1 R Output - Phylogenetic Regression

R code 1.1: Output

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[1] "PHYLOGENETIC REGRESSION OUTPUT"
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Comparison 1a: fmax vs. endo
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No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
     AIC      BIC  logLik
  48.304 52.08176 -20.152

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev: 1.47222e-05 0.6988585

Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept)  -0.69401  0.484474 12 -1.432500  0.1775
cofactor    204.67365 27.443213 12  7.458079  0.0000
 Correlation:
         (Intr)
cofactor -0.937

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5631828 -0.4547487 -0.3134237  0.1820794  2.8729745

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 252.03527  <.0001
cofactor        1    12  55.62294  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  2.3348 0.1013
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.86287, p-value = 0.01094

    Effect   Rsq upper.CL lower.CL
1    Model 0.859    0.952    0.712
2 cofactor 0.859    0.952    0.712
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  46.49261 50.27037 -19.24631

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3346582 0.8549784

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept)  -0.60848   0.67523 12 -0.901154  0.3852
cofactor    209.23572  38.30416 12  5.462480  0.0001
 Correlation:
         (Intr)
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```
cofactor -0.936

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.27751384 -0.48680663 -0.23909253  0.07758264  1.62808300

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 144.36488  <.0001
cofactor        1    12  29.83869   1e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5   2.237 0.1125
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.92528, p-value = 0.1417

    Effect   Rsq upper.CL lower.CL
1    Model 0.933    0.978    0.862
2 cofactor 0.933    0.978    0.862
$d
[1] -0.07391626

$ci
[1] -0.15497447 -0.02182315

$p
[1] 5e-04

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Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC     logLik
  9.304364 13.08212 -0.6521818

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 1.880546e-06 0.2504206

Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept) -0.19651  0.173601 12 -1.131970  0.2798
cofactor    64.51922  9.833675 12  6.561049  0.0000
 Correlation:
         (Intr)
cofactor -0.937

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.59532233 -0.78561202 -0.00728833  0.35425967  2.46096554

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 205.42599  <.0001
cofactor        1    12  43.04736  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.0314 0.4394
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.95651, p-value = 0.5058

    Effect   Rsq upper.CL lower.CL
1    Model 0.825    0.941    0.644
2 cofactor 0.825    0.941    0.644
Linear mixed-effects model fit by maximum likelihood
```

```
 Data: raw.data
       AIC     BIC   logLik
  4.849454 8.62721 1.575273

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.1230478 0.2818893

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept) -0.12742  0.228645 12 -0.557279  0.5876
cofactor    63.85621 12.946157 12  4.932445  0.0003
 Correlation:
         (Intr)
cofactor -0.934

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.3569143 -0.7514013 -0.1263181  0.2601205  1.3879102

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 128.83823  <.0001
cofactor        1    12  24.32901   3e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.5647 0.7257
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.96527, p-value = 0.6794

    Effect   Rsq upper.CL lower.CL
1    Model 0.915    0.972    0.827
2 cofactor 0.915    0.972    0.827
$d
[1] -0.0907978

$ci
[1] -0.19543805 -0.02849268

$p
[1] 5e-04

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  49.95519 53.73295 -20.9776

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev: 1.41364e-05 0.7298951

Fixed effects: phenotype ~ log(cofactor)
                  Value Std.Error DF  t-value p-value
(Intercept)   18.699576  2.280464 12 8.199899       0
log(cofactor)  3.849191  0.546669 12 7.041173       0
 Correlation:
              (Intr)
log(cofactor) 0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7978797 -0.6493403 -0.1094924  0.4539460  2.4098949

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```
Number of Observations: 19
Number of Groups: 6
                numDF denDF   F-value p-value
(Intercept)         1    12 231.05693  <.0001
log(cofactor)       1    12  49.57811  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.6972 0.2045
      13

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.96049, p-value = 0.5821

         Effect   Rsq upper.CL lower.CL
1         Model 0.844    0.947    0.683
2 log(cofactor) 0.844    0.947    0.683
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  46.14852 49.92627 -19.07426

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 6.531427e-05 0.9121923

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                  Value Std.Error DF  t-value p-value
(Intercept)   20.166636 2.7680561 12 7.285487       0
log(cofactor)  4.170849 0.6654833 12 6.267398       0
 Correlation:
              (Intr)
log(cofactor) 0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.6010423 -0.6570865 -0.1916801  0.1478170  1.7149799

Number of Observations: 19
Number of Groups: 6
                numDF denDF   F-value p-value
(Intercept)         1    12 207.12307  <.0001
log(cofactor)       1    12  39.28028  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.2595 0.3381
      13

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.96646, p-value = 0.7041

         Effect Rsq upper.CL lower.CL
1         Model   1        1        1
2 log(cofactor)   1        1        1
$d
[1] -0.1558688

$ci
[1] -0.31380301 -0.05493487

$p
[1] 0

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Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
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```
  6.269717 10.04747 0.8651414

Random effects:
 Formula: ~1 | species
         (Intercept) Residual
StdDev: 4.330228e-07   0.2312

Fixed effects: log(phenotype) ~ log(cofactor)
                 Value Std.Error DF  t-value p-value
(Intercept)   6.135496 0.7223549 12 8.493742       0
log(cofactor) 1.265934 0.1731617 12 7.310703       0
 Correlation:
              (Intr)
log(cofactor) 0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-2.0410211 -0.6670324 -0.2487904  0.3847870  2.2801485

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 241.00172  <.0001
log(cofactor)     1    12  53.44638  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.8055 0.5657
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.94321, p-value = 0.301

         Effect   Rsq upper.CL lower.CL
1         Model 0.854    0.951    0.702
2 log(cofactor) 0.854    0.951    0.702
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  1.415069 5.192825 3.292466

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.05787534 0.2740456

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                 Value Std.Error DF  t-value p-value
(Intercept)   6.464760 0.8801017 12 7.345469       0
log(cofactor) 1.333644 0.2114985 12 6.305691       0
 Correlation:
              (Intr)
log(cofactor) 0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8313788 -0.6059318 -0.4628514  0.1919480  1.5309202

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 205.32862  <.0001
log(cofactor)     1    12  39.76175  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9296 0.4931
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.95073, p-value = 0.4067

         Effect   Rsq upper.CL lower.CL
1         Model 0.989    0.996    0.977
2 log(cofactor) 0.989    0.996    0.977
```

```
$d
[1] -0.1352321

$ci
[1] -0.2817255 -0.0448665

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df   LogLik Df   Chisq Pr(>Chisq)
1   4 -19.2463
2   4 -19.0743  0  0.3441  < 2.2e-16 ***
3   4   1.5753  0 41.2991  < 2.2e-16 ***
4   4   3.2925  0  3.4344  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df       AIC
simple.brownian  4 46.492611
x.brownian       4 46.148516
y.brownian       4  4.849454
xy.brownian      4  1.415069
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Comparison 1b: fmax vs. exo
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No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  63.57557 67.35333 -27.78779

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.8685932 0.8342239

Fixed effects: phenotype ~ cofactor
                Value Std.Error DF  t-value p-value
(Intercept)   2.07256   0.51079 12 4.057550  0.0016
cofactor    103.20205  41.64541 12 2.478114  0.0291
 Correlation:
         (Intr)
cofactor -0.521

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5680120 -0.4978605 -0.1559111  0.3849042  2.1076104

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 39.30857  <.0001
cofactor        1    12  6.14105  0.0291
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  2.0028 0.1452
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.94554, p-value = 0.3309

    Effect   Rsq upper.CL lower.CL
1    Model 0.335    0.735    0.014
2 cofactor 0.335    0.735    0.014
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
```

```
       AIC      BIC    logLik
  58.83548 62.61323 -25.41774

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:    1.005648 0.9878792

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept)  2.17406   0.58257 12 3.731858  0.0029
cofactor    98.16527  49.02419 12 2.002384  0.0684
 Correlation:
         (Intr)
cofactor -0.552

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5373104 -0.3707125 -0.1589185  0.3578723  1.4948318

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 33.61175  0.0001
cofactor        1    12  4.00954  0.0684
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.7887 0.1844
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.97362, p-value = 0.8458

    Effect   Rsq upper.CL lower.CL
1    Model 0.372    0.754    0.026
2 cofactor 0.372    0.754    0.026
$d
[1] -0.03639469

$ci
[1] -0.069084298  0.001431907

$p
[1] 0.022

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Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
      AIC      BIC    logLik
  24.3744 28.15216 -8.187201

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3036321 0.2990984

Fixed effects: log(phenotype) ~ cofactor
                Value Std.Error DF  t-value p-value
(Intercept)  0.759157  0.180514 12 4.205536  0.0012
cofactor    20.617830 14.911724 12 1.382659  0.1920
 Correlation:
         (Intr)
cofactor -0.528

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-2.06801806 -0.37426269 -0.09008912  0.53497612  1.67140135

Number of Observations: 19
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```
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 33.76569  0.0001
cofactor        1    12  1.91175  0.1920
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6402 0.6734
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.98366, p-value = 0.9762

    Effect   Rsq upper.CL lower.CL
1    Model 0.137    0.598    0.001
2 cofactor 0.137    0.598    0.001
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  17.27526 21.05301 -4.637629

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3346907 0.3316403

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept)  0.79237  0.194599 12 4.071807  0.0015
cofactor    19.27667 16.448798 12 1.171920  0.2640
 Correlation:
         (Intr)
cofactor -0.554

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.8696489 -0.3152334 -0.1113084  0.4627267  1.1321901

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 32.15243  0.0001
cofactor        1    12  1.37340  0.2640
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.5405 0.7426
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.9306, p-value = 0.1776

    Effect   Rsq upper.CL lower.CL
1    Model 0.509    0.819    0.133
2 cofactor 0.509    0.819    0.133
$d
[1] -0.3717984

$ci
[1] -0.3797103 -0.1287814

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  65.58087 69.35863 -28.79044
```

```
641
642 Random effects:
643  Formula: ~1 | species
644         (Intercept)  Residual
645 StdDev:   0.8743781 0.8916421
646
647 Fixed effects: phenotype ~ log(cofactor)
648                 Value Std.Error DF  t-value p-value
649 (Intercept)   7.916571 2.6752071 12 2.959237  0.0119
650 log(cofactor) 0.993325 0.5054216 12 1.965340  0.0729
651  Correlation:
652               (Intr)
653 log(cofactor) 0.986
654
655 Standardized Within-Group Residuals:
656        Min          Q1         Med          Q3         Max
657 -1.7142281 -0.4923451 -0.1405828  0.5279692  1.9974675
658
659 Number of Observations: 19
660 Number of Groups: 6
661               numDF denDF  F-value p-value
662 (Intercept)       1    12 37.61965  0.0001
663 log(cofactor)     1    12  3.86256  0.0729
664 Levene's Test for Homogeneity of Variance (center = median)
665       Df F value Pr(>F)
666 group  5  2.3082 0.1042
667       13
668
669   Shapiro-Wilk normality test
670
671 data:  residuals(x.transformed, type = "normalized")
672 W = 0.98217, p-value = 0.9645
673
674          Effect  Rsq upper.CL lower.CL
675 1         Model 0.26    0.691    0.004
676 2 log(cofactor) 0.26    0.691    0.004
677 Linear mixed-effects model fit by maximum likelihood
678  Data: raw.data
679        AIC      BIC    logLik
680   60.43202 64.20977 -26.21601
681
682 Random effects:
683  Formula: ~1 | species
684         (Intercept) Residual
685 StdDev:    1.020634 1.039661
686
687 Correlation Structure: corBrownian
688  Formula: ~1 | species
689  Parameter estimate(s):
690 numeric(0)
691 Fixed effects: phenotype ~ log(cofactor)
692                   Value Std.Error DF  t-value p-value
693 (Intercept)   7.392778 3.0483989 12 2.425135  0.0320
694 log(cofactor) 0.881931 0.5798511 12 1.520960  0.1542
695  Correlation:
696               (Intr)
697 log(cofactor) 0.987
698
699 Standardized Within-Group Residuals:
700        Min          Q1         Med          Q3         Max
701 -1.4850079 -0.4509161 -0.1453328  0.4232930  1.2577476
702
703 Number of Observations: 19
704 Number of Groups: 6
705               numDF denDF  F-value p-value
706 (Intercept)       1    12 32.16588  0.0001
707 log(cofactor)     1    12  2.31332  0.1542
708 Levene's Test for Homogeneity of Variance (center = median)
709       Df F value Pr(>F)
710 group  5  2.2229 0.1142
711       13
712
713   Shapiro-Wilk normality test
714
715 data:  residuals(x.brownian, type = "normalized")
716 W = 0.97178, p-value = 0.8115
717
718          Effect   Rsq upper.CL lower.CL
719 1         Model 0.651    0.877    0.327
720 2 log(cofactor) 0.651    0.877    0.327
721 $d
```

