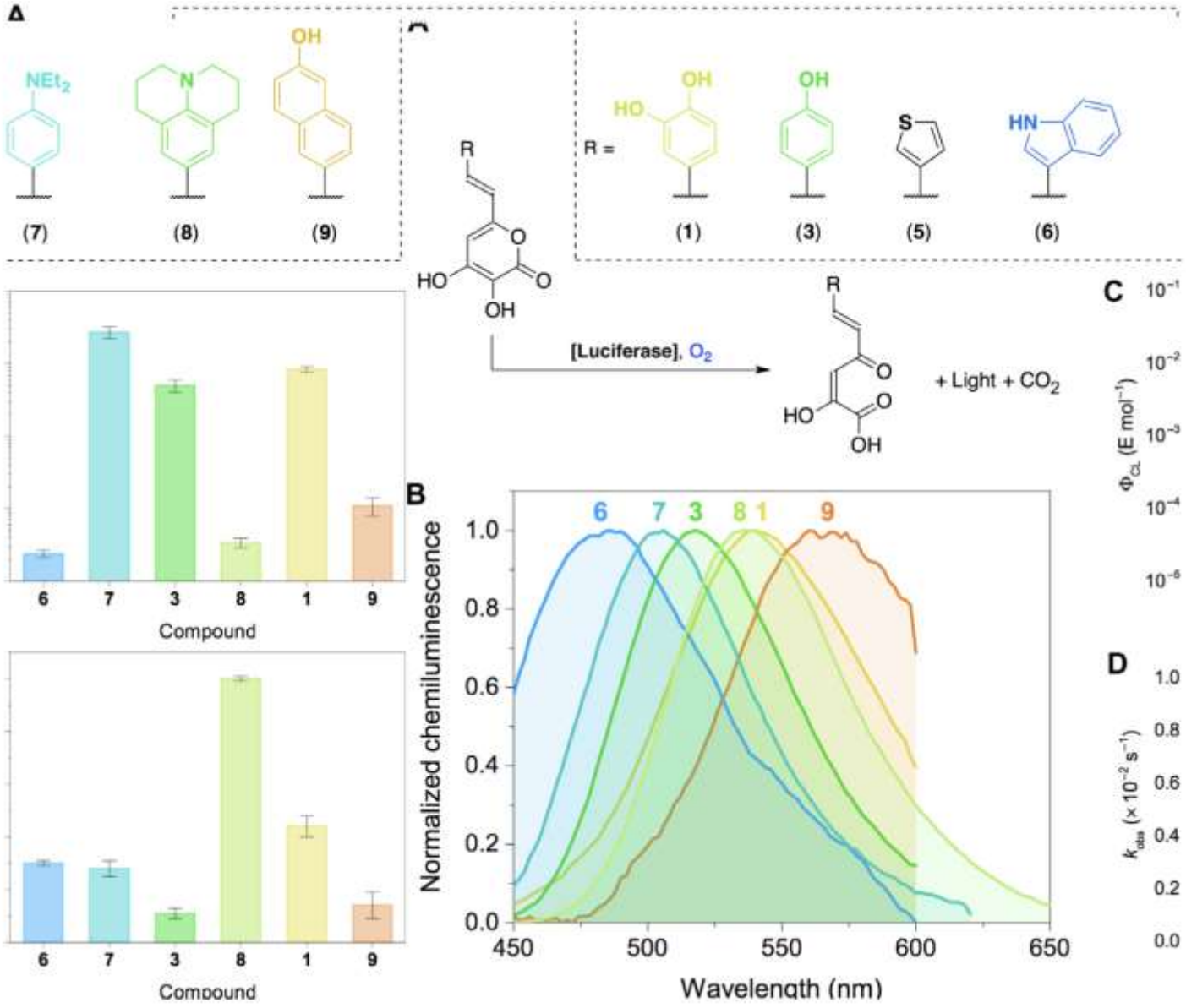
Mycena luxaeterna

https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.inaturalist.org%2Ftaxa%2F1141243-Mycena-luxaeterna%2Fbrowse_photos&psig=AOvVaw19tOK3f02sg9_Y2ejp6a-7&ust=1698003974182000&source=images&cd=vfe&opi=89978449&ved=0CBMQjhxqFwoTCKC0re_zh4IDFQAAAAAdAAAAABA

