Supplementary Index

Tissue-level flammability testing: A review of existing methods and a comparison of a novel hot plate design to an epiradiator design

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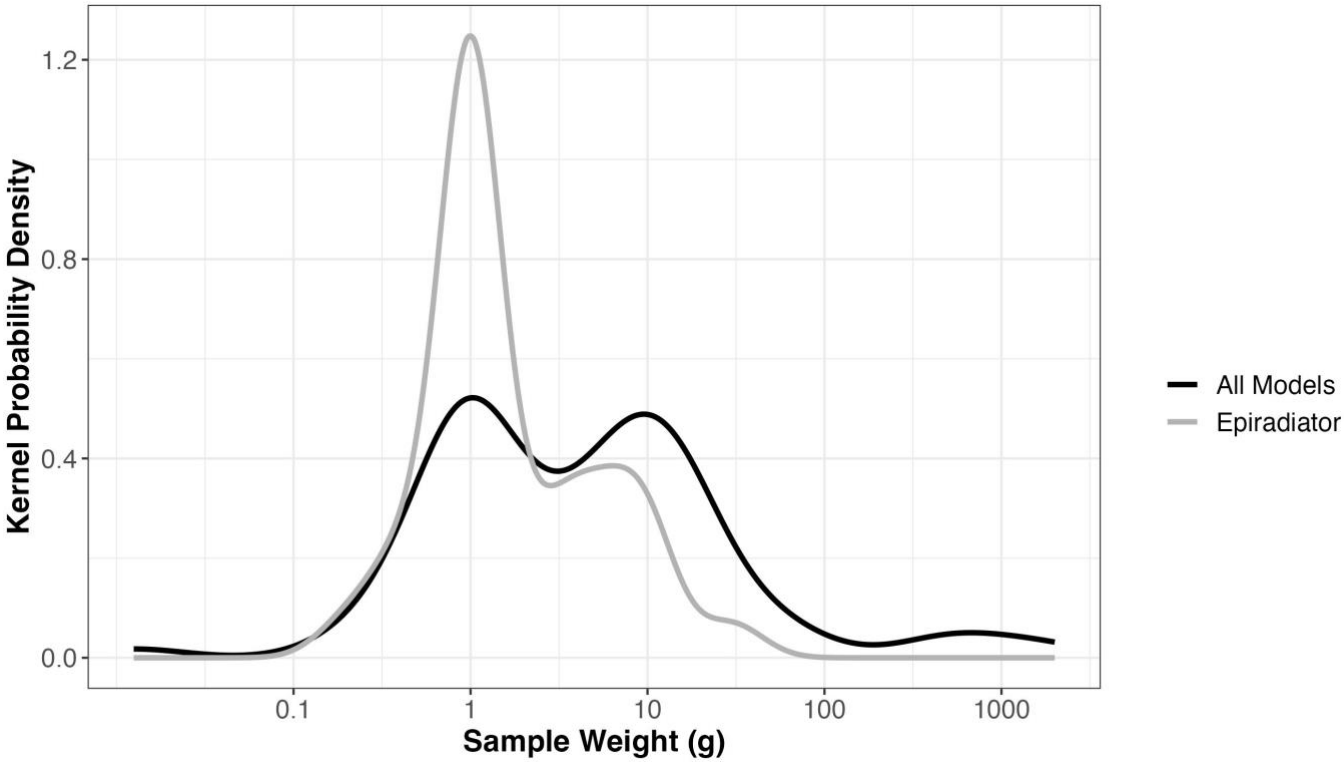

Figure S1: Summary of quantitative data gathered from literature review showing the kernel probability density of sample weights reported from 54 studies including 26 studies using an epiradiator (which are highlighted with the grey line and included in the black, all models, line), 6 using a mass loss calorimeter, 6 using a xylene-soaked lattice of strings, 5 using a bomb calorimeter, 4 using a fire propagation apparatus calorimeter, 4 using a wind tunnel, 3 using a cone calorimeter, 2 using a direct flame, 1 using a steel ring surrounding a litter bed and 1 using a unique experimental design [51]. Sample weights can be dry or fresh weights depending on the protocol presented in the study (i.e., whether dry or fresh fuel was burned), but in all cases it represents the weight of the sample prior to testing the flammability. Weights spanned 5 orders of magnitude from 0.0125g [51] to 2000g (large scale wind tunnel [142]).

