|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | Proportion reproductive costs (%) | | | | |  | Proportion success costs (%) | |
|  |  |  |  | Discarded | | Success | | |  |  |  |
| species | Seed size (mg) | Seedset | Reproductive costs  (mg) | Pollen attraction | Packaging and dispersal | Pollen attraction | Packaging and dispersal | Seed | Success costs (mg) | Pollen attraction | Provisioning |
| *Epacris microphylla* | 0.014 | 0.317 | 0.525 | 54.6 | 12.3 | 27.0 | 1.9 | 4.2 | 0.112 | 81.6 | 18.4 |
| *Pimelea linifolia* | 0.183 | 0.274 | 10.463 | 64.0 | 2.1 | 23.7 | 8.1 | 2.0 | 3.05 | 70.0 | 30.0 |
| *Hemigenia purpurea* | 0.222 | 0.312 | 7.054 | 45.5 | 21.8 | 21.7 | 6.9 | 4.1 | 1.841 | 65.5 | 34.5 |
| *Leucopogon esquamatus* | 0.405 | 0.312 | 24.695 | 29.4 | 25.6 | 13.1 | 28.4 | 3.5 | 5.164 | 28.8 | 71.2 |
| *Conospermum ericifolium* | 0.589 | 0.177 | 24.020 | 43.0 | 34.5 | 11.1 | 8.7 | 2.7 | 5.078 | 52.4 | 47.6 |
| *Pultenaea tuberculata* | 0.867 | 0.067 | 121.561 | 85.1 | 5.5 | 5.9 | 2.4 | 1.2 | 6.951 | 62.8 | 37.2 |
| *Phyllota phylicoides* | 1.394 | 0.047 | 302.609 | 87.1 | 4.4 | 4.0 | 2.9 | 1.6 | 7.449 | 48.0 | 52.0 |
| *Boronia ledifolia* | 2.158 | 0.036 | 151.481 | 68.8 | 11.9 | 4.2 | 12.3 | 2.8 | 14.802 | 21.8 | 78.2 |
| *Petrophile pulchella* | 2.531 | 0.341 | 180.254 | 18.2 | 10.5 | 8.5 | 60.5 | 2.2 | 119.907 | 11.3 | 88.7 |
| *Persoonia lanceolata* | 3.368 | 0.062 | 1140.445 | 50.6 | 12.2 | 2.3 | 34.4 | 0.4 | 283.475 | 6.4 | 93.6 |
| *Hakea teretifolia* | 7.559 | 0.004 | 4348.682 | 80.0 | 14.0 | 0.3 | 5.5 | 0.2 | 205.875 | 5.6 | 94.4 |
| *Grevillea speciosa* | 7.728 | 0.014 | 587.822 | 59.4 | 19.5 | 1.6 | 17.4 | 2.0 | 83.208 | 8.0 | 92.0 |
| *Banksia ericifolia* | 18.511 | 0.032 | 3385.342 | 16.8 | 10.4 | 0.7 | 71.0 | 1.1 | 2218.899 | 0.8 | 99.2 |
| *Grevillea buxifolia* | 22.408 | 0.015 | 844.298 | 68.7 | 9.5 | 1.4 | 17.1 | 3.3 | 149.768 | 6.2 | 93.8 |

# Tables

**Table 1.** Reproductive investment data for each species. Seed size indicates the mass of the embryo and endosperm only (mg). Seedset is mature seeds per ovule initiated. Reproductive costs are the total reproductive investment per seed matured. The proportion of reproductive costs allocated to discarded tissues formed for pollen-attraction versus packaging and dispersal, successful pollen-attraction tissues, successful packaging and dispersal tissues and the seed itself are shown. Success costs are the components of total reproductive costs required for the formation of a successful seed, and are divided into two components, pollen attraction costs and provisioning costs. Note that for seed costs, the weight of the seed itself is considered part of provisioning costs. Colored dots indicate plotting colors used for each species in Figure 3.

|  |  |  |
| --- | --- | --- |
| Reproductive cost component | r2 | Slope  *(confidence interval)* |
| Total accessory costs | 0.90 | 1.27 (1.05 - 1.54) |
| Success costs | 0.87 | 1.28 (1.02 - 1.60) |
| Pollen-attraction costs | 0.82 | 0.67 (0.51 - 0.87) |
| Provisioning costs | 0.89 | 1.52 (1.24 - 1.87) |
| Discarded tissue costs | 0.87 | 1.26 (1.01 - 1.57) |
| Discarded pollen-attraction costs | 0.85 | 1.23 (0.97 - 1.57) |
| Discarded provisioning costs | 0.85 | 1.28 (1.01 - 1.63) |

**Table 2.** Scaling of reproductive tissue costs with seed size. All variables were showed a strong correlation with seed size (p < 0.0001). Tables show properties of SMA line fits, between different variables and seed size.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Estimate of reproductive investment | | n | | r2 | |
| Total plant weight (mg) | | 357 | | 0.620 | |
| Propagule investment (mg) | | 223 | | 0.525 | |
| Fruit investment (mg) | | 223 | | 0.675 | |
| Flower investment (mg)  (flower weight \* bud count) | | 223 | | 0.922 | |
| Successful investment (mg)  (seed costs \* seed count) | | 223 | | 0.728 | |
| Successful pre-pollination investment (mg) | | 223 | | 0.380 | |
| Provisioning investment (mg) | | 223 | | 0.736 | |
| Failed tissues (mg) | | 357 | | 0.968 | |

**Table 3. Correlation of different estimates of reproductive investment (and total plant weight) against total reproductive investment (mg).** Regressions are done across all individuals of all 14 study species for which both reproductive investment and the *estimate* variable are greater than zero. The total cost of failed tissues or simply the energy expenditure into flowers provides the best approximation of total reproductive investment. All fits were highly significant with p < 0.0001.