Molecular mechanism



Zinaida M. Kaskova *et al.*, Mechanism and color modulation of fungal bioluminescence.*Sci. Adv.***3**,e1602847(2017).DOI:10.1126/sciadv.1602847



Zinaida M. Kaskova *et al.*, Mechanism and color modulation of fungal bioluminescence.*Sci. Adv.***3**,e1602847(2017).DOI:10.1126/sciadv.1602847

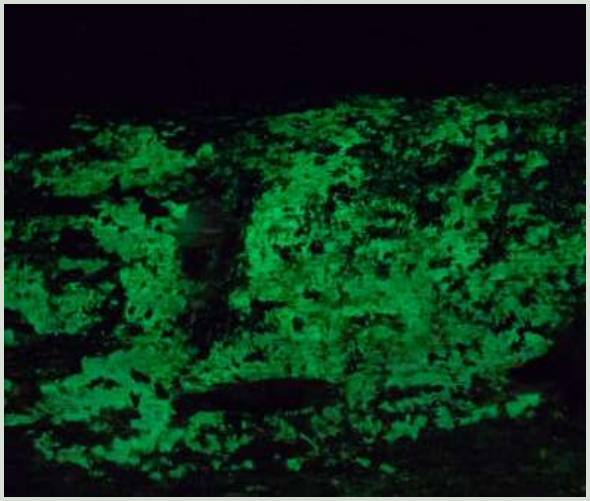
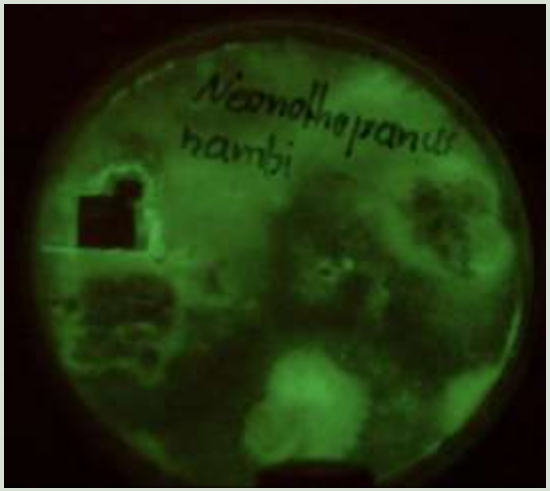
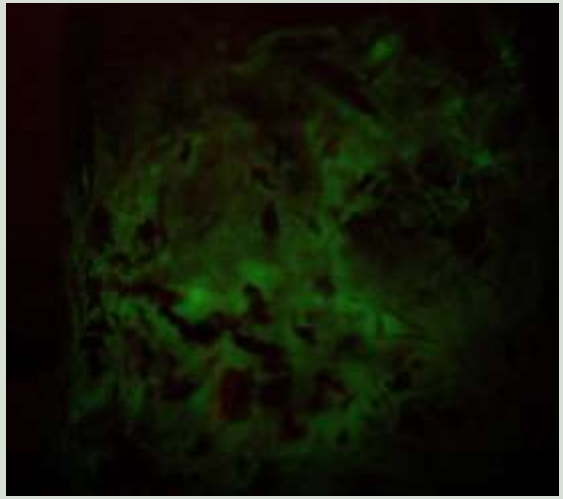
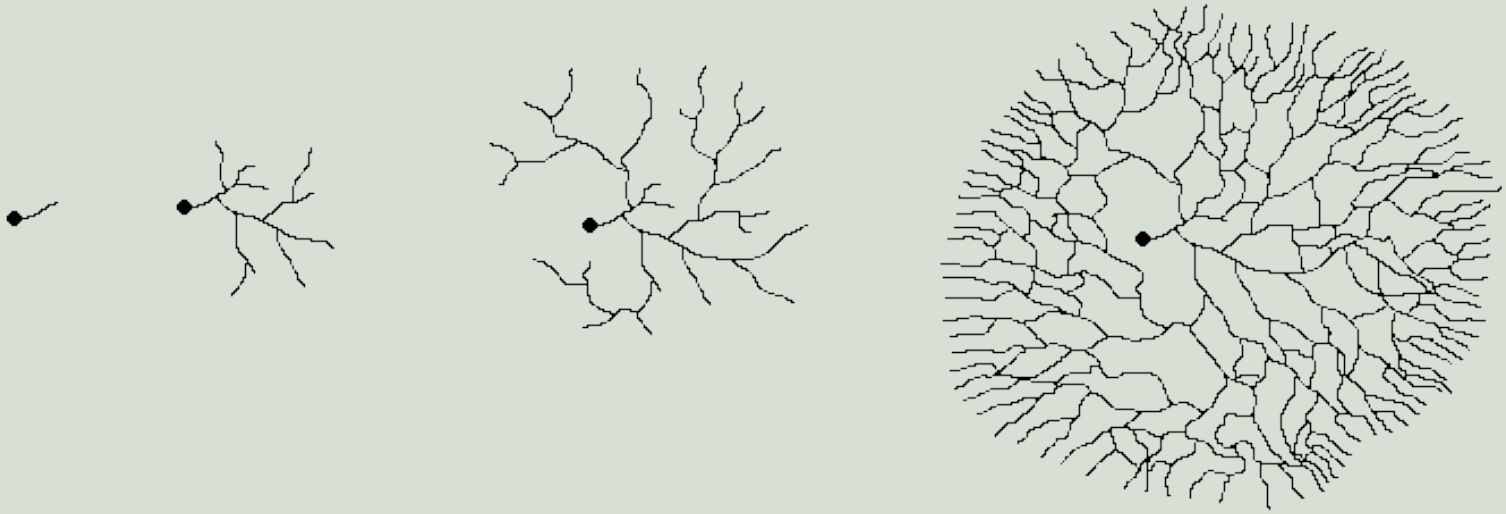