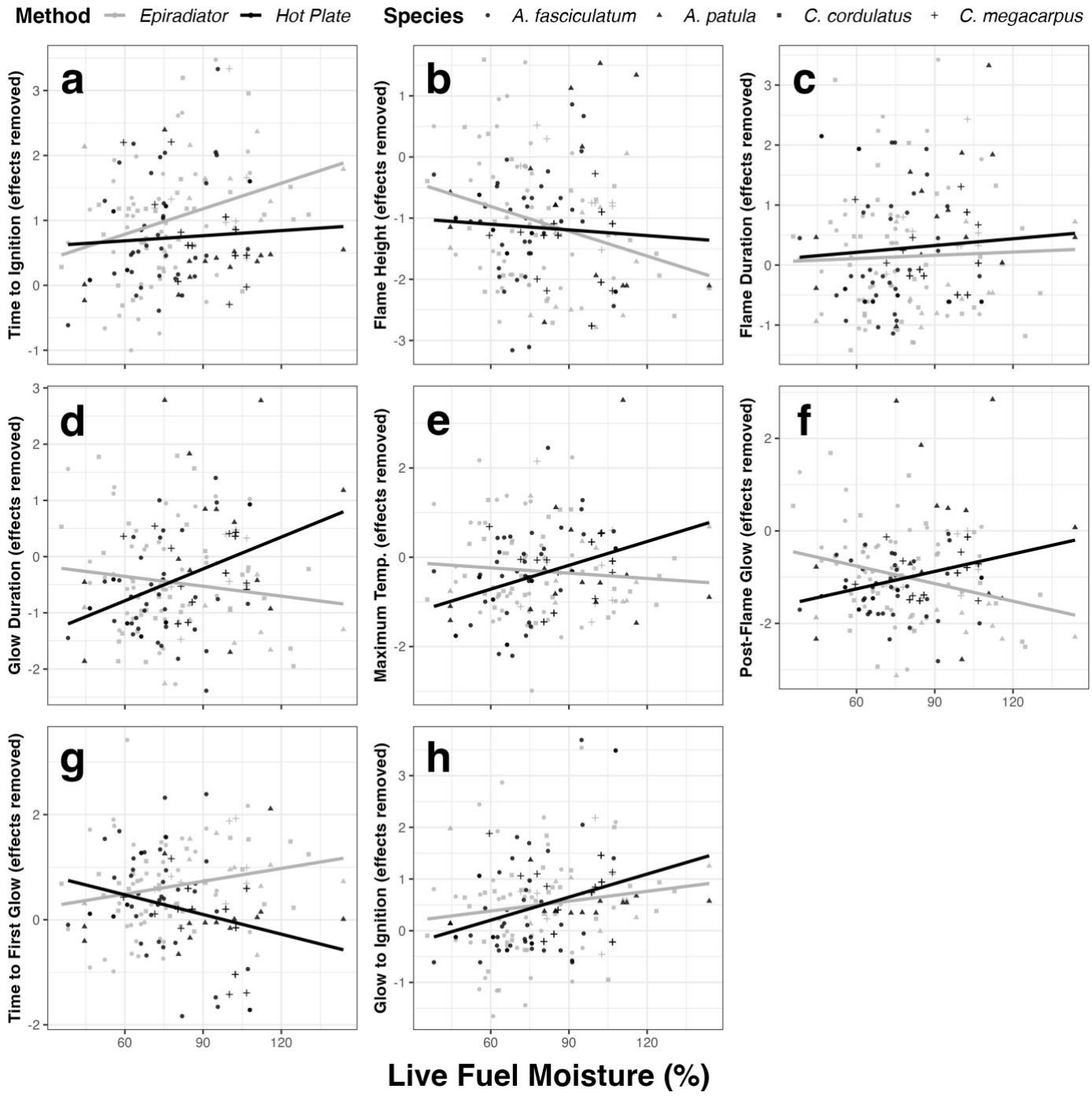

Figure S2: The relationship between live fuel moisture and eight flammability metrics. Prior to visualization, 'remef' was used to remove partial effects of covariates and the random effect of individual from the best-performing models to isolate the effects of the primary predictor and the flammability chamber model. Flammability chamber models are visualized with different colors, with gray points and lines representing epiradiator data points and black points and lines representing hot plate data points. The four species-of-interest are visualized using different shapes as reported in the legend.