```
[1] -0.3908348

$ci
[1] -0.4413065 -0.1758217

$p
[1] 0

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Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC     BIC    logLik
  25.39804 29.1758 -8.699021

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3090393 0.3081185

Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)   1.7724119 0.9264961 12 1.9130270  0.0799
log(cofactor) 0.1689497 0.1750016 12 0.9654181  0.3534
 Correlation:
              (Intr)
log(cofactor) 0.986

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-2.0986505 -0.3851319 -0.1063804  0.7137330  1.6186842

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 32.38886  0.0001
log(cofactor)     1    12  0.93203  0.3534
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6205  0.687
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.98072, p-value = 0.9504

         Effect   Rsq upper.CL lower.CL
1         Model 0.078    0.535        0
2 log(cofactor) 0.078    0.535        0
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  18.12153 21.89929 -5.060765

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3394365 0.3400382

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)   1.6688690 0.9993473 12 1.6699590  0.1208
log(cofactor) 0.1446179 0.1900393 12 0.7609894  0.4614
 Correlation:
              (Intr)
log(cofactor) 0.986

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8808224 -0.3494617 -0.1224661  0.6225276  0.9803464

```

```
Number of Observations: 19
Number of Groups: 6
                numDF denDF   F-value p-value
(Intercept)         1    12 31.124953  0.0001
log(cofactor)       1    12  0.579105  0.4614
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4872   0.78
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.92254, p-value = 0.1261

         Effect  Rsq upper.CL lower.CL
1         Model 0.26    0.691    0.004
2 log(cofactor) 0.26    0.691    0.004
$d
[1] -0.1825349

$ci
[1] -0.203174837 -0.002306132

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df   LogLik Df   Chisq Pr(>Chisq)
1   4 -25.4177
2   4 -26.2160  0  1.5965  < 2.2e-16 ***
3   4  -4.6376  0 43.1568  < 2.2e-16 ***
4   4  -5.0608  0  0.8463  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df      AIC
simple.brownian  4 58.83548
x.brownian       4 60.43202
y.brownian       4 17.27526
xy.brownian      4 18.12153
================================================================================
================================================================================
Comparison 1c: uts vs. ratio
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  194.0458 197.8235 -93.02289

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    7.042817 31.63451

Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 152.03812  17.34116 12  8.767469  0.0000
cofactor    -92.10914  41.55221 12 -2.216708  0.0467
 Correlation:
         (Intr)
cofactor -0.877

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5405259 -0.5494926 -0.3351262  0.2717919  2.6697140

Number of Observations: 19
Number of Groups: 6
```

```
            numDF denDF  F-value p-value
(Intercept)     1    12 201.1767  <.0001
cofactor        1    12   4.9138  0.0467
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.6676 0.2115
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.90022, p-value = 0.04911

    Effect   Rsq upper.CL lower.CL
1    Model 0.342    0.739    0.016
2 cofactor 0.342    0.739    0.016
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  190.5304 194.3082 -91.26522

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    18.89843 36.39991

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept)  164.0498  21.10093 12  7.774532  0.0000
cofactor    -104.6264  44.78069 12 -2.336417  0.0376
 Correlation:
         (Intr)
cofactor -0.841

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2884595 -0.5371885 -0.2097447  0.1254340  1.4675818

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 115.02394  <.0001
cofactor        1    12   5.45884  0.0376
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5   1.533 0.2467
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.95778, p-value = 0.5295

    Effect   Rsq upper.CL lower.CL
1    Model 0.576    0.847    0.215
2 cofactor 0.576    0.847    0.215
$d
[1] -0.2331407

$ci
[1] -0.28520145 -0.09514151

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC     logLik
  8.428849 12.20661 -0.2144247

```

```
Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.06725742 0.2361867

Fixed effects: log(phenotype) ~ cofactor
                Value Std.Error DF  t-value p-value
(Intercept)  5.035068 0.1317531 12 38.21593  0.0000
cofactor    -0.828383 0.3116388 12 -2.65815  0.0209
 Correlation:
         (Intr)
cofactor -0.869

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8463467 -0.6455644 -0.2025454  0.3954217  2.2170884

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 5261.338  <.0001
cofactor        1    12    7.066  0.0209
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9534 0.4801
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.96789, p-value = 0.7336

    Effect   Rsq upper.CL lower.CL
1    Model 0.424     0.78    0.056
2 cofactor 0.424     0.78    0.056
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  2.810292 6.588048 2.594854

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.1301822 0.2622733

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
                Value Std.Error DF  t-value p-value
(Intercept)  5.109458 0.1502024 12 34.01715  0.0000
cofactor    -0.895151 0.3204555 12 -2.79337  0.0162
 Correlation:
         (Intr)
cofactor -0.844

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.6278476 -0.6515780 -0.2232015  0.2460866  1.4129775

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 3486.505  <.0001
cofactor        1    12    7.803  0.0162
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.8493 0.5391
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.97844, p-value = 0.9227

    Effect   Rsq upper.CL lower.CL
1    Model 0.873    0.957    0.741
2 cofactor 0.873    0.957    0.741
$d
[1] -0.4492521
```

```
$ci
[1] -0.681241 -0.174659

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  194.0135 197.7913 -93.00677

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:  0.02709782 32.33513

Fixed effects: phenotype ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    72.72636  22.15322 12  3.282879  0.0065
log(cofactor) -40.70467  18.59877 12 -2.188568  0.0491
 Correlation:
              (Intr)
log(cofactor) 0.935

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.6589770 -0.6043978 -0.1484124  0.3139587  2.7581105

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 226.66336  <.0001
log(cofactor)     1    12   4.78983  0.0491
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.4771 0.2631
      13

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.90489, p-value = 0.05969

         Effect   Rsq upper.CL lower.CL
1         Model 0.343     0.74    0.016
2 log(cofactor) 0.343     0.74    0.016
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  190.5585 194.3362 -91.27923

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    18.86352 36.44478

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    74.44184  23.62761 12  3.150629  0.0084
log(cofactor) -46.29474  19.87290 12 -2.329541  0.0381
 Correlation:
              (Intr)
log(cofactor) 0.875

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.3754723 -0.5145437 -0.2837832  0.1665598  1.4606935

Number of Observations: 19
```

```
Number of Groups: 6
             numDF denDF   F-value p-value
(Intercept)      1    12 115.11139  <.0001
log(cofactor)    1    12   5.42676  0.0381
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.3381 0.3088
      13

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.95637, p-value = 0.5032

         Effect   Rsq upper.CL lower.CL
1         Model 0.868    0.956    0.731
2 log(cofactor) 0.868    0.956    0.731
$d
[1] -0.5245993

$ci
[1] -0.7156531 -0.2106114

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC     logLik
  8.575684 12.35344 -0.2878421

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.03565122 0.2431368

Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    4.328228 0.1674943 12 25.841048  0.0000
log(cofactor) -0.360636 0.1403007 12 -2.570451  0.0245
 Correlation:
              (Intr)
log(cofactor) 0.931

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.96721576 -0.64841399 -0.04926403  0.44828512  2.30131602

Number of Observations: 19
Number of Groups: 6
             numDF denDF  F-value p-value
(Intercept)      1    12 5955.627  <.0001
log(cofactor)    1    12    6.607  0.0245
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.7229 0.6181
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.97352, p-value = 0.844

         Effect   Rsq upper.CL lower.CL
1         Model 0.416    0.776     0.05
2 log(cofactor) 0.416    0.776     0.05
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  3.002342 6.780098 2.498829

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
```

```
StdDev:   0.1273762 0.264866

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    4.346042 0.1691788 12 25.689045  0.0000
log(cofactor) -0.392986 0.1429984 12 -2.748183  0.0177
 Correlation:
              (Intr)
log(cofactor) 0.881

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7211974 -0.6327484 -0.2639773  0.3271246  1.4433133

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 3525.181  <.0001
log(cofactor)     1    12    7.553  0.0177
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.7154  0.623
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.97472, p-value = 0.8653

         Effect   Rsq upper.CL lower.CL
1         Model 0.666    0.883    0.352
2 log(cofactor) 0.666    0.883    0.352
$d
[1] -0.2505032

$ci
[1] -0.33698304 -0.09825795

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df  LogLik Df   Chisq Pr(>Chisq)
1   4 -91.265
2   4 -91.279  0   0.028  < 2.2e-16 ***
3   4   2.595  0 187.748  < 2.2e-16 ***
4   4   2.499  0   0.192  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
               df        AIC
simple.brownian  4 190.530446
x.brownian       4 190.558463
y.brownian       4   2.810292
xy.brownian      4   3.002342
================================================================================
================================================================================
Comparison 2a: ufs vs. Etanl
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC       BIC   logLik
  -51.56084 -47.78308 29.78042

Random effects:
```

```
 Formula: ~1 | species
        (Intercept)   Residual
StdDev:  0.02815979 0.04458408

Fixed effects: phenotype ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept)  0.2051013 0.02560626 12  8.009810  0.0000
cofactor    -0.0000783 0.00002071 12 -3.780517  0.0026
 Correlation:
         (Intr)
cofactor -0.757

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-0.77148088 -0.58123261 -0.29139007  0.09768854  2.77660161

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 62.11110  <.0001
cofactor        1    12 14.29231  0.0026
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.7548 0.1916
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.75473, p-value = 0.0002699

    Effect   Rsq upper.CL lower.CL
1    Model 0.596    0.856    0.243
2 cofactor 0.596    0.856    0.243
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC       BIC   logLik
  -54.74435 -50.96659 31.37217

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.04460047 0.0517933

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                   Value  Std.Error DF   t-value p-value
(Intercept)  0.21814616 0.03260680 12  6.690205  0.0000
cofactor    -0.00008203 0.00002356 12 -3.481655  0.0045
 Correlation:
         (Intr)
cofactor -0.727

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.37847567 -0.58544760 -0.20762764  0.02956975  1.52514653

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 36.67848  0.0001
cofactor        1    12 12.12192  0.0045
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.5067 0.2543
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.90829, p-value = 0.06888

    Effect   Rsq upper.CL lower.CL
1    Model 0.692    0.893    0.395
2 cofactor 0.692    0.893    0.395
$d
[1] -0.0959109
```

```
$ci
[1] -0.18233666 -0.02384673

$p
[1] 0.003

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  12.38489 16.16265 -2.192445

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.07151349 0.2628217

Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF    t-value p-value
(Intercept) -1.4684205 0.12547924 12 -11.702497       0
cofactor    -0.0007727 0.00011331 12  -6.819404       0
 Correlation:
         (Intr)
cofactor -0.82

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.4499680 -0.6965377 -0.2328735  0.3747247  2.3455009

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 911.7196  <.0001
cofactor        1    12  46.5043  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.8735 0.5249
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.90776, p-value = 0.06734

