



A volunteer cleans oil from rocks on a beach in northeastern Brazil.

Edited by **Jennifer Sills**

Retraction

After publication of the Report “Site-selective enzymatic C–H amidation for synthesis of diverse lactams” (1), efforts to reproduce the work showed that the enzymes do not catalyze the reactions with the activities and selectivities claimed. Careful examination of the first author’s lab notebook then revealed missing contemporaneous entries and raw data for key experiments. The authors are therefore retracting the paper.

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REFERENCES AND NOTES

1. I. Cho, Z.-J. Jia, F. H. Arnold, *Science* **364**, 575 (2019).

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Brazil oil spill response: Time for coordination

In his News In Depth story “Mystery oil spill threatens marine sanctuary in Brazil” (8 November 2019, p. 672), H. Escobar discusses a dense crude oil spill that arrived at Brazil’s northeastern tropical coast in late August 2019. Given its extent (more than 3000 km) (1) and the recorded impacts (2), this spill is considered the most severe environmental disaster ever recorded in tropical coastal regions. More than 40 marine protected areas and a unique set of poorly explored coastal ecosystems (3) that

include intertidal rocky shores, rhodolith beds, sandy beaches, mangroves, estuarine systems, seagrass beds, and coral reefs have been affected. Exacerbating the ecological, social, and economic impacts, Brazil’s government action has been inadequate.

The Brazilian federal government has shown poor coordination with the non-governmental organizations, military, civil society, states, and Brazilian municipalities to address the oil spill’s effects (4). The lack of coordination and proper transparent guidelines made a rapid response nearly impossible. The federal government disbanded the executive and support committees responsible for oil-spill accidents (Contingency Plan for Oil Pollution team) in early 2019 (4). The resulting lack of leadership delayed the governmental response to the oil spill (5). Moreover, the recent budget cuts to science (6, 7) and unraveling of environmental policies (8, 9) undermine the capacity of Brazilian institutions to understand and solve the impacts of this uncontrolled environmental disaster.

Shallow and deep oil extraction is a delicate matter. The inadequate response to this disaster highlights the importance of establishing science-based solutions to prevent extensive and long-term impacts of coastal and offshore oil extraction. Governments must execute a coordinated response so as not to aggravate the problems.

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REFERENCES AND NOTES

1. The International Tanker Owners Pollution Federation, “Oil tanker spill statistics 2018” (ITOPF, 2018); www.itopf.org/knowledge-resources/data-statistics/statistics.
2. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, “Manchas de óleo/Litoral Brasileiro” (IBAMA, 2019); www.ibama.gov.br/manchasdeoleo/#fauna [in Portuguese].
3. Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, “Manchas de óleo/Litoral Brasileiro” (IBAMA, 2019); www.ibama.gov.br/manchasdeoleo/#localidades [in Portuguese].
4. Government of Brazil, “Decreto no. 9.759 de 11 de abril de 2019: Extingue e estabelece diretrizes, regras e limitações para colegiados da administração pública federal” (2019); www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/71137350/dole-2019-04-11-decreto-n-9-759-de-11-de-abril-de-2019-71137335 [in Portuguese].
5. M. N. Jha, J. Levy, Y. Gao, *Sensors* **8**, 236 (2008).
6. C. Angelo, *Nature* **568**, 2 (2019).
7. C. Nobre, *Nature* **574**, 455 (2019).
8. D. Abessa, A. Famá, L. B. Buraem, *Nat. Ecol. Evol.* **3**, 510 (2019).
9. M. T. C. Thomé and C. F. B. Haddad, *Science* **364**, 1144 (2019).

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Brazil oil spill response: Government inaction

In his News In Depth story “Mystery oil spill threatens marine sanctuary in Brazil” (8 November 2019, p. 672), H. Escobar describes the contamination of 2500 km of Brazil’s northeast coast caused by oil from an offshore oil spill, which is threatening marine biodiversity, livelihoods, and human health in one of the country’s most iconic and touristic places. The spill has already affected 15 marine protected areas (1) and had incalculable impacts on wildlife and

ecological services, which could last for decades (2, 3). Escobar also mentioned the Brazilian government's delayed action and disinformation campaign in response to the spill, but he does not sufficiently describe the government's malfeasance.

Brazil's federal government has been profoundly lax in the face of this environmental catastrophe. On 17 October 2019, the Federal Prosecution Service, responsible for ensuring social and individual rights in matters of public interest, denounced the government's inaction (4). The government responded that the Contingency Plan for Oil Pollution Incidents (5) had already been activated, with "necessary adaptations," but never clarified what those adaptations were (4). This Contingency Plan was improperly implemented: It should have contained a comprehensive set of guidelines to organize an integrated action plan that mitigated further contamination from the spill and alleviated its impacts (5).

While the government neglected its responsibilities, volunteers from civil society risked their lives to help remove more than 5000 tons of oiled residue from 980 areas (6), including beaches and mangroves, often without support or personal protective equipment (7). State and local governments have collaborated as best as they can, but they depend on federal agencies' direction and resources. The oil is no longer reaching the beaches (6), but environmental and human health monitoring will be necessary for several years (8).