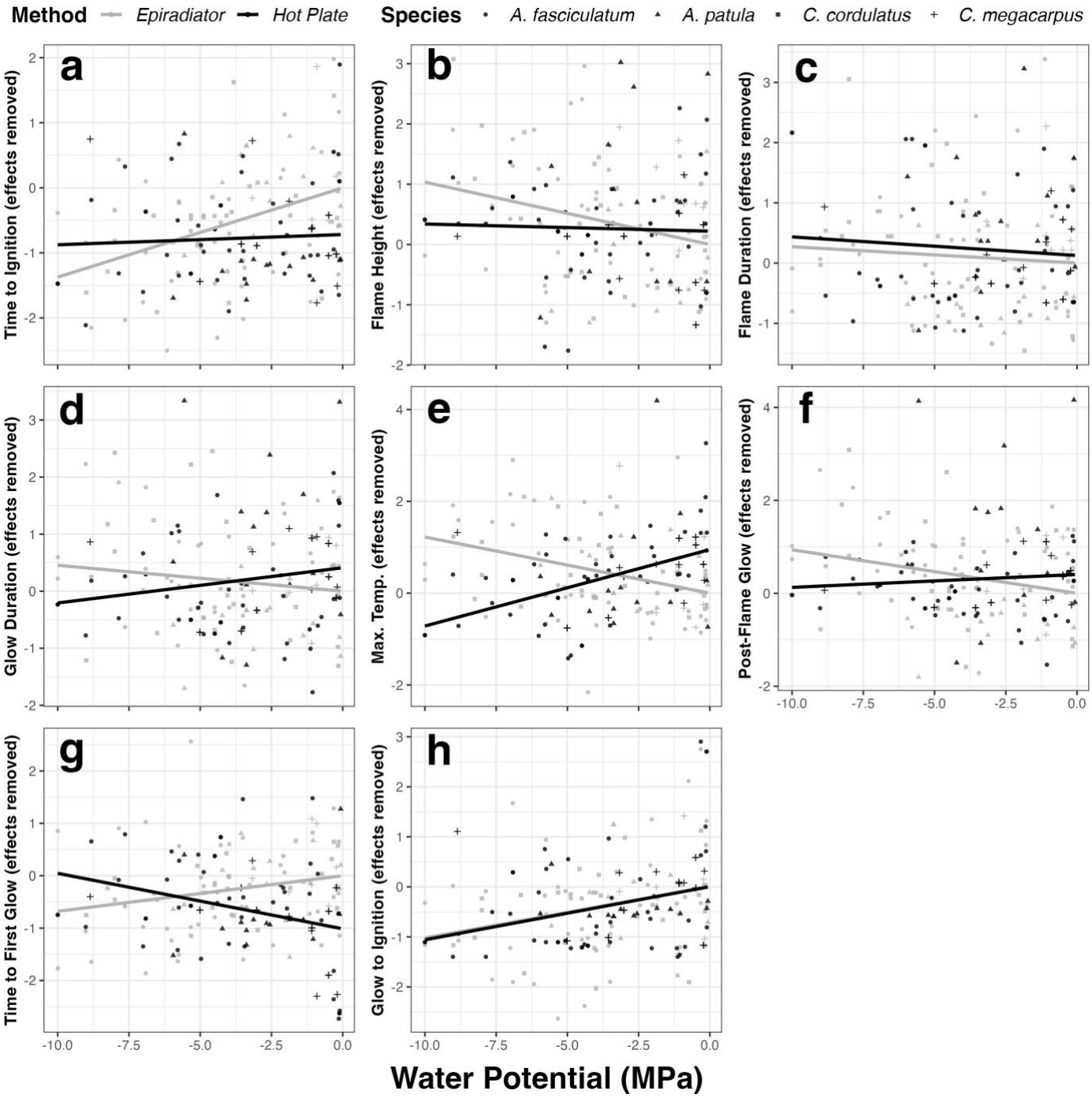

Figure S3: The relationship between water potential and eight flammability metrics. Prior to visualization, 'remef' was used to remove partial effects of covariates and the random effect of individual from linear mixed effects models (with water potential, site, timing, species and individual as predictors) to isolate the effects of the primary predictor and the flammability chamber model. Flammability chamber models are visualized with different colors, with gray points and lines representing epiradiator data points and black points and lines representing hot plate data points. The four species-of-interest are visualized using different shapes as reported in the legend.