Suggestions:

To avoid overfitting, we should probably check predictive capacity using leave-one out testing.

# Figures

***Investment categories***

***Pollen-attraction costs***

***Provisioning costs***

***Success costs***

***Discarded tissue costs***

***Reproductive costs***

***Packaging and dispersal costs***

***Seed size***

***Trade-offs***

***a.***

***Discarded pollen-attraction costs***

***Discarded provisioning costs***

***Predictions***





Figure 1. a) Categories of reproductive investment, expressed as “costs”, defined as investment divided by count of seeds matured. Categories in red are components of total accessory costs. b) Plants, relative to their size, are predicted to have a fixed amount of energy to invest in pollen-attraction tissues and seeds, such that trade-offs between mature ovule count and pollen-attraction costs and between seed count and total success costs are predicted. c) A trade-off between “choosiness”, the ratio of mature ovules to mature seeds, and pollen-attraction costs, scaled to plant size, is also predicted, for a plant with more costly pollen-attraction tissues will be able to produce fewer excess ovules. These trade-offs lead to three predictions: d) larger-seeded species will spend a greater proportion of their success costs on provisioning tissues (versus pollen-attraction tissues); e) larger-seeded species will spend a greater proportion of their pollen-attraction investment on discarded tissues (versus successful tissues); and f) larger-seeded species will spend a greater proportion of their provisioning investment on successful tissues (versus discarded tissues).



Figure 2. Species shift energy allocation patterns with seed size, reflecting different tissue construction costs and counts of ovules and seed produced. a) The hypothesized trade-offs between pollen-attraction costs and ovule count (r2=0.##) and between total success costs and seed count (r2=0.##) both exist. b) There also exists a trade-off between pollen-attraction costs (scaled to total leaf area) and choosiness (the ratio of mature ovules to mature seeds). As a result of these trade-offs, the proportion of energy invested in discarded versus successful tissues and into pollen-attraction costs versus provosioning costs shifts with seed size: c) larger seeded species invest a greater proportion of their success costs into provisioning tissues; d) larger seed species invest a greater proportion of pollen-attraction investment into discarded tissues versus successful tissues; e) there is a weak trend toward larger seeded species investing a greater proportion of their provisioning investment into successful tissues versus discarded tissues. Together, these allocation differences mean that the slope of the successful pollen-attraction costs-seed size regression is significantly lower than the slope of the successful provosioning costs-seed size regression.



**Figure 3.** Propagule investment is much more poorly correlated with total reproductive investment, than is a composite variable, the product of a count of the buds initiated multiplied by average flower weight. In each plot, different colored points represent the 14 study species; see Table 1 for the key. The colored lines are best fit lines through each species’ points. There are more points in panel b, as some individuals produce buds, but no seeds. In this plot, propagule weight, the weight of the dispersed unit, not embryo and endosperm weight are used, as the purpose is to plot the commonly used currency.

# Supplemental figures and tables

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *Total reproductive investment*  *vs*  *seed investment* | | | *Total reproductive investment*  *vs*  *“flower weight\*bud count”* | | |
| species | n | r2 | *p-value* | n | r2 | *p-value* |
| *Banksia ericifolia* | 6 | 0.85 | 0.0089 | 6 | 0.92 | 0.0022 |
| *Boronia ledifolia* | 24 | 0.53 | 0.0001 | 24 | 0.95 | <0.0001 |
| *Conospermum ericifolium* | 14 | 0.89 | <0.0001 | 14 | 0.95 | <0.0001 |
| *Epacris microphylla* | 28 | 0.74 | <0.0001 | 28 | 0.97 | <0.0001 |
| *Grevillea buxifolia* | 12 | 0.51 | 0.0096 | 12 | 0.97 | <0.0001 |
| *Grevillea speciosa* | 12 | 0.55 | 0.0058 | 12 | 0.54 | 0.0067 |
| *Hakea teretifolia* | 12 | 0.77 | 0.0002 | 12 | 0.89 | <0.0001 |
| *Hemigenia purpurea* | 17 | 0.70 | <0.0001 | 17 | 0.98 | <0.0001 |
| *Leucopogon esquamatus* | 23 | 0.71 | <0.0001 | 23 | 0.99 | <0.0001 |
| *Persoonia lanceolata* | 6 | 0.84 | 0.0102 | 6 | 0.92 | 0.0022 |
| *Petrophile puchella* | 9 | 0.30 | 0.1290 | 9 | 0.98 | <0.0001 |
| *Phyllota phyllicoides* | 19 | 0.32 | 0.0123 | 19 | 0.99 | <0.0001 |
| *Pimelea linifolia* | 13 | 0.78 | 0.0001 | 13 | 0.99 | <0.0001 |
| *Pultanaea tuberculata* | 28 | 0.49 | <0.0001 | 28 | 0.99 | <0.0001 |

**Table S1.** Correlations, within each of the 14 study species, between total reproductive investment (mg) and investment in seeds (mg) and between reproductive investment (mg) and investment as defined by the composite variable, flower weight \* bud count. All regressions include only those individuals that produced at least 1 seed.