    Effect   Rsq upper.CL lower.CL
1    Model 0.834    0.944    0.663
2 cofactor 0.834    0.944    0.663
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  6.191188 9.968944 0.9044059

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.1885115 0.2694933

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept) -1.4157131 0.15350742 12 -9.222441       0
cofactor    -0.0007884 0.00011586 12 -6.804755       0
 Correlation:
         (Intr)
cofactor -0.754

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.0360812 -0.6804104 -0.1424531  0.2023267  1.6915638

Number of Observations: 19
Number of Groups: 6
```

```
            numDF denDF  F-value p-value
(Intercept)     1    12 478.1721  <.0001
cofactor        1    12  46.3047  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.7182 0.6212
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.95698, p-value = 0.5144

    Effect   Rsq upper.CL lower.CL
1    Model 0.972    0.991    0.943
2 cofactor 0.972    0.991    0.943
$d
[1] -0.1379773

$ci
[1] -0.27431647 -0.04594893

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC       BIC   logLik
  -57.85369 -54.07594 32.92685

Random effects:
 Formula: ~1 | species
         (Intercept)   Residual
StdDev: 2.001908e-06 0.04276948

Fixed effects: phenotype ~ log(cofactor)
                   Value  Std.Error DF   t-value p-value
(Intercept)    0.8052986 0.12410788 12  6.488699   0e+00
log(cofactor) -0.1016204 0.01864817 12 -5.449347   1e-04
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.3205869 -0.5917912 -0.2349009  0.3380640  3.1187707

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 160.35949  <.0001
log(cofactor)     1    12  29.69539   1e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5  3.3353 0.03713 *
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.87595, p-value = 0.01827

         Effect   Rsq upper.CL lower.CL
1         Model 0.764    0.919    0.527
2 log(cofactor) 0.764    0.919    0.527
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC       BIC   logLik
  -60.0769 -56.29914 34.03845

Random effects:
 Formula: ~1 | species
```

```
        (Intercept)  Residual
StdDev:  0.02913352 0.0485437

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                   Value  Std.Error DF   t-value p-value
(Intercept)    0.8466590 0.14235429 12  5.947548   1e-04
log(cofactor) -0.1060653 0.02113983 12 -5.017322   3e-04
 Correlation:
              (Intr)
log(cofactor) -0.993

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.2841949 -0.5921565 -0.2549534  0.2175715  1.4677682

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 69.11011  <.0001
log(cofactor)     1    12 25.17352   3e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5   2.763 0.06492 .
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.95557, p-value = 0.4886

         Effect   Rsq upper.CL lower.CL
1         Model 0.857    0.952    0.708
2 log(cofactor) 0.857    0.952    0.708
$d
[1] -0.09245828

$ci
[1] -0.1871376 -0.0277520

$p
[1] 0.002

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  4.469895 8.247651 1.765053

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 1.362137e-06 0.2205048

Fixed effects: log(phenotype) ~ log(cofactor)
                   Value Std.Error DF   t-value p-value
(Intercept)    3.546772 0.6398575 12  5.543065   1e-04
log(cofactor) -0.861265 0.0961436 12 -8.958117   0e+00
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.55630426 -0.75893355  0.05923759  0.70968471  1.96768544

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 1638.9478  <.0001
```

```
log(cofactor)     1    12   80.2479  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.2147 0.3561
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.96483, p-value = 0.6703

         Effect   Rsq upper.CL lower.CL
1         Model 0.898    0.966    0.791
2 log(cofactor) 0.898    0.966    0.791
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC      BIC   logLik
  -2.418591 1.359165 5.209295

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.02805075 0.2522209

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF    t-value p-value
(Intercept)    4.266436 0.5865901 12   7.273284       0
log(cofactor) -0.965919 0.0878050 12 -11.000734       0
 Correlation:
              (Intr)
log(cofactor) -0.995

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7031611 -0.4646712 -0.1828606  0.4454772  1.7546710

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 1463.9878  <.0001
log(cofactor)     1    12  121.0162  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.4087 0.2846
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.97491, p-value = 0.8684

         Effect   Rsq upper.CL lower.CL
1         Model 0.987    0.996    0.974
2 log(cofactor) 0.987    0.996    0.974
$d
[1] -0.08983634

$ci
[1] -0.1825432 -0.0296269

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df LogLik Df   Chisq Pr(>Chisq)
1   4 31.372
2   4 34.038  0  5.3326  < 2.2e-16 ***
3   4  0.904  0 66.2681  < 2.2e-16 ***
4   4  5.209  0  8.6098  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df        AIC
```

```
simple.brownian  4 -54.744345
x.brownian       4 -60.076898
y.brownian       4   6.191188
xy.brownian      4  -2.418591
================================================================================
================================================================================
Comparison 2b: ufs vs. Esec
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC       BIC   logLik
  -49.00714 -45.22939 28.50357

Random effects:
 Formula: ~1 | species
        (Intercept)   Residual
StdDev:  0.02104012 0.05046461

Fixed effects: phenotype ~ cofactor
                  Value   Std.Error DF   t-value p-value
(Intercept)  0.20779950 0.027626784 12  7.521668  0.0000
cofactor    -0.00006622 0.000019859 12 -3.334494  0.0059
 Correlation:
         (Intr)
cofactor -0.825

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.00422359 -0.42692837 -0.26493741  0.02240183  2.98719132

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 71.37454  <.0001
cofactor        1    12 11.11885  0.0059
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.4089 0.2846
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.75744, p-value = 0.0002931

    Effect   Rsq upper.CL lower.CL
1    Model 0.548    0.836    0.179
2 cofactor 0.548    0.836    0.179
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC       BIC   logLik
  -51.88769 -48.10993 29.94384

Random effects:
 Formula: ~1 | species
        (Intercept)   Residual
StdDev:   0.0471779 0.05615786

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                   Value  Std.Error DF   t-value p-value
(Intercept)  0.2165749 0.03698667 12  5.855486  0.0001
cofactor    -0.0000659 0.00002305 12 -2.859225  0.0144
 Correlation:
         (Intr)
cofactor -0.764

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.33035455 -0.46335635 -0.22920685  0.08273405  1.56587426
```

```
Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 32.40174  0.0001
cofactor        1    12  8.17516  0.0144
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.2398 0.3459
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.91289, p-value = 0.08366

    Effect   Rsq upper.CL lower.CL
1    Model 0.625    0.867    0.286
2 cofactor 0.625    0.867    0.286
$d
[1] -0.0768038

$ci
[1] -0.15205793 -0.01206271

$p
[1] 0.007

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  17.52411 21.30186 -4.762053

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 6.097648e-06 0.3108937

Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept) -1.4363538 0.14940678 12 -9.613712   0e+00
cofactor    -0.0006453 0.00011422 12 -5.649834   1e-04
 Correlation:
         (Intr)
cofactor -0.863

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2371984 -0.7471713 -0.1255163  0.2506925  2.4783811

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 824.4743  <.0001
cofactor        1    12  31.9206   1e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4975 0.7729
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.89633, p-value = 0.04178

    Effect   Rsq upper.CL lower.CL
1    Model 0.777    0.924    0.552
2 cofactor 0.777    0.924    0.552
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC     BIC   logLik
  12.63414 16.4119 -2.31707

Random effects:
```

```
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.2271345 0.3178858

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept) -1.3933812 0.19536883 12 -7.132055   0e+00
cofactor    -0.0006638 0.00012583 12 -5.275548   2e-04
 Correlation:
         (Intr)
cofactor -0.787

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.1292980 -0.6707851 -0.2094629  0.2240394  1.7022697

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 334.4147  <.0001
cofactor        1    12  27.8314   2e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.3859 0.8497
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.94401, p-value = 0.311

    Effect   Rsq upper.CL lower.CL
1    Model 0.864    0.954    0.723
2 cofactor 0.864    0.954    0.723
$d
[1] -0.08726104

$ci
[1] -0.18669133 -0.02351407

$p
[1] 0.002

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC      BIC   logLik
  -51.49826 -47.7205 29.74913

Random effects:
 Formula: ~1 | species
         (Intercept)   Residual
StdDev: 2.142245e-06 0.05055557

Fixed effects: phenotype ~ log(cofactor)
                   Value Std.Error DF   t-value p-value
(Intercept)    0.8208047 0.1705852 12  4.811699  0.0004
log(cofactor) -0.1000201 0.0246833 12 -4.052137  0.0016
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.43427914 -0.45453044 -0.17842557  0.09785261  3.28771082

Number of Observations: 19
Number of Groups: 6
               numDF denDF   F-value p-value
(Intercept)        1    12 114.76903  <.0001
log(cofactor)      1    12  16.41981  0.0016
```

```
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  2.0619 0.1361
      13

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.80386, p-value = 0.001301

         Effect   Rsq upper.CL lower.CL
1         Model 0.642    0.874    0.313
2 log(cofactor) 0.642    0.874    0.313
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC       BIC   logLik
  -53.11564 -49.33788 30.55782

Random effects:
 Formula: ~1 | species
        (Intercept)   Residual
StdDev:  0.03855116 0.05697417

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                   Value  Std.Error DF   t-value p-value
(Intercept)    0.8501186 0.21356799 12  3.980553  0.0018
log(cofactor) -0.1025800 0.03056028 12 -3.356643  0.0057
 Correlation:
              (Intr)
log(cofactor) -0.995

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.27582772 -0.56008950 -0.12280955  0.07839771  1.50344246

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 42.96045  <.0001
log(cofactor)     1    12 11.26705  0.0057
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5   1.732 0.1966
      13

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.92694, p-value = 0.1521

         Effect  Rsq upper.CL lower.CL
1         Model 0.74    0.911    0.482
2 log(cofactor) 0.74    0.911    0.482
$d
[1] -0.09790378

$ci
[1] -0.19044628 -0.02355222

$p
[1] 0.0035

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  14.11168 17.88943 -3.055838

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
```

```
StdDev: 4.143324e-06 0.2841921

Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    3.999730 0.9589243 12  4.171059  0.0013
log(cofactor) -0.894349 0.1387542 12 -6.445564  0.0000
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7574903 -0.8477933  0.1041812  0.3234646  2.4316692

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 986.6818  <.0001
log(cofactor)     1    12  41.5453  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4581 0.8004
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.95941, p-value = 0.5608

         Effect   Rsq upper.CL lower.CL
1         Model 0.819    0.939    0.634
2 log(cofactor) 0.819    0.939    0.634
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC     logLik
  9.986502 13.76426 -0.9932511

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.1548211 0.3176725

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    4.747137 1.0914751 12  4.349285   9e-04
log(cofactor) -0.998803 0.1565428 12 -6.380379   0e+00
 Correlation:
              (Intr)
log(cofactor) -0.996

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.62993737 -0.68552312 -0.03623807  0.34605876  1.30483946

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 512.8830  <.0001
log(cofactor)     1    12  40.7092  <.0001
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.3787 0.8545
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.96083, p-value = 0.5889

         Effect   Rsq upper.CL lower.CL
1         Model 0.984    0.995    0.966
2 log(cofactor) 0.984    0.995    0.966
$d
[1] -0.1641459

$ci
[1] -0.3300582 -0.0547161
```

```
$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df  LogLik Df   Chisq Pr(>Chisq)
1   4 29.9438
2   4 30.5578  0  1.2279  < 2.2e-16 ***
3   4 -2.3171  0 65.7498  < 2.2e-16 ***
4   4 -0.9933  0  2.6476  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df        AIC
simple.brownian  4 -51.887688
x.brownian       4 -53.115637
y.brownian       4  12.634139
xy.brownian      4   9.986502
================================================================================
================================================================================
Comparison 2c: U vs. Etanl
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  125.0551 128.8328 -58.52754

Random effects:
 Formula: ~1 | species
         (Intercept) Residual
StdDev: 0.0003629403 5.266987

Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 11.933327 2.3575577 12  5.061733  0.0003
cofactor    -0.004886 0.0022058 12 -2.215116  0.0468
 Correlation:
         (Intr)
cofactor -0.84

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-0.84812188 -0.68402892 -0.19214439  0.09053415  3.39477118

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 34.87728  0.0001
cofactor        1    12  4.90674  0.0468
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5  3.3006 0.03837 *
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.74208, p-value = 0.0001846

    Effect   Rsq upper.CL lower.CL
1    Model 0.349    0.742    0.018
2 cofactor 0.349    0.742    0.018
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
      AIC      BIC    logLik
  124.305 128.0828 -58.15252
```

```
Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    3.865977  6.16339

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 13.834942  3.345289 12  4.135649  0.0014
cofactor    -0.005417  0.002572 12 -2.106145  0.0569
 Correlation:
          (Intr)
cofactor -0.766

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.34729423 -0.61800386 -0.13958869  0.04661893  1.56766761

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 15.385591  0.0020
cofactor        1    12  4.435846  0.0569
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5  2.8833 0.05754 .
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.92583, p-value = 0.1451

    Effect Rsq upper.CL lower.CL
1    Model 0.5    0.815    0.123
2 cofactor 0.5    0.815    0.123
$d
[1] -0.1511442

$ci
[1] -0.19376424 -0.05814492

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
      AIC      BIC    logLik
  34.8345 38.61226 -13.41725

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 1.358494e-05 0.4902855

Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept)  2.4376844 0.21945684 12 11.107808  0.0000
cofactor    -0.0007102 0.00020533 12 -3.458869  0.0047
 Correlation:
          (Intr)
cofactor -0.84

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.3744654 -0.7802765 -0.1065462  0.4195502  2.3419200

Number of Observations: 19
Number of Groups: 6
```

```
            numDF denDF   F-value p-value
(Intercept)     1    12 229.06113  <.0001
cofactor        1    12  11.96377  0.0047
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6553 0.6631
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.91352, p-value = 0.08592

    Effect   Rsq upper.CL lower.CL
1    Model 0.566    0.844    0.203
2 cofactor 0.566    0.844    0.203
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  29.64701 33.42477 -10.82351

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:   0.2240331 0.545658

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept)  2.6266347 0.25361058 12 10.356960  0.0000
cofactor    -0.0008395 0.00020541 12 -4.086889  0.0015
 Correlation:
         (Intr)
cofactor -0.795

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.1185498 -0.7651380 -0.2273898  0.2702607  1.7203484

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 137.11698  <.0001
cofactor        1    12  16.70266  0.0015
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6249 0.6839
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.96145, p-value = 0.6013

    Effect   Rsq upper.CL lower.CL
1    Model 0.958    0.986    0.914
2 cofactor 0.958    0.986    0.914
$d
[1] -0.3915156

$ci
[1] -0.6997467 -0.1421896

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  121.9524 125.7301 -56.97618

```

```
Random effects:
 Formula: ~1 | species
         (Intercept) Residual
StdDev: 0.0002050665 4.854021

Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF   t-value p-value
(Intercept)   49.16477  14.08533 12  3.490495  0.0045
log(cofactor) -6.27578   2.11643 12 -2.965268  0.0118
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2011535 -0.5552337 -0.2167575  0.1658472  3.2418965

Number of Observations: 19
Number of Groups: 6
                numDF denDF  F-value p-value
(Intercept)         1    12 41.06424  <.0001
log(cofactor)       1    12  8.79282  0.0118
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  4.4779 0.0136 *
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.83886, p-value = 0.004442

         Effect  Rsq upper.CL lower.CL
1         Model 0.49    0.811    0.113
2 log(cofactor) 0.49    0.811    0.113
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  121.2069 124.9847 -56.60345

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:     2.57411 6.043852

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF   t-value p-value
(Intercept)   59.96916 16.252241 12  3.689901  0.0031
log(cofactor) -7.69861  2.420614 12 -3.180436  0.0079
 Correlation:
              (Intr)
log(cofactor) -0.994

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.1858622 -0.6269642 -0.2745641  0.1751270  1.6238763

Number of Observations: 19
Number of Groups: 6
                numDF denDF  F-value p-value
(Intercept)         1    12 24.52754  0.0003
log(cofactor)       1    12 10.11518  0.0079
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5   3.875 0.02271 *
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.94704, p-value = 0.3515

         Effect   Rsq upper.CL lower.CL
```

```
1         Model 0.739     0.91     0.48
2 log(cofactor) 0.739     0.91     0.48
$d
[1] -0.2491792

$ci
[1] -0.37749672 -0.09236574

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  31.62811 35.40587 -11.81406

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 8.561358e-06 0.4506131

Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    7.217496 1.3075827 12  5.519725  0.0001
log(cofactor) -0.816924 0.1964745 12 -4.157916  0.0013
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.25683743 -0.87357768 -0.01821886  0.56103207  2.01858789

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 271.17009  <.0001
log(cofactor)     1    12  17.28827  0.0013
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9858 0.4628
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.92872, p-value = 0.164

         Effect   Rsq upper.CL lower.CL
1         Model 0.654    0.878    0.332
2 log(cofactor) 0.654    0.878    0.332
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  25.04395 28.82171 -8.521976

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 2.617516e-05 0.5234637

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                  Value Std.Error DF   t-value p-value
(Intercept)    8.777962 1.1989234 12  7.321537   0e+00
log(cofactor) -1.044415 0.1795643 12 -5.816384   1e-04
 Correlation:
              (Intr)
log(cofactor) -0.995

Standardized Within-Group Residuals:
```

```
       Min         Q1        Med         Q3        Max
-1.4767651 -0.6639426 -0.2856563  0.3301078  1.8975712

Number of Observations: 19
Number of Groups: 6
             numDF denDF   F-value p-value
(Intercept)      1    12 258.73313  <.0001
log(cofactor)    1    12  33.83032   1e-04
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.2732 0.3328
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.97892, p-value = 0.9291

         Effect Rsq upper.CL lower.CL
1         Model   1        1        1
2 log(cofactor)   1        1        1
$d
[1] -0.3462261

$ci
[1] -0.6701083 -0.1268263

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df  LogLik Df   Chisq Pr(>Chisq)
1   4 -58.153
2   4 -56.603  0  3.0981  < 2.2e-16 ***
3   4 -10.824  0 91.5599  < 2.2e-16 ***
4   4  -8.522  0  4.6031  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df       AIC
simple.brownian  4 124.30503
x.brownian       4 121.20689
y.brownian       4  29.64701
xy.brownian      4  25.04395
================================================================================
================================================================================
Comparison 2d: U vs. Esec
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  126.3748 130.1526 -59.18742

Random effects:
 Formula: ~1 | species
         (Intercept) Residual
StdDev: 0.0003748676 5.453125

Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 11.738246 2.6206187 12  4.479189  0.0008
cofactor    -0.003714 0.0020034 12 -1.853839  0.0885
 Correlation:
         (Intr)
cofactor -0.863

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.01584496 -0.55339602 -0.24946191  0.02249022  3.42638767
```

```
Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 32.53690  0.0001
cofactor        1    12  3.43672  0.0885
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5  2.7146 0.06819 .
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.7325, p-value = 0.0001393

    Effect   Rsq upper.CL lower.CL
1    Model 0.273    0.699    0.004
2 cofactor 0.273    0.699    0.004
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  125.8396 129.6174 -58.9198

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    4.192503 6.354968

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 13.303300  3.782724 12  3.516857  0.0042
cofactor    -0.004003  0.002470 12 -1.620378  0.1311
 Correlation:
         (Intr)
cofactor -0.796

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.36374968 -0.55062928 -0.18163356  0.06925084  1.56687876

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 13.543743  0.0031
cofactor        1    12  2.625624  0.1311
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  2.2596 0.1098
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.91596, p-value = 0.09529

    Effect   Rsq upper.CL lower.CL
1    Model 0.692    0.893    0.395
2 cofactor 0.692    0.893    0.395
$d
[1] -0.4187542

$ci
[1] -0.4832450 -0.1947424

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
```

```
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  37.76083 41.53858 -14.88041

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 1.344276e-05 0.5295335

Fixed effects: log(phenotype) ~ cofactor
                 Value  Std.Error DF   t-value p-value
(Intercept)  2.4144256 0.25447889 12  9.487724  0.0000
cofactor    -0.0005443 0.00019454 12 -2.798108  0.0161
 Correlation:
         (Intr)
cofactor -0.863

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.32777017 -0.74632111 -0.06930007  0.37229784  2.38484538

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 196.36434  <.0001
cofactor        1    12   7.82941  0.0161
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4934 0.7757
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.92624, p-value = 0.1476

    Effect   Rsq upper.CL lower.CL
1    Model 0.461    0.798    0.085
2 cofactor 0.461    0.798    0.085
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  33.41863 37.19638 -12.70931

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3088905 0.5804384

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
                 Value Std.Error DF   t-value p-value
(Intercept)  2.5734390  0.319359 12  8.058139  0.0000
cofactor    -0.0006453  0.000215 12 -3.000534  0.0111
 Correlation:
         (Intr)
cofactor -0.816

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2558376 -0.6419893 -0.2367171  0.3301011  1.6106204

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 94.13641  <.0001
cofactor        1    12  9.00320  0.0111
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4156 0.8297
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.95336, p-value = 0.4499
```

```
    Effect   Rsq upper.CL lower.CL
1    Model 0.713    0.901    0.433
2 cofactor 0.713    0.901    0.433
$d
[1] -0.2520836

$ci
[1] -0.3658758 -0.1024814

$p
[1] 0
```

Natural log transformation of dependent variable

```
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  125.4409 129.2186 -58.72043

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev: 0.000251299  5.32073

Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF   t-value p-value
(Intercept)   45.38827 17.953272 12  2.528134  0.0265
log(cofactor) -5.49016  2.597798 12 -2.113391  0.0562
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.1995484 -0.4652645 -0.1972934  0.0168710  3.3966701

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 34.17627  0.0001
log(cofactor)     1    12  4.46642  0.0562
Levene's Test for Homogeneity of Variance (center = median)
      Df F value  Pr(>F)
group  5  3.2036 0.04208 *
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.76994, p-value = 0.0004318

         Effect   Rsq upper.CL lower.CL
1         Model 0.328    0.731    0.012
2 log(cofactor) 0.328    0.731    0.012
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  125.2964 129.0741 -58.64819

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    3.632877  6.45151

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF   t-value p-value
(Intercept)   52.64466  23.00411 12  2.288489  0.0410
log(cofactor) -6.35548   3.29617 12 -1.928140  0.0778
 Correlation:
              (Intr)
```

```
log(cofactor) -0.996

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.30970873 -0.51280949 -0.12929097  0.07024106  1.62131710

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 16.051808  0.0017
log(cofactor)     1    12  3.717722  0.0778
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  2.8298 0.0607 .
      13
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.93245, p-value = 0.1921

         Effect  Rsq upper.CL lower.CL
1         Model 0.51     0.82    0.134
2 log(cofactor) 0.51     0.82    0.134
$d
[1] -0.1817028

$ci
[1] -0.21736888 -0.07931652

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  36.50711 40.28487 -14.25356

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 9.817237e-06 0.5123479

Fixed effects: log(phenotype) ~ log(cofactor)
                   Value Std.Error DF   t-value p-value
(Intercept)    7.120786 1.7287706 12  4.118989  0.0014
log(cofactor) -0.771946 0.2501492 12 -3.085942  0.0094
 Correlation:
              (Intr)
log(cofactor) -0.997

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.5801002 -0.9202651 -0.0195231  0.4077265  2.3186217

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 209.75845  <.0001
log(cofactor)     1    12   9.52304  0.0094
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.4041 0.8375
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.95525, p-value = 0.4828

         Effect  Rsq upper.CL lower.CL
1         Model 0.51     0.82    0.134
```

```
2 log(cofactor) 0.51     0.82    0.134
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  32.16724 35.94499 -12.08362