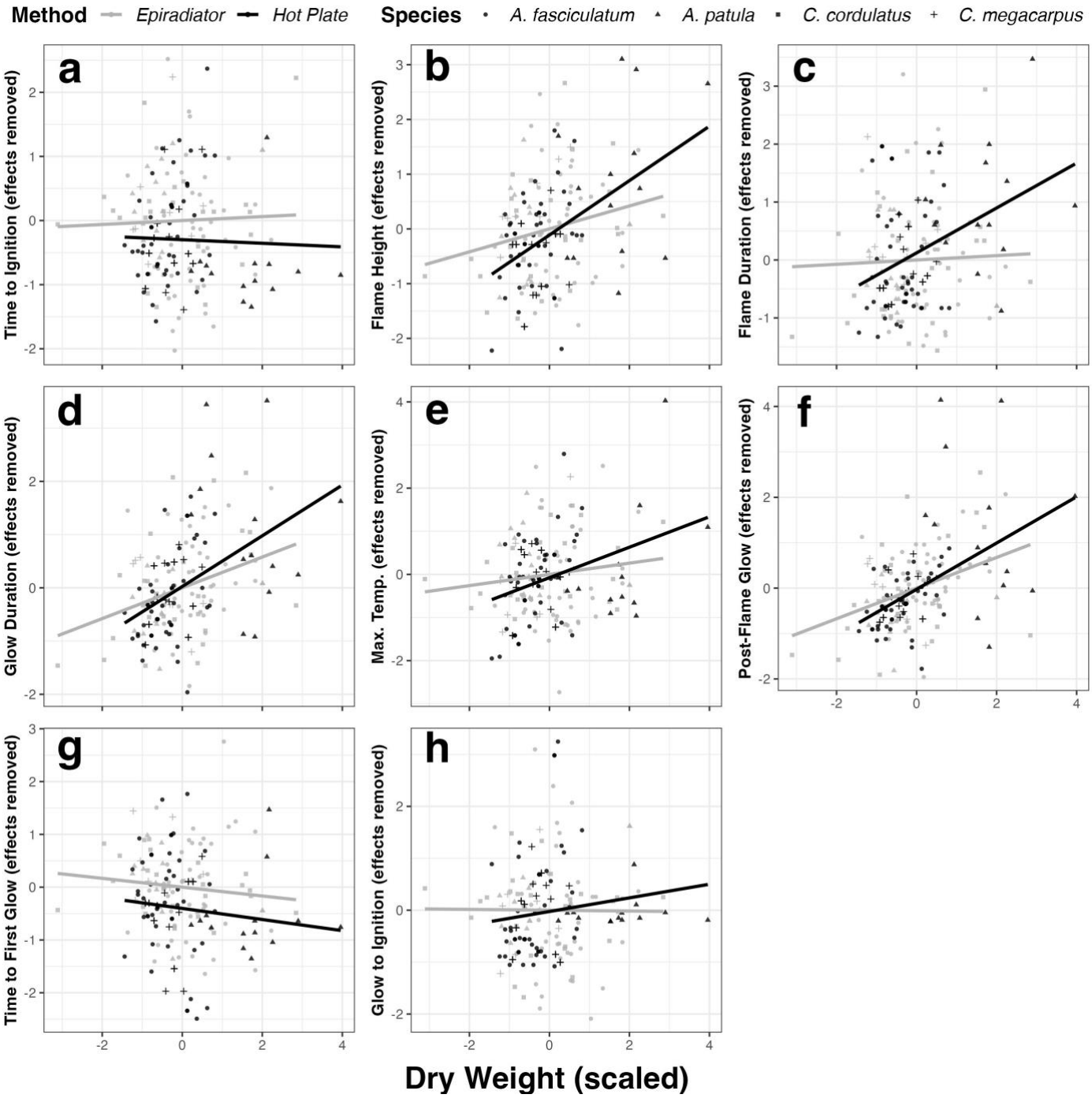

Figure S4: The relationship between dry weight and eight flammability metrics. Prior to visualization, 'remef' was used to remove partial effects of covariates and the random effect of individual from linear mixed effects models (with water potential, site, timing, species and individual as predictors) to isolate the effects of the primary predictor and the flammability chamber model. Flammability chamber models are visualized with different colors, with gray points and lines representing epiradiator data points and black points and lines representing hot plate data points. The four species-of-interest are visualized using different shapes as reported in the legend.