Photo by Steve Axford.
Bioluminescent mycelia on bamboo substrate.

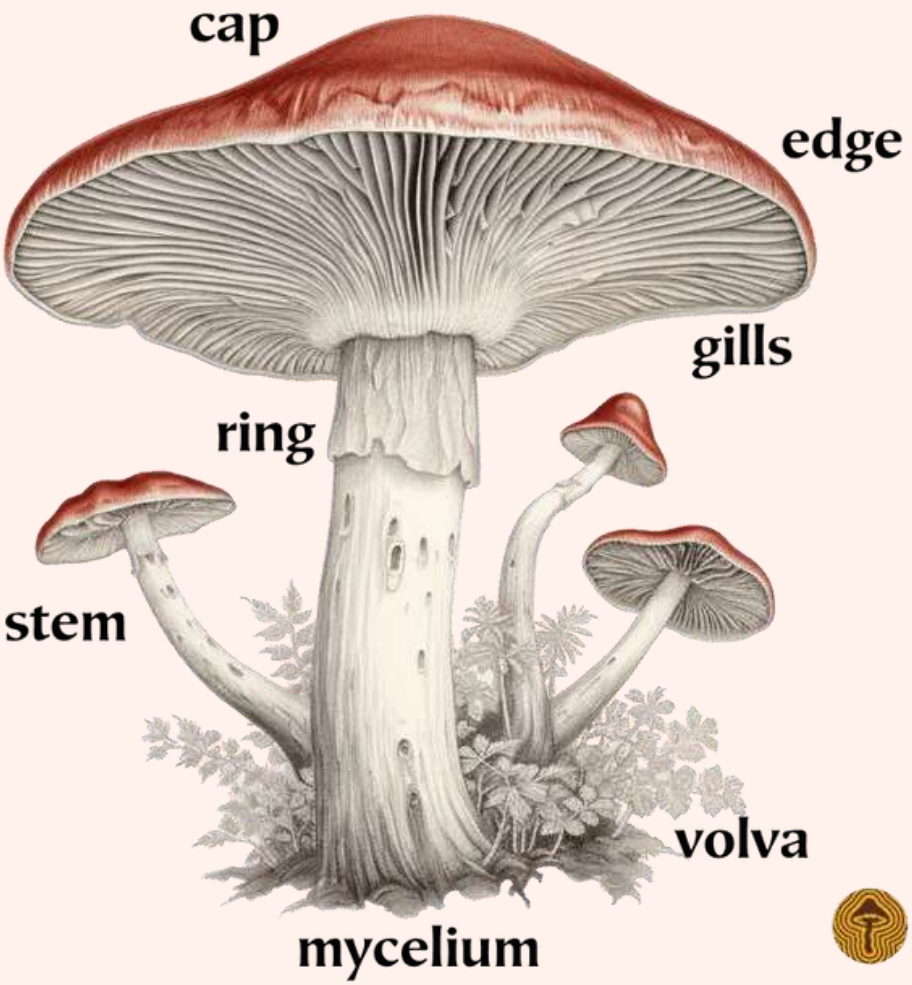




By Rick M, from myceliumsociety.com
https://www.myceliumsociety.com/2021/11/14/andreleo-grows-bioluminscent-fungus.html