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.2284927 0.5868126

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                   Value Std.Error DF   t-value p-value
(Intercept)    8.651421 1.9158831 12  4.515631  0.0007
log(cofactor) -0.986726 0.2751413 12 -3.586251  0.0037
 Correlation:
              (Intr)
log(cofactor) -0.996

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5349111 -0.6038602 -0.1151023  0.3642676  1.4312340

Number of Observations: 19
Number of Groups: 6
               numDF denDF   F-value p-value
(Intercept)        1    12 123.82611  <.0001
log(cofactor)      1    12  12.86119  0.0037
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.3869 0.8491
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.95941, p-value = 0.5608

         Effect   Rsq upper.CL lower.CL
1         Model 0.809    0.935    0.614
2 log(cofactor) 0.809    0.935    0.614
$d
[1] -0.2994071

$ci
[1] -0.4850053 -0.1102824

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df  LogLik Df   Chisq Pr(>Chisq)
1   4 -58.920
2   4 -58.648  0  0.5432  < 2.2e-16 ***
3   4 -12.709  0 91.8778  < 2.2e-16 ***
4   4 -12.084  0  1.2514  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
               df       AIC
simple.brownian  4 125.83961
x.brownian       4 125.29638
y.brownian       4  33.41863
xy.brownian      4  32.16724
================================================================================
================================================================================
Comparison 3a: Etan low vs. length
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables
```

```
2990
2991
2992 ------------------------------------------------------------------------------
2993 Linear mixed-effects model fit by maximum likelihood
2994  Data: raw.data
2995        AIC      BIC    logLik
2996   300.7297 304.5074 -146.3648
2997
2998 Random effects:
2999  Formula: ~1 | species
3000         (Intercept) Residual
3001 StdDev:  0.03491519 536.1818
3002
3003 Fixed effects: phenotype ~ cofactor
3004                Value Std.Error DF  t-value p-value
3005 (Intercept) 379.1867  334.7871 12 1.132621  0.2795
3006 cofactor     80.4656   47.8203 12 1.682668  0.1183
3007  Correlation:
3008          (Intr)
3009 cofactor -0.921
3010
3011 Standardized Within-Group Residuals:
3012        Min         Q1        Med         Q3        Max
3013 -1.1489570 -0.5502091 -0.2340353 -0.1043322  2.6271731
3014
3015 Number of Observations: 19
3016 Number of Groups: 6
3017             numDF denDF  F-value p-value
3018 (Intercept)     1    12 47.71497  <.0001
3019 cofactor        1    12  2.83137  0.1183
3020 Levene's Test for Homogeneity of Variance (center = median)
3021       Df F value Pr(>F)
3022 group  5   0.903  0.508
3023       13
3024
3025   Shapiro-Wilk normality test
3026
3027 data:  residuals(simple.model, type = "normalized")
3028 W = 0.73548, p-value = 0.0001519
3029
3030     Effect   Rsq upper.CL lower.CL
3031 1    Model 0.236    0.675    0.002
3032 2 cofactor 0.236    0.675    0.002
3033 Linear mixed-effects model fit by maximum likelihood
3034  Data: raw.data
3035        AIC      BIC    logLik
3036   295.0653 298.8431 -143.5326
3037
3038 Random effects:
3039  Formula: ~1 | species
3040         (Intercept) Residual
3041 StdDev:    495.5763   497.65
3042
3043 Correlation Structure: corBrownian
3044  Formula: ~1 | species
3045  Parameter estimate(s):
3046 numeric(0)
3047 Fixed effects: phenotype ~ cofactor
3048                Value Std.Error DF   t-value p-value
3049 (Intercept) 477.8785  560.8940 12 0.8519944  0.4109
3050 cofactor     84.8500   80.8376 12 1.0496354  0.3146
3051  Correlation:
3052          (Intr)
3053 cofactor -0.903
3054
3055 Standardized Within-Group Residuals:
3056         Min          Q1         Med          Q3         Max
3057 -1.24098737 -0.45046223 -0.14129189 -0.05477712  2.16330581
3058
3059 Number of Observations: 19
3060 Number of Groups: 6
3061             numDF denDF   F-value p-value
3062 (Intercept)     1    12 17.617844  0.0012
3063 cofactor        1    12  1.101734  0.3146
3064 Levene's Test for Homogeneity of Variance (center = median)
3065       Df F value Pr(>F)
3066 group  5  0.6172 0.6892
3067       13
3068
3069   Shapiro-Wilk normality test
3070
```

```
data:  residuals(simple.brownian, type = "normalized")
W = 0.71902, p-value = 9.452e-05

    Effect   Rsq upper.CL lower.CL
1    Model 0.313    0.723    0.009
2 cofactor 0.313    0.723    0.009
$d
[1] -0.07672868

$ci
[1] -0.09645834 -0.00772503

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  34.93394 38.71169 -13.46697

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 8.194989e-06 0.4915701

Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept) 6.014342 0.3069320 12 19.595033  0.0000
cofactor    0.095734 0.0438415 12  2.183643  0.0496
 Correlation:
         (Intr)
cofactor -0.921

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.49832494 -0.72112189 -0.04657175  0.11881827  2.39490378

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 3094.2788  <.0001
cofactor        1    12    4.7683  0.0496
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.0845 0.4136
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.88625, p-value = 0.02763

    Effect   Rsq upper.CL lower.CL
1    Model 0.342    0.739    0.016
2 cofactor 0.342    0.739    0.016
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  29.35466 33.13241 -10.67733

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.4380807 0.4631044

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept) 6.000517 0.5067892 12 11.840263  0.0000
cofactor    0.112173 0.0732463 12  1.531449  0.1516
 Correlation:
```

```
         (Intr)
cofactor -0.906

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.41942841 -0.53136978 -0.05726218  0.17645387  2.29997731

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 971.7983  <.0001
cofactor        1    12   2.3453  0.1516
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6729 0.6513
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.77277, p-value = 0.0004719

    Effect   Rsq upper.CL lower.CL
1    Model 0.499    0.815    0.123
2 cofactor 0.499    0.815    0.123
$d
[1] -0.1568262

$ci
[1] -0.19927487 -0.05992435

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  300.5687 304.3465 -146.2843

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:  0.03494555 533.9156

Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF    t-value p-value
(Intercept)   -142.9108  614.9173 12 -0.2324065  0.8201
log(cofactor)  583.0716  336.6322 12  1.7320732  0.1089
 Correlation:
             (Intr)
log(cofactor) -0.978

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2348005 -0.5342622 -0.3032046 -0.1022325  2.5903320

Number of Observations: 19
Number of Groups: 6
               numDF denDF  F-value p-value
(Intercept)        1    12 48.12089  <.0001
log(cofactor)      1    12  3.00008  0.1089
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9338 0.4908
      13

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.73116, p-value = 0.0001339

         Effect   Rsq upper.CL lower.CL
1         Model 0.247    0.682    0.003
2 log(cofactor) 0.247    0.682    0.003
```

```
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  294.8685 298.6462 -143.4342

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    485.3901 497.6382

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                 Value Std.Error DF    t-value p-value
(Intercept)   -147.0639 1044.4910 12 -0.1407996  0.8904
log(cofactor)  654.6475  575.9849 12  1.1365706  0.2779
 Correlation:
              (Intr)
log(cofactor) -0.974

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.33846723 -0.41346335 -0.18200122 -0.07378411  2.14405047

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 18.185989  0.0011
log(cofactor)     1    12  1.291793  0.2779
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6383 0.6747
      13

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.72553, p-value = 0.0001138

         Effect   Rsq upper.CL lower.CL
1         Model 0.359    0.748    0.021
2 log(cofactor) 0.359    0.748    0.021
$d
[1] -0.1124292

$ci
[1] -0.1336216 -0.0196849

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  34.58107 38.35883 -13.29054

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 7.847956e-06 0.4870266

Fixed effects: log(phenotype) ~ log(cofactor)
                 Value Std.Error DF  t-value p-value
(Intercept)   5.384390 0.5609146 12 9.599304   0.000
log(cofactor) 0.698631 0.3070688 12 2.275160   0.042
 Correlation:
              (Intr)
log(cofactor) -0.978

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.62133169 -0.64027301 -0.05199606  0.10723778  2.35572431
```

```
Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 3152.2825  <.0001
log(cofactor)     1    12    5.1764   0.042
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9238 0.4963
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.88444, p-value = 0.02567

         Effect   Rsq upper.CL lower.CL
1         Model 0.361    0.749    0.022
2 log(cofactor) 0.361    0.749    0.022
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC     BIC    logLik
  29.05284 32.8306 -10.52642

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.4208043 0.4641961

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                Value Std.Error DF  t-value p-value
(Intercept)   5.21384 0.9346700 12 5.578268  0.0001
log(cofactor) 0.84298 0.5160489 12 1.633527  0.1283
 Correlation:
              (Intr)
log(cofactor) -0.975

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.56461685 -0.50594577 -0.08848169  0.14488667  2.26842990

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 1032.1867  <.0001
log(cofactor)     1    12    2.6684  0.1283
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6475 0.6685
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.78051, p-value = 0.0006037

         Effect   Rsq upper.CL lower.CL
1         Model 0.545    0.835    0.176
2 log(cofactor) 0.545    0.835    0.176
$d
[1] -0.1842249

$ci
[1] -0.23252792 -0.07522848

$p
[1] 0

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df   LogLik Df    Chisq Pr(>Chisq)
1   4 -143.533
2   4 -143.434  0   0.1968  < 2.2e-16 ***
```

```
3   4  -10.677  0 265.5138  < 2.2e-16 ***
4   4  -10.526  0   0.3018  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df       AIC
simple.brownian  4 295.06530
x.brownian       4 294.86846
y.brownian       4  29.35466
xy.brownian      4  29.05284
================================================================================
================================================================================
Comparison 3b: Esec vs. length
================================================================================
================================================================================
--------------------------------------------------------------------------------


No transformation of variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  303.9805 307.7582 -147.9902

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:   0.0276538 584.0699

Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept) 399.3009  364.6880 12 1.094911  0.2950
cofactor    113.1550   52.0912 12 2.172246  0.0506
 Correlation:
         (Intr)
cofactor -0.921

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.2494641 -0.4929929 -0.2912915 -0.1452860  2.2409932

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 63.55179  <.0001
cofactor        1    12  4.71865  0.0506
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9666  0.473
      13

  Shapiro-Wilk normality test

data:  residuals(simple.model, type = "normalized")
W = 0.69333, p-value = 4.635e-05

    Effect  Rsq upper.CL lower.CL
1    Model 0.34    0.738    0.015
2 cofactor 0.34    0.738    0.015
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  298.3049 302.0827 -145.1525

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    396.1075 593.1031

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept) 579.3534  535.0546 12 1.082793  0.3002
cofactor    102.5534   78.4654 12 1.306989  0.2157
 Correlation:
         (Intr)
```

```
cofactor -0.915

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2247009 -0.3758167 -0.2459776 -0.1204433  2.1572007

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 32.09562  0.0001
cofactor        1    12  1.70822  0.2157
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6681 0.6545
      13

  Shapiro-Wilk normality test

data:  residuals(simple.brownian, type = "normalized")
W = 0.69571, p-value = 4.944e-05

    Effect   Rsq upper.CL lower.CL
1    Model 0.444     0.79    0.071
2 cofactor 0.444     0.79    0.071
$d
[1] -0.1035667

$ci
[1] -0.13760080 -0.03763911

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of independent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  28.32492 32.10268 -10.16246

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 6.940895e-06 0.4130973

Fixed effects: log(phenotype) ~ cofactor
               Value  Std.Error DF   t-value p-value
(Intercept) 6.238594 0.25793422 12 24.186764  0.0000
cofactor    0.101452 0.03684277 12  2.753643  0.0175
 Correlation:
         (Intr)
cofactor -0.921