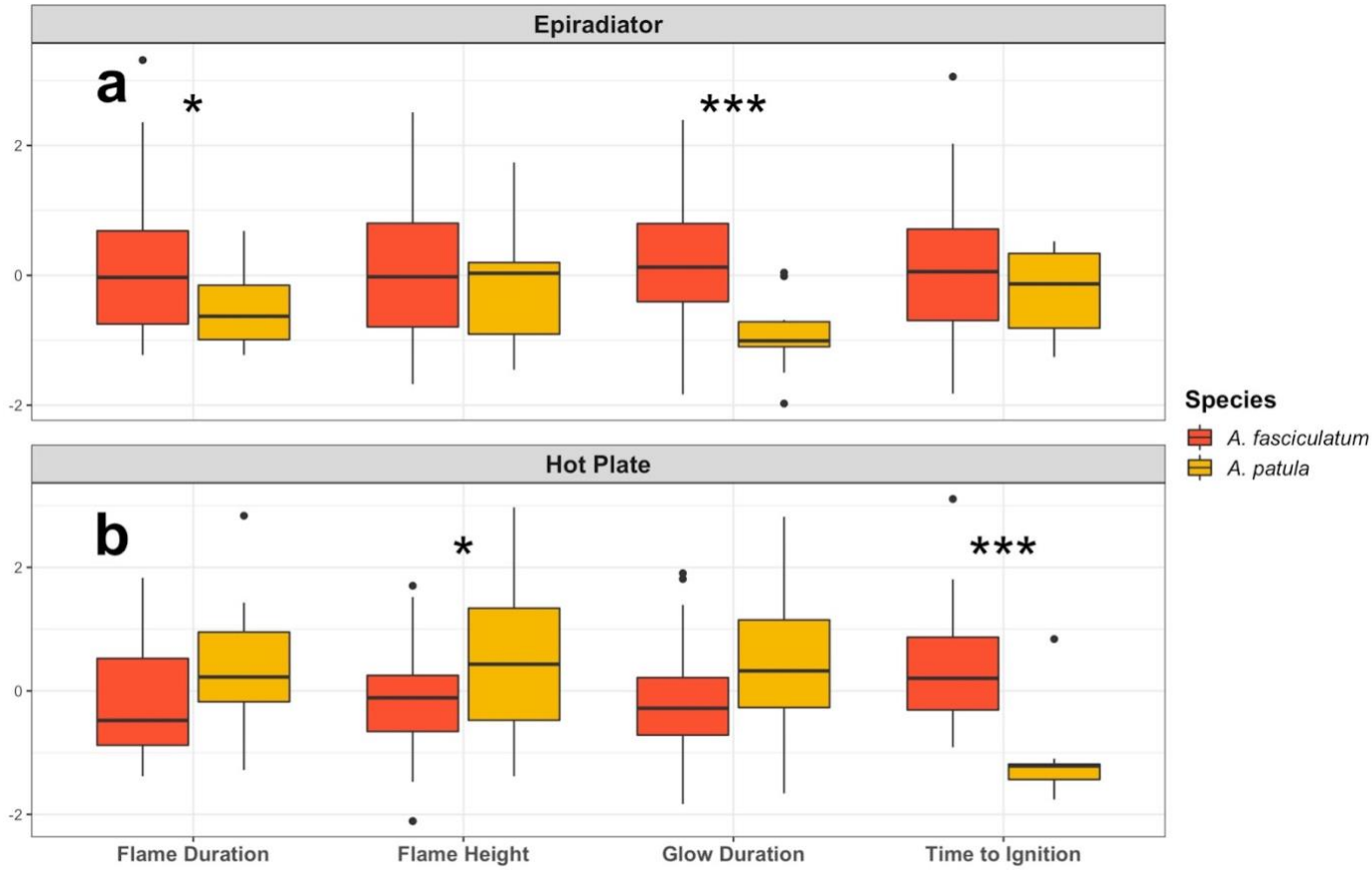

Figure S5: A comparison of *A. fasciculatum* (orange) and *A. patula* (yellow) across four flammability metrics chosen to represent the four axes in the 4-axis model – flame duration (sustainability), flame height (combustibility), glow duration (consumability), and time to ignition (ignitability) – for epiradiator (**a**) and hot plate (**b**) tests. Only species with n>10 ignitions for *both* methods were selected when investigating interspecific differences (*A. fasciculatum*: n=49 ignitions for hot plate, n=45 for epiradiator; *A. patula*: n=14 ignitions for both hot plate and epiradiator), hence the exclusion of *C. megacarpus* (n=20 ignitions for hot plate, n=0 for epiradiator) and *C. ceanothus* (n=0 ignitions for hot plate, n=29 for epiradiator). Metrics were scaled and centered by method. Asterisks denote significance of interspecific differences (Welch's t-test; *p < 0.05, **p<0.01, ***p<0.001).

Discussion S1: *Could interspecific differences help explain inter-method differences?*

For both methods, differences in flammability existed between *A. patula* and *A. fasciculatum*, but they were present for different flammability metrics depending on the method used (Figure S5). Because interspecific differences were prevalent for different flammability metrics and we did not take measurements on secondary effects (e.g., VOCs, cuticular waxes, leaf mass per area), it is challenging to compare the methods by investigating interspecific differences, but we were able to speculate about underlying mechanisms.