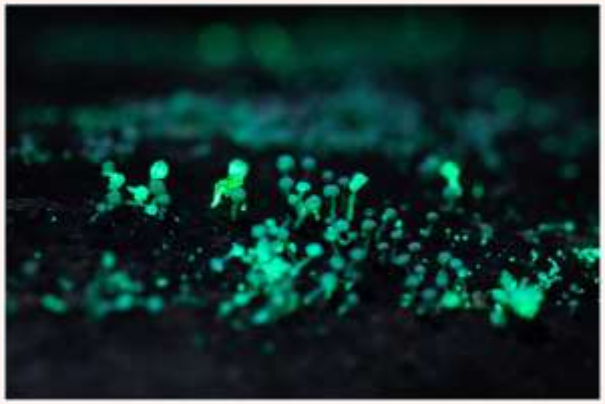


From Australian National Botanic Gaedens,
https://www.anbg.gov.au/fungi/mycelium.html



Basic anatomy of fungi.
From https://www.shroomer.com/anatomy-mushroom-parts/#the-basic-mushroom-anatomy

Roridomyces phyllostachydis
From https://theteenagertoday.com/



Fruitbody of Mycena lazulina. Photo by Yoshinori Nishino on Iriomote Island, Okinawa Prefecture.
Oba, Y.; Hosaka, K. The Luminous Fungi of Japan. *J. Fungi* **2023**,*9*,615. https://doi.org/10.3390/jof9060615

Omphalotus olearius
Kushwaha Vinodkumar and Hajirnis Sarita (2016) A Review on Bioluminescent fungi: A Torch of Curiosity , Int. J.of. Life Sciences, Special Issue, A7:107-110.

Kultura

Kadr z filmu „Avatar” reż. James Cameron, 2009r.
From https://pl.pinterest.com/pin/497507090058752829/

Oba, Y.; Hosaka, K. The Luminous Fungi of Japan. *J. Fungi* **2023**,*9*,615. https://doi.org/10.3390/jof9060615

Georg Eberhard Rumphius (1627–1702), the only portrait of him made by his son Paul Augustus around 1695-96

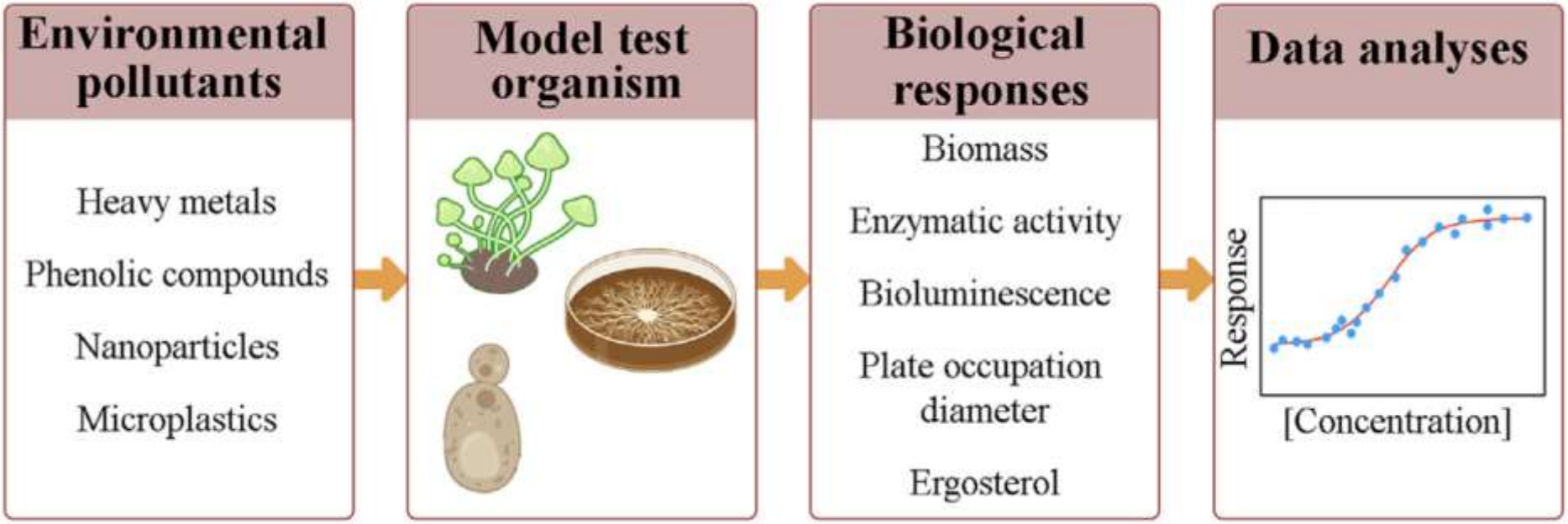
Moluccas. From Encyclopædia Britannica
https://www.britannica.com/place/Moluccas#/media/1/388553/281895

