LETTER

Paleoecological changes at Lake Cuitzeo were not consistent with an extraterrestrial impact

Israde-Alcántara et al. (1) reported evidence for the Younger Dryas (YD) Impact Hypothesis (YDIH), which proposes that an extraterrestrial impact triggered the YD (2). Although most YDIH research has focused on the impact event itself, YDIH proponents, as in this article, have argued that the ecological consequences included "widespread biomass burning, and contributed to the extinction of Late Pleistocene megafauna and to major declines in human populations." To fully test the YDIH, the authors must evaluate evidence and mechanisms for the ecological consequences of an impact. We believe there are flaws in both the interpretation of the paleoecological evidence reviewed by Israde-Alcántara et al. and in its application in testing the YDIH.

Israde-Alcántara et al. used many nonstandard paleoecological methods, despite assertions to the contrary. Specifically, they (*i*) conflated incomparable data types across sites (e.g., pollen percentages, accumulation rates, and concentrations); (*ii*) failed to correct for time elapsed between samples when calculating turnover rates; (*iii*) neglected to provide accurate sources for regional pollen data and radiocarbon dates; (*iv*) relied on (often circular) wiggle-matching rather than explicit tests for synchroneity; and (*v*) represented charcoal data per unit weight rather than volume (with heterogeneous sediment types). Regional comparisons were further limited by what we perceive to be a weak chronology.

Lake Cuitzeo is interesting because it contains an organic-rich layer resembling a "black mat" (3). YDIH proponents have yet to provide a mechanism for mat formation but imply that mats indicate widespread biomass burning (4). There are several problems with this interpretation. First, continental-scale burning does not occur at 12.9 ka; large fires are recorded at different times and regions throughout late-glacial North America (5). Second, black mats are not ubiquitous but rather located predominantly in western North America, where they appear throughout the late Quaternary and are likely algal mats and paleosols associated with regional increases in moisture. We suggest an alternate hypothesis for the formation of the organic-rich layer at Cuitzeo. The lake is large (300–400 km^2) and shallow (0.8–2.2-m water depth), so small variations in regional moisture strongly impact lake levels. The "black mat" is bracketed with sand, gastropods, and rootlets, consistent with the formation of marly beaches and soils at low water levels. Low pollen concentrations are also consistent with poor preservation due to lake-level lowering, supported by increases in *Typha* pollen and algae. We suggest that the vegetation, sedimentary charcoal, and sedimentary changes at Cuitzeo are consistent with regional hydrological variations as opposed to continental-scale environmental changes.

Overall, the authors examine changes in vegetation and fire as indicators of the YD and use those changes to support the YDIH. In our opinion, regional climate change remains a more plausible explanation for observed ecological changes at Lake Cuitzeo than a putative impact event. We call on the authors to provide a clear explanation of the mechanism for observed ecological changes (or lack thereof) at the YD using conventional methods and rigorous statistical tests that report uncertainties for synchroneity.

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Author contributions: J.L.G., J.L.B., S.G., J.R.M., P.J.B., K.N., A.C.S., and C.W. wrote the paper.

The authors declare no conflict of interest.

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