From our observations of the two species, *A. patula* has thicker, waxier cuticles than *A. fasciculatum*, and as cuticular waxes have been previously observed to promote litter flammability in dry climates [6], cuticular wax content could impact the flammability of live vegetation as well. The hot plate design's inclusion of a pilot flame improves its ability to capture the impact of flammable compounds emitted from the breakdown of cuticular waxes on ignition (like VOCs, as mentioned in *Discussion 4.2*) relative to the epiradiator design. This provides a potential explanation for why we see significant differences in ignitability (time to ignition) and combustibility (flame height) in the hot plate method (Figure S5b), but not the epiradiator method (Figure S5a). The two species also exhibit differences in live fuel moisture (for ignited samples: *A. patula*: 91.81 $\pm$ 26.63%, *A. fasciculatum:* 72.72 $\pm$ 15.83%) which could contribute to understanding the significant differences in flame and glow duration for the epiradiator; however, for the hot plate method, the differences in flame height and time to ignition are not easily explained by the differences in water content alone. Instead, these differences could be explained by the VOC concentrations of the samples decreasing as they dry over the course of the benchtop drydown (as discussed in *Discussion 4.2*).

In the epiradiator tests, the significant interspecific differences in sustainability (flame duration) and consumability (glow duration) could relate to leaf mass per area (LMA). Leaves with high LMA have been linked with increases in combustibility and sustainability [56]. Our observations of leaf shape and size indicate that *A. fasciculatum* has higher LMA than *A. patula* which aligns with increases in sustainability and consumability. Relative to the hot plate method – where we see an opposite, but insignificant trend – we believe that the physical trait of LMA is enhanced in the epiradiator, as it is largely decoupled from chemical traits.