https://www.istockphoto.com/jp/ストックフォト/緑豊かな熱帯雨林の奥深く-gm625793440-110276395

Rumph, Georg Eberhard [1627-1702]; Burman Johannes [1707-1779]. From https://doi.org/10.3931/e-rara-49366

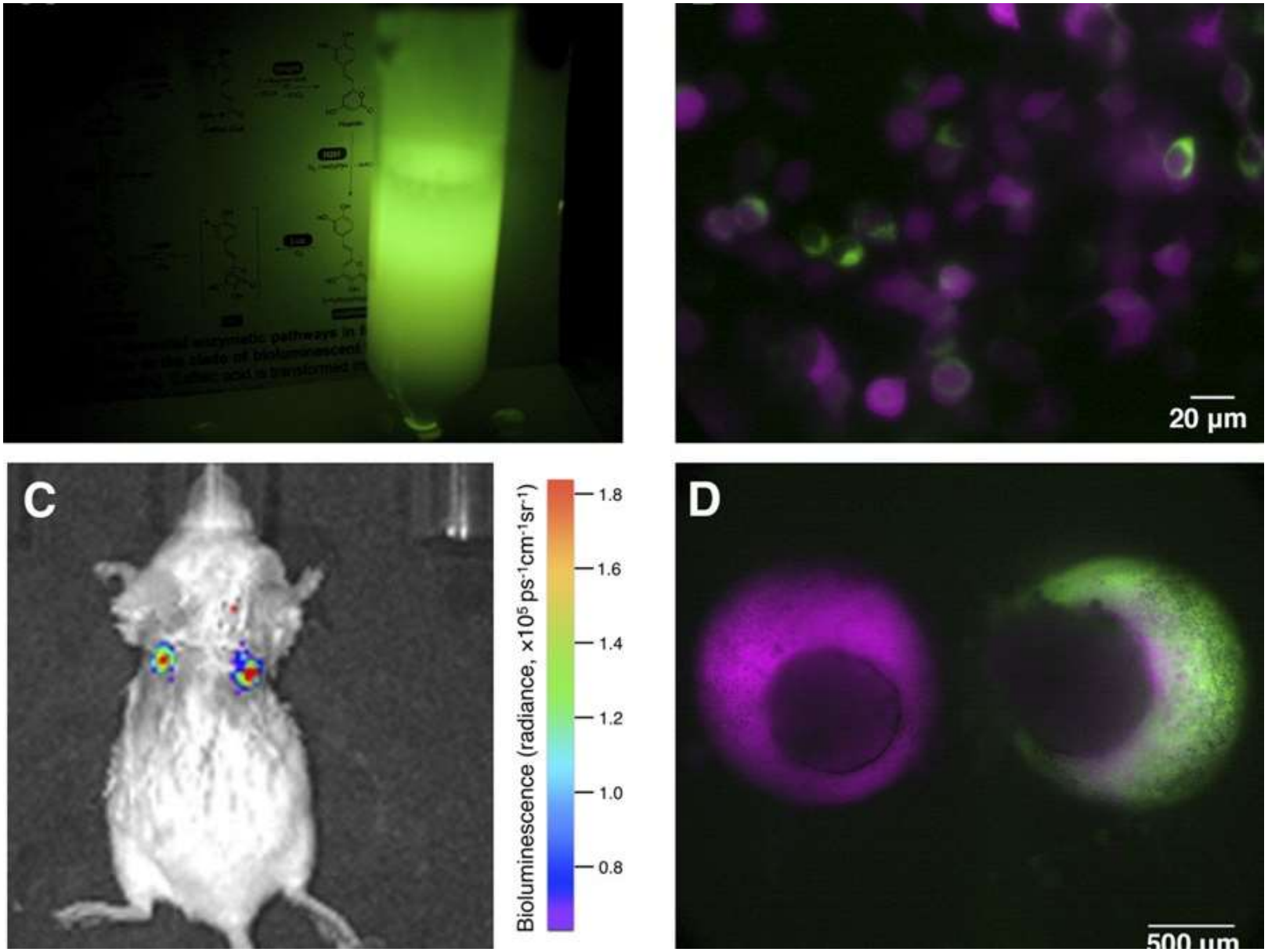
Omphalotus nidiformis

Omphalotus nidiformis. *Bournda National Park, NSW, Australia. By* ***Mark Jekabsons*** *from https://www.flickr.com/photos/jekabsons/52031175083*



