

Response to Comment on “A Brief History of Seed Size”

Grubb *et al.* (1) suggest that the shape of the relation between seed mass and plant size is better explained by the mechanical-constraints hypothesis than by a coordination of life-history traits, as suggested by Moles *et al.* (2). Their preference for the mechanical-constraints idea is largely based on the shape of the relation between seed mass and plant size.

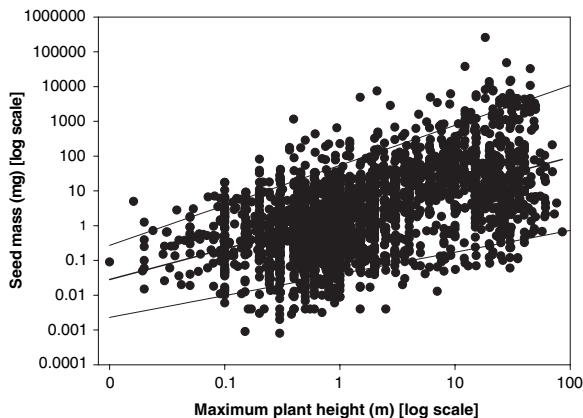


Fig. 1. The relation between seed mass and plant size, across 2589 species from all around the world. The lines show the mean trend and the 95% and 5% quantiles (calculated using R).

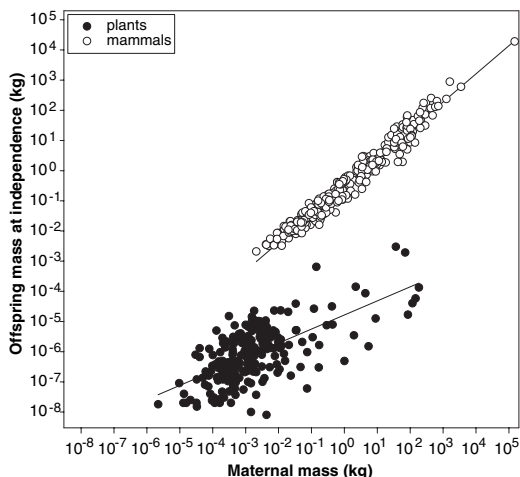


Fig. 2. The relation between maternal mass and offspring size at independence (mass at weaning for mammals, seed mass for plants) for 397 mammal species [data from (7)] and 224 plant species [data from (6)]. The slope of the relation for mammals is 0.93 ($R^2 = 0.97$), whereas the slope of the relation for plants is just 0.47 ($R^2 = 0.43$). Plant species were only included if researchers had published masses (i.e., masses were not derived from diameter measurements). This has resulted in a bias toward small plant species, but we have no reason to believe that this will affect the slope of the relation.

Grubb *et al.* used data from 226 species from an Australian rainforest to show that the slope of the lower boundary (5% quantile) of the relation between seed mass and plant size was shallower than the slope of the upper boundary (95% quantile) (1). We believe that this is not sufficient evidence to exclude a Charnov-like explanation for the relation between seed mass and plant size or to support the mechanical-constraints hypothesis.

Under the mechanical-constraints hypothesis, small plants should only be able to produce small seeds, whereas large plants should be able to produce either large or small seeds. This hypothesis does provide a parsimonious explanation for the relationship presented by Grubb *et al.* [in which the lower boundary (5% quantile) has a slope that is not significantly different from zero (3)]. However, examination of a larger data set [(Fig. 1; data from (4))] reveals a general absence of large plants that produce very small seeds (despite the inclusion of four *Ficus* species) and a 5% quantile line whose slope is significantly different from zero ($P < 0.001$; log-log slope = 0.63) (Fig. 1). Mechanical constraints could explain the upper boundary of this relation but cannot explain the absence of very large plants that produce very small seeds. Thus, although mechanical constraints might contribute to the relation between seed mass and plant size, it cannot be the sole process in operation.

A theory based on coordination of life-history traits provides one possible explanation for the absence of very large plants that produce very small seeds: Large offspring are necessary to offset the low survivorship to adulthood that would otherwise be a consequence of the longer juvenile periods associated with large adult size (5). Grubb *et al.* contend that the shape of the relation between maternal mass and offspring size is too different in plants and in animals to be explained by the same mechanism. It is true that the slope and R^2 of this relation are much

lower for plants than for animals (Fig. 2), but the general shape is similar. In the absence of a full mathematical theory about the shape of the relation for plants, it is impossible to test whether a theory based on coordination of life-history traits could explain both relations, or even to determine whether the greater range of offspring masses displayed by taller plants is consistent or inconsistent with this theory.

We still feel that an explanation based on coordination of life-history traits provides a better fit to the empirical data than do alternatives [full discussion in (6)]. However, further research will be needed if we are to quantify the relative importance of the different proposed mechanisms underlying the relation between plant size and seed size.

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