LETTER

Human arrival scenarios have a strong influence on interpretations of the late Quaternary extinctions

The study by Prescott et al. (1) provides an inspiring quantitative framework for disentangling the effects of humans and climate on megafaunal extinctions, which is essential because their relative importance across time and space remains one of the key missing pieces for solving the late Quaternary extinctions puzzle. However, the analyses of Prescott et al. (1) are based on coarse temporal resolution and alternative scenarios describing the earliest human arrival on five landmasses, which incorporate uncertainties from the literature (table S5 in ref. 1). Nevertheless, we consider that some of the scenarios for each landmass used by Prescott et al. (1) are considerably less plausible than others (Table 1). For instance, human arrivals in North and South America between 30 and 20 kya (2) and less than 10 kya (3), respectively, and in Australia between 30 and 20 kya (4), are less strongly supported in the literature than alternative dates (Table 1), but Prescott et al. (1) assumed all scenarios to be equally plausible.

The assumption of the same degree of plausibility for all human arrival scenarios affects the findings of Prescott et al. (1). We performed multiway ANOVAs using the proportional R^2 from Prescott et al. (figure 2 in ref. 1) as the response variable and potential extinction drivers as factors. We found significant variation in R^2 for South and North America (but not for Eurasia or Australia) depending on the arrival scenario used, with significant effects on the proportion of extinction rates explained by climate, human arrival, and their shared deviation. In general, analyses of the interaction between effects show that climate explains a significantly smaller proportion of the extinction rates than human arrival when the more plausible scenarios are used. However, the pattern reverses under the less plausible scenarios, i.e., climate explains a higher proportion of extinction rates (Fig. 1). This shift in R^2 indicates that the ability to disentangle the relative influence of climate vs. humans is highly sensitive to selection of human arrival dates, rather than robust to dating uncertainty as Prescott et al. (1) report, even at the coarse temporal resolution used. This sensitivity is likely a result of close synchrony between human arrivals and megafaunal extinctions, so that modeling extinction peaks with less plausible arrival scenarios results in detection of a larger climatic influence (Fig. 1). This effect is increasingly evident when multiple less plausible scenarios are simultaneously considered, yielding climate as by far the strongest predictor of global extinction rates.

In conclusion, we applaud the initiative by Prescott et al. (1) of using quantitative models in a global, coherent, and comparable framework to understand late Quaternary extinctions at a macroecological scale. We believe the drawbacks addressed here do not qualitatively change their overall conclusion, mainly because of the strong interaction between human arrival and climate on extinction rates worldwide, which in turn obfuscates the idiosyncratic effects of any single extinction driver. However, the detected magnitude of humans vs. climate differs significantly according to the plausibility of human arrival scenarios, leading to strikingly different conclusions about the role of each in the late Quaternary extinctions.

Table 1. Human arrival scenarios for four landmasses used by Prescott et al. (1)

	Human arrival scenarios, kya	
Landmass	More plausible	Less plausible
South America (3)	20–10	10–0
North America (2)	20–10	30–20
Australia (4)	60–50	40–30
	50–40	30–20
Eurasia (5)*	50–40	
	60–50	

Plausibility for each scenario was assessed from current literature (see Supporting Information in ref. 1), taking into account only reliable dates. Prescott et al. (1) used only one scenario for New Zealand (10–0 kys), so we excluded it from our analyses.

*The Eurasian scenarios are far more complex than those presented by Prescott et al. (1), and are difficult to classify. *Homo sapiens* arrived in eastern/northern Asia and eastern/central Europe as early as 60 to 50 kya, but reached western Europe as late as 30 kya (5). So, we consider the Eurasian scenarios indistinguishable as to their plausibility.

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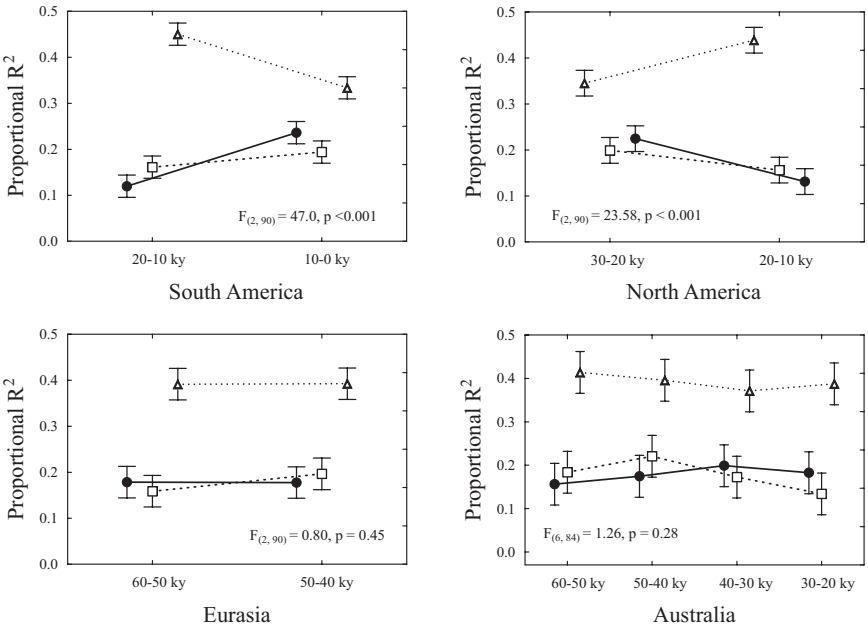

Fig. 1. Two-way interactions between potential extinction drivers and human arrival scenarios from each landmass. The symbols indicate the R^2 mean and their confidence interval (●, climate alone; □, humans alone; ▲, shared deviation). *P* values were obtained from randomization test with 999 permutations.