In less than a year, Brazil has experienced multiple environmental tragedies, including a mudslide (9), uncontrolled fires in the Amazon (10), and now an oil spill. Despite these threats, the Bolsonaro government has dismantled environmental policy (10). Brazilian biodiversity is crucial for ecological services and climate regulation (11). Civil society, researchers, nongovernmental organizations, and international markets should pressure the Brazilian government to reverse its destructive environmental agenda.

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REFERENCES AND NOTES

- C. C. Maretti, "Óleo no litoral do Nordeste e do Brasil." *O Eco* (2019); www.oeco.org.br/colunas/claudio-maretti/oleo-no-litoral-do-nordeste-e-do-brasil/ [in Portuguese].
- P. F. Kingston, *Spill Sci. Tech. Bull.* **7**, 53 (2002).

- M. G. Barron, *Toxic. Path.* **40**, 315 (2012).
- Ministério Público Federal, Ação Civil Pública Cível 0805679-16.2019.4.05.8500 (2019); www.conjur.com.br/dl/justica-federal-manda-mpf-emendar.pdf [in Portuguese].
- Presidência da República, "Decreto no. 8.127 de 22 de outubro de 2013" (2013); www.planalto.gov.br/ccivil_03/ato2011-2014/2013/decreto/d8127.htm [in Portuguese].
- Marinha do Brasil, "Nota à imprensa" (December 17 2019); https://www.marinha.mil.br/sites/default/files/nota_gaa_17dez_0.pdf [in Portuguese].
- D. Phillips, "Brazilians rally to clean beaches amid outrage at Bolsonaro's oil spill inaction" *The Guardian* (2019); www.theguardian.com/world/2019/oct/22/brazil-oil-spill-beaches-bolsonaro-volunteers.
- SEVS, "Intoxicações exógenas relacionadas à exposição ao petróleo no litoral de Pernambuco" (Informe 06/2019); https://12ad4c92-89c7-4218-9e11-0ee136fa4b92.filesusr.com/ugd/3293a8_c5ecdcbfcb41a4a0fb92ac3fa780e718d.pdf [in Portuguese].
- J. V. Campos-Silva, C. A. Peres, *Science* **363**, 1046 (2019).
- D. Abessa, A. Famá, L. Buruaem, *Nat. Ecol. Evol.* **3**, 510 (2019).
- IPBES, "Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services," S. Diaz et al., Eds. (IPBES Secretariat, Bonn, Germany, 2019).

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Brazil oil spill response: Protect rhodolith beds

In his News In Depth story "Mystery oil spill threatens marine sanctuary in Brazil" (8 November 2019, p. 672), H. Escobar highlights important ecosystems that have been affected by the spill. However, he did not mention the Brazilian rhodolith beds—the most extensive, abundant, and diverse biogenic carbonate habitats in the South Atlantic (1). The oil spill severely threatens these ecosystems, which comprise a staggering 2 x 10¹¹ tons of carbonatic bank (2), stretch from 5°N to 27°S along the Brazilian coast, and cover a seabed potential area of 229,000 km² (1).

Brazil's rhodolith beds are recognized as an oasis of diversity (3). Although they harbor species of great economic and ecological value, they remain unprotected. The oil pollution will likely cause major socio-environmental and economic losses, similar to those caused by the Deepwater Horizon incident in the Gulf of Mexico (4). The contamination will compromise the region's food security as well as biodiversity conservation and efficient management. Moreover, the ongoing oil spill could have global consequences given the potential biogeochemical role of rhodolith beds in the oceanic carbon balance (1, 5). Thus, this event must not be downplayed or concealed, as has been attempted in the case of Brazilian mining accidents (6) and Amazon deforestation and fires (7). We advocate urgent action to evaluate and mitigate the oil spill and to remediate and restore areas on the

oil slick route. Brazil must follow in the footsteps of Australia and Europe (8) and prioritize rhodolith bed conservation.

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REFERENCES AND NOTES

- V. F. Carvalho et al., *Mar. Environ. Res.*, 10.1016/j.marenvres.2019.104827 (2019).
- J. D. Milliman, C. A. B. Amaral, *Ann. Congr. Brasil Geo.* **28**, 335 (1974).
- G. M. Amado-Filho, *Ciencias Mar.* **36**, 371 (2012).
- R. Kerr, E. Kintisch, E. Stokstad, *Science* **328**, 674 (2010).
- N. Schubert et al., *Sci. Total Environ.* **676**, 455 (2019).
- H. Escobar, *Science* **350**, 1138 (2015).
- C. A. Nobre, *Nature* **574**, 455 (2019).
- J. J. Kantun et al., in *Rhodolith/Maerl Beds: A Global Perspective* (Springer International Publishing, Boca Raton, 2017), pp. 265–280.

COMPETING INTERESTS

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Brazil oil spill response: Protect rhodolith beds

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