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.2543842 -0.6753521 -0.2267047  0.1142197  2.4128349

Number of Observations: 19
Number of Groups: 6
            numDF denDF  F-value p-value
(Intercept)     1    12 4733.375  <.0001
cofactor        1    12    7.583  0.0175
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.1441 0.3862
      13

  Shapiro-Wilk normality test

data:  residuals(y.transformed, type = "normalized")
W = 0.82165, p-value = 0.002399

    Effect   Rsq upper.CL lower.CL
1    Model 0.453    0.794    0.079
2 cofactor 0.453    0.794    0.079
Linear mixed-effects model fit by maximum likelihood
```

```
 Data: raw.data
       AIC      BIC    logLik
  22.60047 26.37822 -7.300234

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3169837 0.4052492

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept) 6.375506 0.3982145 12 16.010233   0.000
cofactor    0.093319 0.0580616 12  1.607247   0.134
 Correlation:
         (Intr)
cofactor -0.912

Standardized Within-Group Residuals:
         Min           Q1          Med           Q3          Max
-1.178363702 -0.492482099 -0.084912398  0.007026298  2.359475835

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    12 1811.9807  <.0001
cofactor        1    12    2.5832   0.134
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.7827 0.5799
      13

  Shapiro-Wilk normality test

data:  residuals(y.brownian, type = "normalized")
W = 0.72312, p-value = 0.0001062

    Effect   Rsq upper.CL lower.CL
1    Model 0.853     0.95      0.7
2 cofactor 0.853     0.95      0.7
$d
[1] -0.3996034

$ci
[1] -0.6182587 -0.1539103

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of dependent variable


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
      AIC      BIC   logLik
  303.622 307.3997 -147.811

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:  0.02775285  578.586

Fixed effects: phenotype ~ log(cofactor)
                   Value Std.Error DF    t-value p-value
(Intercept)   -346.4829  666.3648 12 -0.5199598  0.6125
log(cofactor)  826.4324  364.7967 12  2.2654601  0.0428
 Correlation:
              (Intr)
log(cofactor) -0.978

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.0946330 -0.4624484 -0.2697732 -0.1418463  2.2615134

```

```
Number of Observations: 19
Number of Groups: 6
                numDF denDF  F-value p-value
(Intercept)         1    12 64.76220  <.0001
log(cofactor)       1    12  5.13231  0.0428
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.9494 0.4822
      13

  Shapiro-Wilk normality test

data:  residuals(x.transformed, type = "normalized")
W = 0.67924, p-value = 3.178e-05

         Effect   Rsq upper.CL lower.CL
1         Model 0.359    0.748    0.021
2 log(cofactor) 0.359    0.748    0.021
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  297.8556 301.6333 -144.9278

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:    379.3614 590.6387

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ log(cofactor)
                   Value Std.Error DF    t-value p-value
(Intercept)   -210.6503  985.2387 12 -0.2138064  0.8343
log(cofactor)  811.2431  546.6065 12  1.4841445  0.1636
 Correlation:
              (Intr)
log(cofactor) -0.977

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.1343335 -0.3066469 -0.2385625 -0.1778877  2.1492706

Number of Observations: 19
Number of Groups: 6
                numDF denDF  F-value p-value
(Intercept)         1    12 33.90797  0.0001
log(cofactor)       1    12  2.20268  0.1636
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6817 0.6454
      13

  Shapiro-Wilk normality test

data:  residuals(x.brownian, type = "normalized")
W = 0.68737, p-value = 3.946e-05

         Effect   Rsq upper.CL lower.CL
1         Model 0.512    0.821    0.137
2 log(cofactor) 0.512    0.821    0.137
$d
[1] -0.1530767

$ci
[1] -0.19606936 -0.06164361

$p
[1] 0

--------------------------------------------------------------------------------


Natural log transformation of both variables


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC     BIC    logLik
```

```
  27.46575 31.2435 -9.732873

Random effects:
 Formula: ~1 | species
         (Intercept) Residual
StdDev: 6.805997e-06 0.403862

Fixed effects: log(phenotype) ~ log(cofactor)
                 Value Std.Error DF   t-value p-value
(Intercept)   5.550385 0.4651329 12 11.932900  0.0000
log(cofactor) 0.751911 0.2546338 12  2.952911  0.0121
 Correlation:
              (Intr)
log(cofactor) -0.978

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.09009121 -0.62709908 -0.14881241  0.02841992  2.48751678

Number of Observations: 19
Number of Groups: 6
              numDF denDF  F-value p-value
(Intercept)       1    12 4952.331  <.0001
log(cofactor)     1    12    8.720  0.0121
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  1.2405 0.3456
      13

  Shapiro-Wilk normality test

data:  residuals(xy.transformed, type = "normalized")
W = 0.79377, p-value = 0.0009293

         Effect   Rsq upper.CL lower.CL
1         Model 0.488     0.81    0.111
2 log(cofactor) 0.488     0.81    0.111
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  21.82962 25.60737 -6.914808

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.2997113 0.4010905

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(phenotype) ~ log(cofactor)
                 Value Std.Error DF  t-value p-value
(Intercept)   5.636584 0.7250005 12 7.774593  0.0000
log(cofactor) 0.749311 0.4014293 12 1.866607  0.0866
 Correlation:
              (Intr)
log(cofactor) -0.976

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.18046327 -0.36667996 -0.15086541 -0.05279163  2.36567818

Number of Observations: 19
Number of Groups: 6
              numDF denDF   F-value p-value
(Intercept)       1    12 1970.0555  <.0001
log(cofactor)     1    12    3.4842  0.0866
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.8571 0.5345
      13

  Shapiro-Wilk normality test

data:  residuals(xy.brownian, type = "normalized")
W = 0.70971, p-value = 7.272e-05

         Effect   Rsq upper.CL lower.CL
1         Model 0.622    0.866    0.283
2 log(cofactor) 0.622    0.866    0.283
```

```
$d
[1] -0.1347552

$ci
[1] -0.21175705 -0.04638704

$p
[1] 5e-04

Likelihood ratio test

Model 1: phenotype ~ cofactor
Model 2: phenotype ~ log(cofactor)
Model 3: log(phenotype) ~ cofactor
Model 4: log(phenotype) ~ log(cofactor)
  #Df   LogLik Df    Chisq Pr(>Chisq)
1   4 -145.152
2   4 -144.928  0   0.4494  < 2.2e-16 ***
3   4   -7.300  0 275.2551  < 2.2e-16 ***
4   4   -6.915  0   0.7709  < 2.2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
                df       AIC
simple.brownian  4 298.30494
x.brownian       4 297.85556
y.brownian       4  22.60047
xy.brownian      4  21.82962
================================================================================
================================================================================
Comparison 5: log(fmax) ~ endo + exo
================================================================================
================================================================================
--------------------------------------------------------------------------------


Compare with and without phylogenetic covariance


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
      AIC      BIC   logLik
  5.66673 11.33336 3.166635

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.06743306 0.2736036

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: log(fmax) ~ endo * exo
                 Value Std.Error DF   t-value p-value
(Intercept)    -0.6067    0.4446 10 -1.364548  0.2023
endo           96.5246   22.9684 10  4.202497  0.0018
exo            20.7277   52.6154 10  0.393947  0.7019
endo:exo    -1553.0660 1702.5213 10 -0.912215  0.3831
 Correlation:
         (Intr) endo   exo
endo     -0.928
exo      -0.784  0.554
endo:exo  0.870 -0.732 -0.947

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7367597 -0.5657005 -0.1560286  0.2538354  1.5036870

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    10 172.09226  <.0001
endo            1    10  30.43283  0.0003
exo             1    10   2.15226  0.1731
endo:exo        1    10   0.83214  0.3831
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.5022 0.7696
      13
```

```
  Shapiro-Wilk normality test

data:  residuals(full.model, type = "normalized")
W = 0.97016, p-value = 0.7796

    Effect   Rsq upper.CL lower.CL
1    Model 0.991    0.997    0.982
2     endo 0.982    0.994    0.963
4 endo:exo 0.640    0.873    0.311
3      exo 0.228    0.669    0.002
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC  logLik
  10.49148 16.15811 0.75426

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 5.543289e-07 0.2325532

Fixed effects: log(fmax) ~ endo * exo
                Value Std.Error DF   t-value p-value
(Intercept)   -0.4705    0.3858 10 -1.219617  0.2506
endo          85.9107   19.3208 10  4.446533  0.0012
exo            5.3193   56.2980 10  0.094485  0.9266
endo:exo    -898.9555 1716.4641 10 -0.523725  0.6119
 Correlation:
         (Intr) endo   exo
endo     -0.911
exo      -0.796  0.527
endo:exo  0.879 -0.698 -0.960

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.90587184 -0.63727389 -0.04530068  0.49910917  2.33208358

Number of Observations: 19
Number of Groups: 6
            numDF denDF   F-value p-value
(Intercept)     1    10 210.18103  <.0001
endo            1    10  44.04378  0.0001
exo             1    10   2.11921  0.1761
endo:exo        1    10   0.27429  0.6119
Levene's Test for Homogeneity of Variance (center = median)
      Df F value Pr(>F)
group  5  0.6688  0.654
      13

  Shapiro-Wilk normality test

data:  residuals(full.simple, type = "normalized")
W = 0.9821, p-value = 0.9638

    Effect   Rsq upper.CL lower.CL
1    Model 0.852    0.951    0.707
2     endo 0.710    0.900    0.427
4 endo:exo 0.033    0.470    0.000
3      exo 0.001    0.405    0.000
$d
[1] 0.1393233

$ci
[1] 0.0444742 0.2757189

$p
[1] 0

--------------------------------------------------------------------------------


R2 calculation for hypothesis testing


--------------------------------------------------------------------------------
      Effect        F                 v1            v2          ncp
 endo    :1   Min.   : 0.4049   Min.   :1.0   Min.   :18   Min.   :  0.4049
 endo:exo:1   1st Qu.: 1.9352   1st Qu.:1.0   1st Qu.:18   1st Qu.:  1.9352
 exo     :1   Median :26.6915   Median :1.0   Median :18   Median : 38.4986
 Model   :1   Mean   :32.0849   Mean   :1.5   Mean   :18   Mean   : 57.5537
              3rd Qu.:56.8412   3rd Qu.:1.5   3rd Qu.:18   3rd Qu.: 94.1171
              Max.   :74.5519   Max.   :3.0   Max.   :18   Max.   :152.8128
```