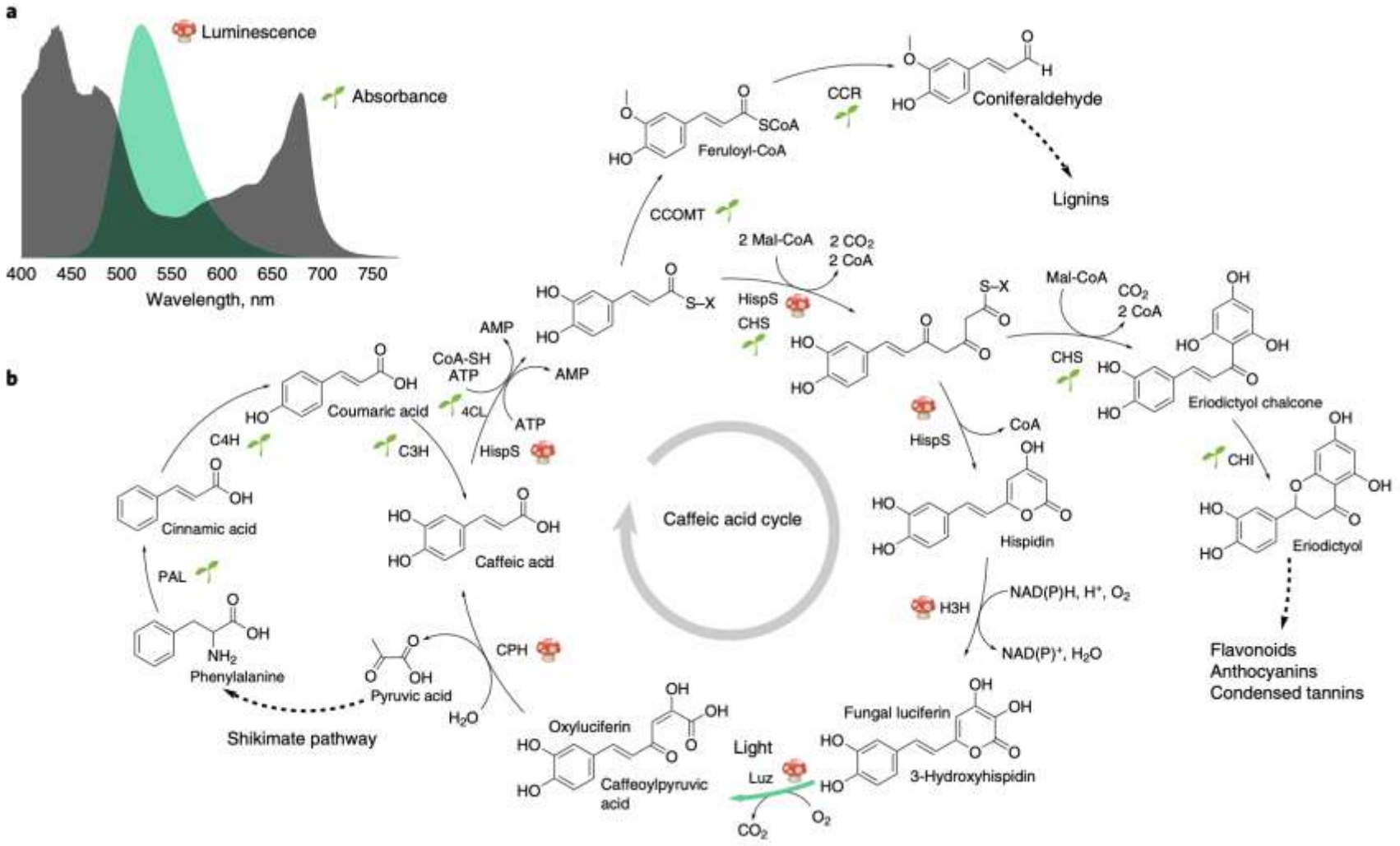
Common steps in ecotoxicological assays, which include: the exposure of a model test organism to different concentrations of a chemical compound or dilutions of an environmental sample; the monitoring of biological responses; and the obtention of a concentration-response curve.

