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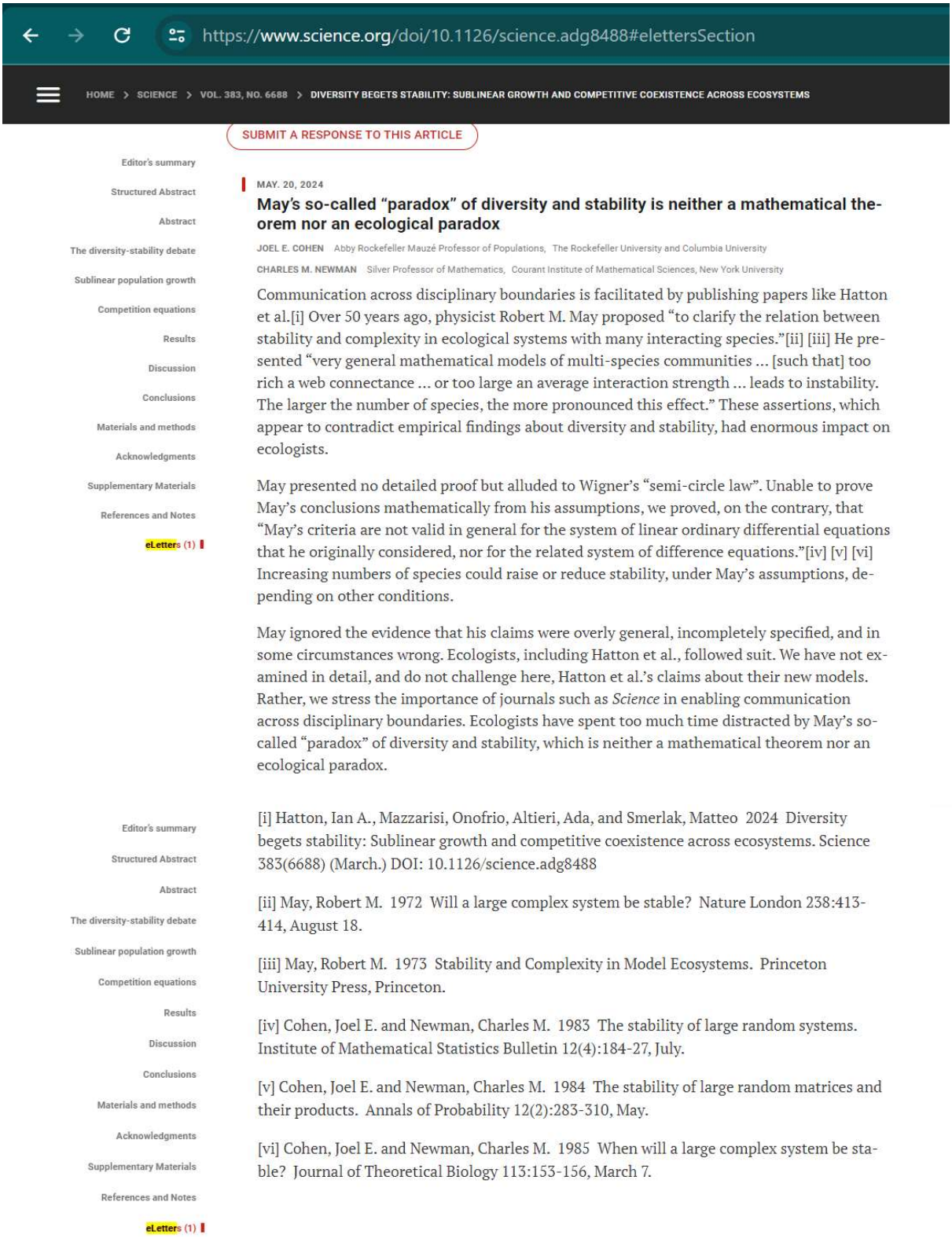

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May's so-called "paradox" of diversity and stability is neither a mathematical theorem nor an ecological paradox

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Communication across disciplinary boundaries is facilitated by publishing papers like Hatton et al.[i] Over 50 years ago, physicist Robert M. May proposed "to clarify the relation between stability and complexity in ecological systems with many interacting species."[ii] [iii] He presented "very general mathematical models of multi-species communities ... [such that] too rich a web connectance ... or too large an average interaction strength ... leads to instability. The larger the number of species, the more pronounced this effect." These assertions, which appear to contradict empirical findings about diversity and stability, had enormous impact on ecologists.

May presented no detailed proof but alluded to Wigner's "semi-circle law". Unable to prove May's conclusions mathematically from his assumptions, we proved, on the contrary, that "May's criteria are not valid in general for the system of linear ordinary differential equations that he originally considered, nor for the related system of difference equations."[iv] [v] [vi] Increasing numbers of species could raise or reduce stability, under May's assumptions, depending on other conditions.

May ignored the evidence that his claims were overly general, incompletely specified, and in some circumstances wrong. Ecologists, including Hatton et al., followed suit. We have not examined in detail, and do not challenge here, Hatton et al.'s claims about their new models. Rather, we stress the importance of journals such as *Science* in enabling communication across disciplinary boundaries. Ecologists have spent too much time distracted by May's so-called "paradox" of diversity and stability, which is neither a mathematical theorem nor an ecological paradox.

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[i] Hatton, Ian A., Mazzarisi, Onofrio, Altieri, Ada, and Smerlak, Matteo 2024 Diversity begets stability: Sublinear growth and competitive coexistence across ecosystems. Science 383(6688) (March.) DOI: 10.1126/science.adg8488

[ii] May, Robert M. 1972 Will a large complex system be stable? Nature London 238:413-414, August 18.

[iii] May, Robert M. 1973 Stability and Complexity in Model Ecosystems. Princeton University Press, Princeton.

[iv] Cohen, Joel E. and Newman, Charles M. 1983 The stability of large random systems. Institute of Mathematical Statistics Bulletin 12(4):184-27, July.

[v] Cohen, Joel E. and Newman, Charles M. 1984 The stability of large random matrices and their products. Annals of Probability 12(2):283-310, May.

[vi] Cohen, Joel E. and Newman, Charles M. 1985 When will a large complex system be stable? Journal of Theoretical Biology 113:153-156, March 7.