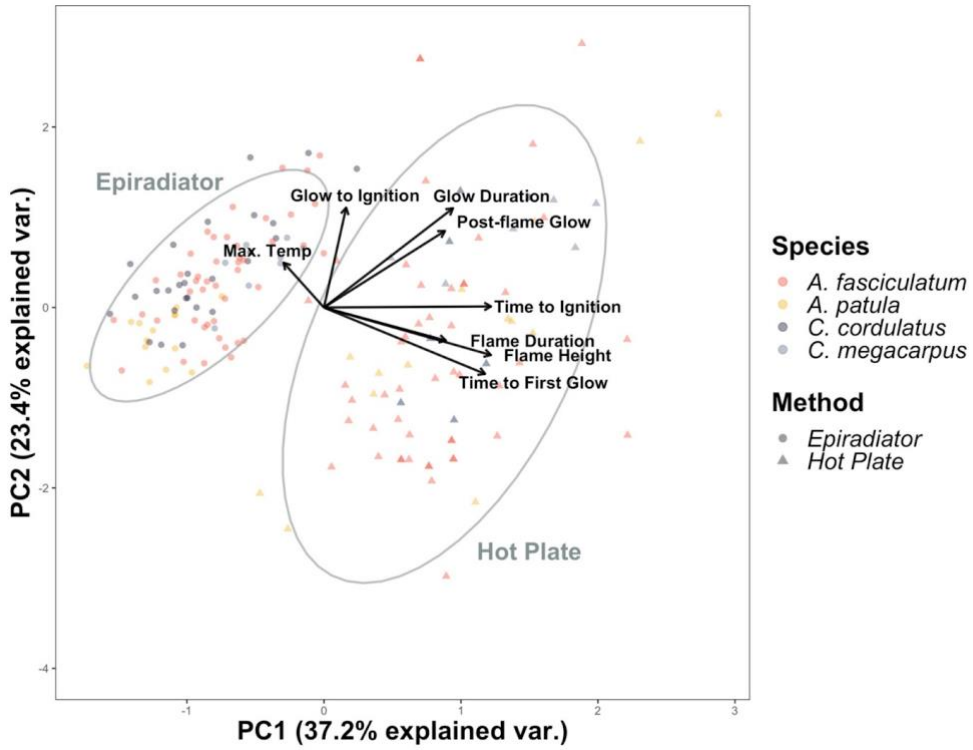

Figure S6: Principal component analysis of all ignited points across both methods without any prior data manipulation. Species are visualized with different colors as reported in the legend and different methods are visualized with different shapes with circular points representing the epiradiator method and triangular points representing the hot plate method. Gray ellipses are drawn around clusters of points grouped by flammability chamber design.

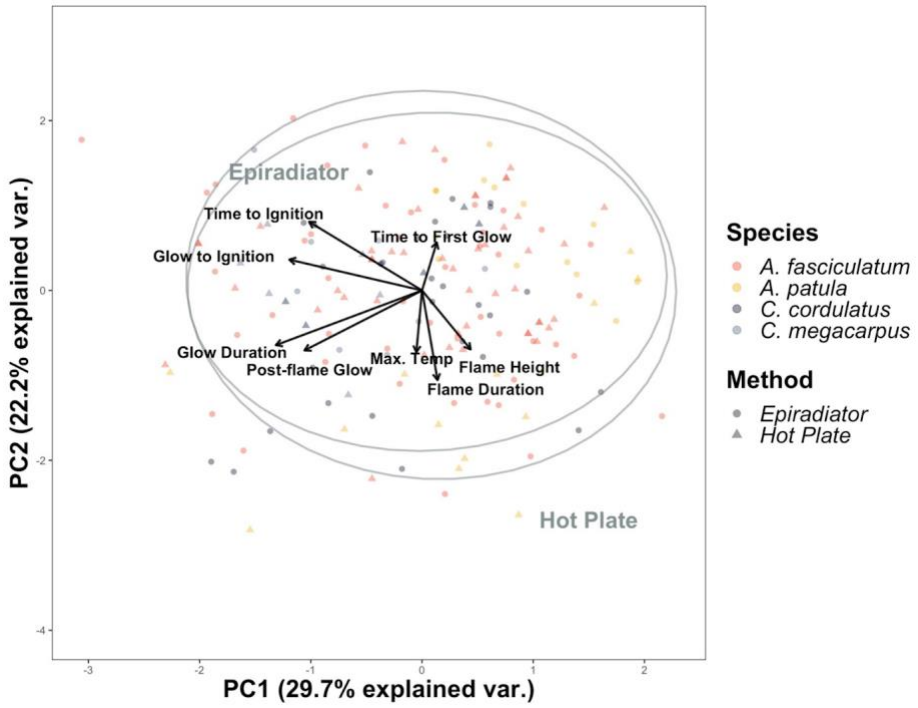

Figure S7: Principal component analysis of all ignited points across both methods after scaling and centering flammability metrics separately by chamber design. Species are visualized with different colors as reported in the legend and different methods are visualized with different shapes with circular points representing the epiradiator method and triangular points representing the hot plate method. Gray ellipses are drawn around clusters of points grouped by flammability chamber design.