Soares DMM, Procópio DP, Zamuner CK, Nóbrega BB, Bettim MR, de Rezende G, Lopes PM, Pereira ABD, Bechara EJ, Oliveira AG, Freire RS and Stevani CV (2022), Fungal bioassays for environmental monitoring. Front. Bioeng. Biotechnol. 10:954579. doi: 10.3389/fbioe.2022.954579



Kotlobay, A. A., Sarkisyan, K. S., Mokrushina, Y. A., Marcet-Houben, M., Serebrovskaya, E. O., Markina, N. M., Gonzalez Somermeyer, L., Gorokhovatsky, A. Y., Vvedensky, A., Purtov, K. V., Petushkov, V. N., Rodionova, N. S., Chepurnyh, T. V., Fakhranurova, L. I., Guglya, E. B., Ziganshin, R., Tsarkova, A. S., Kaskova, Z. M., Shender, V., Abakumov, M., … Yampolsky, I. V. (2018). Genetically encodable bioluminescent system from fungi. Proceedings of the National Academy of Sciences of the United States of America, 115(50), 12728–12732. https://doi.org/10.1073/pnas.1803615115

nature biotechnology



Mitiouchkina, T., Mishin, A.S., Somermeyer, L.G. *et al.* Plants with genetically encoded autoluminescence. *Nat Biotechnol* **38**, 944–946 (2020). https://doi.org/10.1038/s41587-020-0500-9

Mitiouchkina, T., Mishin, A.S., Somermeyer, L.G. *et al.* Plants with genetically encoded autoluminescence. *Nat Biotechnol* **38**, 944–946 (2020). https://doi.org/10.1038/s41587-020-0500-9