```
      Rsq             upper.CL          lower.CL
 Min.   :0.0220   Min.   :0.3112   Min.   :0.0000841
 1st Qu.:0.0952   1st Qu.:0.4253   1st Qu.:0.0005030
 Median :0.4626   Median :0.6864   Median :0.3310785
 Mean   :0.4604   Mean   :0.6590   Mean   :0.3699272
 3rd Qu.:0.8278   3rd Qu.:0.9200   3rd Qu.:0.7005026
 Max.   :0.8946   Max.   :0.9520   Max.   :0.8174677
   Effect        F               v1          v2          ncp             Rsq
 endo :1   Min.   :85.27   Min.   :1   Min.   :18   Min.   :85.27   Min.   :0.8257
 Model:1   1st Qu.:85.27   1st Qu.:1   1st Qu.:18   1st Qu.:85.27   1st Qu.:0.8257
           Median :85.27   Median :1   Median :18   Median :85.27   Median :0.8257
           Mean   :85.27   Mean   :1   Mean   :18   Mean   :85.27   Mean   :0.8257
           3rd Qu.:85.27   3rd Qu.:1   3rd Qu.:18   3rd Qu.:85.27   3rd Qu.:0.8257
           Max.   :85.27   Max.   :1   Max.   :18   Max.   :85.27   Max.   :0.8257
    upper.CL        lower.CL
 Min.   :0.919   Min.   :0.6959
 1st Qu.:0.919   1st Qu.:0.6959
 Median :0.919   Median :0.6959
 Mean   :0.919   Mean   :0.6959
 3rd Qu.:0.919   3rd Qu.:0.6959
 Max.   :0.919   Max.   :0.6959
   Effect        F               v1          v2          ncp             Rsq
 exo  :1   Min.   :1.487   Min.   :1   Min.   :18   Min.   :1.487   Min.   :0.07633
 Model:1   1st Qu.:1.487   1st Qu.:1   1st Qu.:18   1st Qu.:1.487   1st Qu.:0.07633
           Median :1.487   Median :1   Median :18   Median :1.487   Median :0.07633
           Mean   :1.487   Mean   :1   Mean   :18   Mean   :1.487   Mean   :0.07633
           3rd Qu.:1.487   3rd Qu.:1   3rd Qu.:18   3rd Qu.:1.487   3rd Qu.:0.07633
           Max.   :1.487   Max.   :1   Max.   :18   Max.   :1.487   Max.   :0.07633
    upper.CL         lower.CL
 Min.   :0.4085   Min.   :0.0002479
 1st Qu.:0.4085   1st Qu.:0.0002479
 Median :0.4085   Median :0.0002479
 Mean   :0.4085   Mean   :0.0002479
 3rd Qu.:0.4085   3rd Qu.:0.0002479
 Max.   :0.4085   Max.   :0.0002479
$d
[1] 0.06891381

$ci
[1] 0.02669818 0.13002662

$p
[1] 0

$d
[1] 0.8182919

$ci
[1] 0.5320081 0.8527663

$p
[1] 0

$d
[1] 0.7493781

$ci
[1] 0.3943781 0.8893781

$p
[1] 4.88154e-12

           Model df      AIC      BIC   logLik   Test  L.Ratio p-value
full.model     1  6 5.666730 11.33336 3.166635
endo.model     2  4 4.849454  8.62721 1.575273 1 vs 2 3.182724  0.2036
Likelihood ratio test

Model 1: log(fmax) ~ endo * exo
Model 2: log(fmax) ~ endo
  #Df LogLik Df  Chisq Pr(>Chisq)
1   6 3.1666
2   4 1.5753 -2 3.1827     0.2036
           Model df      AIC      BIC    logLik   Test  L.Ratio p-value
full.model     1  6  5.66673 11.33336  3.166635
exo.model      2  4 17.27526 21.05301 -4.637629 1 vs 2 15.60853   4e-04
Likelihood ratio test

Model 1: log(fmax) ~ endo * exo
Model 2: log(fmax) ~ exo
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   6  3.1666
```

```
2   4 -4.6376 -2 15.608   0.000408 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
================================================================================
================================================================================
Model 1a: log(fmax) ~ log(endo)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  1.415069 5.192825 3.292466

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.05787534 0.2740456

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept) 6.464760 0.8801017 12 7.345469       0
cofactor    1.333644 0.2114985 12 6.305691       0
 Correlation:
         (Intr)
cofactor 0.997

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8313788 -0.6059318 -0.4628514  0.1919480  1.5309202

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1378843 -1.027828 greater  0.867

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2006249 -1.071713 greater  0.867
```

```
--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -24.75061

$logL0
[1] -24.75028

$P
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.3945796

$P
[1] 0.898

--------------------------------------------------------------------------------


R2 hypothesis testing


--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :162.6   Min.   :1   Min.   :18   Min.   :162.6   Min.   :0.9003
           1st Qu.:162.6   1st Qu.:1   1st Qu.:18   1st Qu.:162.6   1st Qu.:0.9003
           Median :162.6   Median :1   Median :18   Median :162.6   Median :0.9003
           Mean   :162.6   Mean   :1   Mean   :18   Mean   :162.6   Mean   :0.9003
           3rd Qu.:162.6   3rd Qu.:1   3rd Qu.:18   3rd Qu.:162.6   3rd Qu.:0.9003
           Max.   :162.6   Max.   :1   Max.   :18   Max.   :162.6   Max.   :0.9003
    upper.CL         lower.CL
 Min.   :0.9541   Min.   :0.8252
 1st Qu.:0.9541   1st Qu.:0.8252
 Median :0.9541   Median :0.8252
 Mean   :0.9541   Mean   :0.8252
 3rd Qu.:0.9541   3rd Qu.:0.8252
 Max.   :0.9541   Max.   :0.8252
   Effect        F               v1          v2            ncp             Rsq
 Model:1   Min.   :915.3   Min.   :1   Min.   :10.24   Min.   :915.3   Min.   :0.9889
           1st Qu.:915.3   1st Qu.:1   1st Qu.:10.24   1st Qu.:915.3   1st Qu.:0.9889
           Median :915.3   Median :1   Median :10.24   Median :915.3   Median :0.9889
           Mean   :915.3   Mean   :1   Mean   :10.24   Mean   :915.3   Mean   :0.9889
           3rd Qu.:915.3   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:915.3   3rd Qu.:0.9889
           Max.   :915.3   Max.   :1   Max.   :10.24   Max.   :915.3   Max.   :0.9889
    upper.CL         lower.CL
 Min.   :0.9963   Min.   :0.9775
 1st Qu.:0.9963   1st Qu.:0.9775
 Median :0.9963   Median :0.9775
 Mean   :0.9963   Mean   :0.9775
 3rd Qu.:0.9963   3rd Qu.:0.9775
 Max.   :0.9963   Max.   :0.9775
================================================================================
================================================================================
Model 1b: log(fmax) ~ exo
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
```

```
       AIC      BIC    logLik
  18.12153 21.89929 -5.060765

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.3394365 0.3400382

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept) 1.6688690 0.9993473 12 1.6699590  0.1208
cofactor    0.1446179 0.1900393 12 0.7609894  0.4614
 Correlation:
         (Intr)
cofactor 0.986

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.8808224 -0.3494617 -0.1224661  0.6225276  0.9803464

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1664261 -1.272207 greater   0.93

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2229836 -1.210614 greater  0.918

--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -23.18127

$logL0
[1] -23.18096

$P
```

```
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.3929312

$P
[1] 0.889

--------------------------------------------------------------------------------


R2 hypothesis testing


--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :0.673   Min.   :1   Min.   :18   Min.   :0.673   Min.   :0.03604
           1st Qu.:0.673   1st Qu.:1   1st Qu.:18   1st Qu.:0.673   1st Qu.:0.03604
           Median :0.673   Median :1   Median :18   Median :0.673   Median :0.03604
           Mean   :0.673   Mean   :1   Mean   :18   Mean   :0.673   Mean   :0.03604
           3rd Qu.:0.673   3rd Qu.:1   3rd Qu.:18   3rd Qu.:0.673   3rd Qu.:0.03604
           Max.   :0.673   Max.   :1   Max.   :18   Max.   :0.673   Max.   :0.03604
    upper.CL         lower.CL
 Min.   :0.3415   Min.   :0.0001099
 1st Qu.:0.3415   1st Qu.:0.0001099
 Median :0.3415   Median :0.0001099
 Mean   :0.3415   Mean   :0.0001099
 3rd Qu.:0.3415   3rd Qu.:0.0001099
 Max.   :0.3415   Max.   :0.0001099
   Effect        F               v1          v2             ncp             Rsq
 Model:1   Min.   :3.597   Min.   :1   Min.   :10.24   Min.   :3.597   Min.   :0.26
           1st Qu.:3.597   1st Qu.:1   1st Qu.:10.24   1st Qu.:3.597   1st Qu.:0.26
           Median :3.597   Median :1   Median :10.24   Median :3.597   Median :0.26
           Mean   :3.597   Mean   :1   Mean   :10.24   Mean   :3.597   Mean   :0.26
           3rd Qu.:3.597   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:3.597   3rd Qu.:0.26
           Max.   :3.597   Max.   :1   Max.   :10.24   Max.   :3.597   Max.   :0.26
    upper.CL         lower.CL
 Min.   :0.6908   Min.   :0.00354
 1st Qu.:0.6908   1st Qu.:0.00354
 Median :0.6908   Median :0.00354
 Mean   :0.6908   Mean   :0.00354
 3rd Qu.:0.6908   3rd Qu.:0.00354
 Max.   :0.6908   Max.   :0.00354
================================================================================
================================================================================
Model 1c:log(uts) ~ log(ratio)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC   logLik
  3.002342 6.780098 2.498829

Random effects:
 Formula: ~1 | species
        (Intercept) Residual
StdDev:   0.1273762 0.264866

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF   t-value p-value
(Intercept)  4.346042 0.1691788 12 25.689045  0.0000
cofactor    -0.392986 0.1429984 12 -2.748183  0.0177
 Correlation:
```

```
         (Intr)
cofactor 0.881

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7211974 -0.6327484 -0.2639773  0.3271246  1.4433133

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1531006 -1.218296 greater  0.919

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2160349 -1.203095 greater  0.923

--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -24.74211

$logL0
[1] -24.74177

$P
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.3934738

$P
[1] 0.907

--------------------------------------------------------------------------------
```

```
R2 hypothesis testing


--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :15.59   Min.   :1   Min.   :18   Min.   :15.59   Min.   :0.4642
           1st Qu.:15.59   1st Qu.:1   1st Qu.:18   1st Qu.:15.59   1st Qu.:0.4642
           Median :15.59   Median :1   Median :18   Median :15.59   Median :0.4642
           Mean   :15.59   Mean   :1   Mean   :18   Mean   :15.59   Mean   :0.4642
           3rd Qu.:15.59   3rd Qu.:1   3rd Qu.:18   3rd Qu.:15.59   3rd Qu.:0.4642
           Max.   :15.59   Max.   :1   Max.   :18   Max.   :15.59   Max.   :0.4642
    upper.CL          lower.CL
 Min.   :0.7305   Min.   :0.1695
 1st Qu.:0.7305   1st Qu.:0.1695
 Median :0.7305   Median :0.1695
 Mean   :0.7305   Mean   :0.1695
 3rd Qu.:0.7305   3rd Qu.:0.1695
 Max.   :0.7305   Max.   :0.1695
   Effect        F               v1          v2             ncp             Rsq
 Model:1   Min.   :20.42   Min.   :1   Min.   :10.24   Min.   :20.42   Min.   :0.6661
           1st Qu.:20.42   1st Qu.:1   1st Qu.:10.24   1st Qu.:20.42   1st Qu.:0.6661
           Median :20.42   Median :1   Median :10.24   Median :20.42   Median :0.6661
           Mean   :20.42   Mean   :1   Mean   :10.24   Mean   :20.42   Mean   :0.6661
           3rd Qu.:20.42   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:20.42   3rd Qu.:0.6661
           Max.   :20.42   Max.   :1   Max.   :10.24   Max.   :20.42   Max.   :0.6661
    upper.CL          lower.CL
 Min.   :0.8831   Min.   :0.3522
 1st Qu.:0.8831   1st Qu.:0.3522
 Median :0.8831   Median :0.3522
 Mean   :0.8831   Mean   :0.3522
 3rd Qu.:0.8831   3rd Qu.:0.3522
 Max.   :0.8831   Max.   :0.3522
================================================================================
================================================================================
Model 2a: log(ufs) ~ log(Etanl)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
        AIC      BIC   logLik
  -2.418591 1.359165 5.209295

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:  0.02805075 0.2522209

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF    t-value p-value
(Intercept)  4.266436 0.5865901 12   7.273284       0
cofactor    -0.965919 0.0878050 12 -11.000734       0
 Correlation:
         (Intr)
cofactor -0.995

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.7031611 -0.4646712 -0.1828606  0.4454772  1.7546710

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
```

```
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test         Obs    Std.Obs   Alter Pvalue
1   dt -0.03886482 -0.2793617 greater  0.543