Dziękuję za uwagę

Bibliografia

- Martyn Ainsworth, Searching for luminous mushrooms of the Marsh Fungus Armillaria ectypa, Field Mycology, Volume 5, Issue 4, 2004, Pages 142-144, ISSN 1468-1641, https://doi.org/10.1016/S1468-1641(10)60279-4.
- Mihail J.D., Bioluminescence patterns among North American Armillaria species, Fungal Biology, Volume 119, Issue 6, 2015, Pages 528-537, ISSN 1878-6146, https://doi.org/10.1016/j.funbio.2015.02.004.
- Mendes LF, Bastos EL, Desjardin DE, Stevani CV. Influence of culture conditions on mycelial growth and bioluminescence of Gerronema viridilucens. FEMS Microbiol Lett. 2008 May;282(1):132-9. doi: 10.1111/j.1574-6968.2008.01118.x. Epub 2008 Mar 18. PMID: 18355288.
- Chew AL, Tan Y-S, Desjardin DE, Musa MY, Sabaratnam V (2014). "Four new bioluminescent taxa of *Mycena* sect. *Calodontes* from Peninsular Malaysia". *Mycologia*. 106 (5): 976–988. doi:10.3852/13-274. PMID 24891424. S2CID 207706192.
- Weinstein, P., Delean, S., Wood, T, Austin A. D. Bioluminescence in the ghost fungus *Omphalotus nidiformis* does not attract potential spore dispersing insects. *IMA Fungus* 7, 229–234 (2016). https://doi.org/10.5598/imafungus.2016.07.02.01
- Oba Y, Hosaka K. The Luminous Fungi of Japan. *Journal of Fungi*. 2023; 9(6):615. https://doi.org/10.3390/jof9060615
- Laurence O. S, Conney J.J., Gadd G.M. "Toxicity of Organotins towards the Marine Yeast Debaryomyces Hansenii." *Microbial Ecology*, vol. 17, no. 3, 1989, pp. 275–85. *JSTOR*, http://www.jstor.org/stable/4251059. Accessed 28 June 2023.
- Chang, Chiung-Chih; Chen, Chi-Yu; Lin, Wen-Wen; Kao, Hsiao-Wei (2020). "*Mycena jingyinga*, *Mycena luguensis*, and *Mycena venus*: three new species of bioluminescent fungi from Taiwan". *Taiwania*. 65 (3): 396–406. doi:10.6165/tai.2020.65.396.
- G Shirmila Jose, PM Radhamany, Identification and determination of antioxidant constituents of bioluminescent mushroom, Asian Pacific Journal of Tropical Biomedicine, Volume 2, Issue 1, Supplement, 2012, Pages S386-S391, ISSN 2221-1691, https://doi.org/10.1016/S2221-1691(12)60194-4.
- Kushwaha Vinodkumar and Hajirnis Sarita (2016) A Review on Bioluminescent fungi: A Torch of Curiosity , Int. J.of. Life Sciences, Special Issue, A7:107-110.
- Desjardin, D.E., Oliveira, A.G. & Stevani, C.V. Fungi bioluminescence revisited. *Photochem Photobiol Sci*7, 170–182 (2008). https://doi.org/10.1039/b713328f
- National Center for Biotechnology Information (2023). PubChem Compound Summary for CID 131841536, 3-Hydroxyhispidin. Retrieved October 23, 2023 From https://pubchem.ncbi.nlm.nih.gov/compound/3-Hydroxyhispidin.
- Zinaida M. Kaskova *et al.*, Mechanism and color modulation of fungal bioluminescence.*Sci. Adv.*3,e1602847(2017).DOI:10.1126/sciadv.1602847
- Oliveira, A.G., Desjardin, D.E., Perry, B.A. *et al.* Evidence that a single bioluminescent system is shared by all known bioluminescent fungal lineages. *Photochem Photobiol Sci* 11, 848–852 (2012). https://doi.org/10.1039/c2pp25032b
- Soares DMM, Procópio DP, Zamuner CK, Nóbrega BB, Bettim MR, de Rezende G, Lopes PM, Pereira ABD, Bechara EJ, Oliveira AG, Freire RS and Stevani CV (2022), Fungal bioassays for environmental monitoring. Front. Bioeng. Biotechnol. 10:954579. doi: 10.3389/fbioe.2022.954579
- Kotlobay, A. A., Sarkisyan, K. S., Mokrushina, Y. A., Marcet-Houben, M., Serebrovskaya, E. O., Markina, N. M., Gonzalez Somermeyer, L., Gorokhovatsky, A. Y., Vvedensky, A., Purtov, K. V., Petushkov, V. N., Rodionova, N. S., Chepurnyh, T. V., Fakhranurova, L. I., Guglya, E. B., Ziganshin, R., Tsarkova, A. S., Kaskova, Z. M., Shender, V., Abakumov, M., … Yampolsky, I. V. (2018). Genetically encodable bioluminescent system from fungi. Proceedings of the National Academy of Sciences of the United States of America, 115(50), 12728–12732. https://doi.org/10.1073/pnas.1803615115
- Malakauskiene, Asta. (2018). Reported and potential bioluminescent species in Lithuania. Biologija. 64. 10.6001/biologija.v64i3.3823.
- Stevani, C.V., Oliveira, A.G., Mendes, L.F., Ventura, F.F., Waldenmaier, H.E., Carvalho, R.P. and Pereira, T.A. (2013), Current Status of Research on Fungal Bioluminescence: Biochemistry and Prospects for Ecotoxicological Application. Photochem Photobiol, 89: 1318-1326. https://doi.org/10.1111/php.12135
- Mitiouchkina, T., Mishin, A.S., Somermeyer, L.G. *et al.* Plants with genetically encoded autoluminescence. *Nat Biotechnol* **38**, 944–946 (2020). https://doi.org/10.1038/s41587-020-0500-9