------------------------------------------------------------------------------


Moran's I


------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs    Std.Obs   Alter Pvalue
1   dt -0.0993468 -0.3468022 greater  0.572

------------------------------------------------------------------------------


Pagel's lambda


------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -26.76534

$logL0
[1] -26.76506

$P
[1] 1

------------------------------------------------------------------------------


Blomberg's kappa


------------------------------------------------------------------------------
$K
[1] 0.4345257

$P
[1] 0.609

------------------------------------------------------------------------------


R2 hypothesis testing


------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :334.2   Min.   :1   Min.   :18   Min.   :334.2   Min.   :0.9489
           1st Qu.:334.2   1st Qu.:1   1st Qu.:18   1st Qu.:334.2   1st Qu.:0.9489
           Median :334.2   Median :1   Median :18   Median :334.2   Median :0.9489
           Mean   :334.2   Mean   :1   Mean   :18   Mean   :334.2   Mean   :0.9489
           3rd Qu.:334.2   3rd Qu.:1   3rd Qu.:18   3rd Qu.:334.2   3rd Qu.:0.9489
           Max.   :334.2   Max.   :1   Max.   :18   Max.   :334.2   Max.   :0.9489
    upper.CL         lower.CL
 Min.   :0.9766   Min.   :0.9103
 1st Qu.:0.9766   1st Qu.:0.9103
 Median :0.9766   Median :0.9103
 Mean   :0.9766   Mean   :0.9103
```

```
 3rd Qu.:0.9766   3rd Qu.:0.9103
 Max.   :0.9766   Max.   :0.9103
   Effect        F             v1          v2             ncp           Rsq
 Model:1   Min.   :802   Min.   :1   Min.   :10.24   Min.   :802   Min.   :0.9874
           1st Qu.:802   1st Qu.:1   1st Qu.:10.24   1st Qu.:802   1st Qu.:0.9874
           Median :802   Median :1   Median :10.24   Median :802   Median :0.9874
           Mean   :802   Mean   :1   Mean   :10.24   Mean   :802   Mean   :0.9874
           3rd Qu.:802   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:802   3rd Qu.:0.9874
           Max.   :802   Max.   :1   Max.   :10.24   Max.   :802   Max.   :0.9874
    upper.CL         lower.CL
 Min.   :0.9958   Min.   :0.9743
 1st Qu.:0.9958   1st Qu.:0.9743
 Median :0.9958   Median :0.9743
 Mean   :0.9958   Mean   :0.9743
 3rd Qu.:0.9958   3rd Qu.:0.9743
 Max.   :0.9958   Max.   :0.9743
================================================================================
================================================================================
Model 2b: log(ufs) ~ log(Esec)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC     logLik
  9.986502 13.76426 -0.9932511

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.1548211 0.3176725

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept)  4.747137 1.0914751 12  4.349285   9e-04
cofactor    -0.998803 0.1565428 12 -6.380379   0e+00
 Correlation:
         (Intr)
cofactor -0.996

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.62993737 -0.68552313 -0.03623807  0.34605877  1.30483948

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs  Std.Obs   Alter Pvalue
1   dt -0.1767016 -1.40783 greater  0.961

--------------------------------------------------------------------------------


Moran's I

```

```
--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2398086 -1.304939 greater  0.935

--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -23.44496

$logL0
[1] -23.44459

$P
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.3841912

$P
[1] 0.945

--------------------------------------------------------------------------------


R2 hypothesis testing


--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :95.93   Min.   :1   Min.   :18   Min.   :95.93   Min.   :0.842
           1st Qu.:95.93   1st Qu.:1   1st Qu.:18   1st Qu.:95.93   1st Qu.:0.842
           Median :95.93   Median :1   Median :18   Median :95.93   Median :0.842
           Mean   :95.93   Mean   :1   Mean   :18   Mean   :95.93   Mean   :0.842
           3rd Qu.:95.93   3rd Qu.:1   3rd Qu.:18   3rd Qu.:95.93   3rd Qu.:0.842
           Max.   :95.93   Max.   :1   Max.   :18   Max.   :95.93   Max.   :0.842
    upper.CL         lower.CL
 Min.   :0.9267   Min.   :0.7239
 1st Qu.:0.9267   1st Qu.:0.7239
 Median :0.9267   Median :0.7239
 Mean   :0.9267   Mean   :0.7239
 3rd Qu.:0.9267   3rd Qu.:0.7239
 Max.   :0.9267   Max.   :0.7239
   Effect        F               v1          v2            ncp             Rsq
 Model:1   Min.   :125.9   Min.   :1   Min.   :10.24   Min.   :125.9   Min.   :0.9248
           1st Qu.:125.9   1st Qu.:1   1st Qu.:10.24   1st Qu.:125.9   1st Qu.:0.9248
           Median :125.9   Median :1   Median :10.24   Median :125.9   Median :0.9248
           Mean   :125.9   Mean   :1   Mean   :10.24   Mean   :125.9   Mean   :0.9248
           3rd Qu.:125.9   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:125.9   3rd Qu.:0.9248
           Max.   :125.9   Max.   :1   Max.   :10.24   Max.   :125.9   Max.   :0.9248
    upper.CL        lower.CL
 Min.   :0.975   Min.   :0.8464
 1st Qu.:0.975   1st Qu.:0.8464
 Median :0.975   Median :0.8464
 Mean   :0.975   Mean   :0.8464
 3rd Qu.:0.975   3rd Qu.:0.8464
 Max.   :0.975   Max.   :0.8464
================================================================================
```

```
================================================================================
Model 2a: log(U) ~ log(Etanl)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  25.04395 28.82171 -8.521976

Random effects:
 Formula: ~1 | species
         (Intercept)  Residual
StdDev: 2.617516e-05 0.5234637

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept)  8.777962 1.1989234 12  7.321537   0e+00
cofactor    -1.044415 0.1795643 12 -5.816384   1e-04
 Correlation:
         (Intr)
cofactor -0.995

Standardized Within-Group Residuals:
       Min          Q1         Med          Q3         Max
-1.4767651 -0.6639426 -0.2856563  0.3301078  1.8975712

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test          Obs    Std.Obs   Alter Pvalue
1   dt -0.05868724 -0.4851516 greater  0.639

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test         Obs    Std.Obs   Alter Pvalue
1   dt -0.1194571 -0.4284498 greater  0.613

--------------------------------------------------------------------------------


Pagel's lambda
```

```
--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -26.54778

$logL0
[1] -26.5475

$P
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.4259599

$P
[1] 0.679

--------------------------------------------------------------------------------


R2 hypothesis testing


--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.    :95.28   Min.    :1   Min.    :18   Min.    :95.28   Min.    :0.8411
           1st Qu.:95.28   1st Qu.:1   1st Qu.:18   1st Qu.:95.28   1st Qu.:0.8411
           Median :95.28   Median :1   Median :18   Median :95.28   Median :0.8411
           Mean   :95.28   Mean   :1   Mean   :18   Mean   :95.28   Mean   :0.8411
           3rd Qu.:95.28   3rd Qu.:1   3rd Qu.:18   3rd Qu.:95.28   3rd Qu.:0.8411
           Max.   :95.28   Max.   :1   Max.   :18   Max.   :95.28   Max.   :0.8411
    upper.CL         lower.CL
 Min.   :0.9263   Min.   :0.7224
 1st Qu.:0.9263   1st Qu.:0.7224
 Median :0.9263   Median :0.7224
 Mean   :0.9263   Mean   :0.7224
 3rd Qu.:0.9263   3rd Qu.:0.7224
 Max.   :0.9263   Max.   :0.7224
   Effect        F                v1          v2             ncp
 Model:1   Min.    :134015   Min.    :1   Min.    :10.24   Min.    :134015
           1st Qu.:134015   1st Qu.:1   1st Qu.:10.24   1st Qu.:134015
           Median :134015   Median :1   Median :10.24   Median :134015
           Mean   :134015   Mean   :1   Mean   :10.24   Mean   :134015
           3rd Qu.:134015   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:134015
           Max.   :134015   Max.   :1   Max.   :10.24   Max.   :134015
     Rsq            upper.CL    lower.CL
 Min.   :0.9999   Min.   :1   Min.   :0.9998
 1st Qu.:0.9999   1st Qu.:1   1st Qu.:0.9998
 Median :0.9999   Median :1   Median :0.9998
 Mean   :0.9999   Mean   :1   Mean   :0.9998
 3rd Qu.:0.9999   3rd Qu.:1   3rd Qu.:0.9998
 Max.   :0.9999   Max.   :1   Max.   :0.9998
================================================================================
================================================================================
Model 2b: log(U) ~ log(Esec)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  32.16724 35.94499 -12.08362

Random effects:
```

```
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.2284927 0.5868126

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
                Value Std.Error DF   t-value p-value
(Intercept)  8.651421 1.9158831 12  4.515631  0.0007
cofactor    -0.986726 0.2751413 12 -3.586251  0.0037
 Correlation:
         (Intr)
cofactor -0.996

Standardized Within-Group Residuals:
       Min         Q1        Med         Q3        Max
-1.5349111 -0.6038602 -0.1151023  0.3642676  1.4312340

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1582943 -1.249247 greater  0.912

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2213866 -1.204019 greater  0.925

--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -24.19247

$logL0
[1] -24.19212

$P
[1] 1

--------------------------------------------------------------------------------
```

```
Blomberg's kappa


------------------------------------------------------------------------------
$K
[1] 0.390273

$P
[1] 0.931

------------------------------------------------------------------------------


R2 hypothesis testing


------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :33.37   Min.   :1   Min.   :18   Min.   :33.37   Min.   :0.6496
           1st Qu.:33.37   1st Qu.:1   1st Qu.:18   1st Qu.:33.37   1st Qu.:0.6496
           Median :33.37   Median :1   Median :18   Median :33.37   Median :0.6496
           Mean   :33.37   Mean   :1   Mean   :18   Mean   :33.37   Mean   :0.6496
           3rd Qu.:33.37   3rd Qu.:1   3rd Qu.:18   3rd Qu.:33.37   3rd Qu.:0.6496
           Max.   :33.37   Max.   :1   Max.   :18   Max.   :33.37   Max.   :0.6496
    upper.CL         lower.CL
 Min.   :0.8323   Min.   :0.4107
 1st Qu.:0.8323   1st Qu.:0.4107
 Median :0.8323   Median :0.4107
 Mean   :0.8323   Mean   :0.4107
 3rd Qu.:0.8323   3rd Qu.:0.4107
 Max.   :0.8323   Max.   :0.4107
   Effect        F              v1          v2             ncp             Rsq
 Model:1   Min.   :43.4   Min.   :1   Min.   :10.24   Min.   :43.4   Min.   :0.8092
           1st Qu.:43.4   1st Qu.:1   1st Qu.:10.24   1st Qu.:43.4   1st Qu.:0.8092
           Median :43.4   Median :1   Median :10.24   Median :43.4   Median :0.8092
           Mean   :43.4   Mean   :1   Mean   :10.24   Mean   :43.4   Mean   :0.8092
           3rd Qu.:43.4   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:43.4   3rd Qu.:0.8092
           Max.   :43.4   Max.   :1   Max.   :10.24   Max.   :43.4   Max.   :0.8092
    upper.CL         lower.CL
 Min.   :0.9353   Min.   :0.6137
 1st Qu.:0.9353   1st Qu.:0.6137
 Median :0.9353   Median :0.6137
 Mean   :0.9353   Mean   :0.6137
 3rd Qu.:0.9353   3rd Qu.:0.6137
 Max.   :0.9353   Max.   :0.6137
==============================================================================
==============================================================================
Model 3a: log(Etanl) ~ log(length)
==============================================================================
==============================================================================
------------------------------------------------------------------------------


Redundant readout of chosen model, see above


------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC     BIC    logLik
  29.05284 32.8306 -10.52642

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.4208043 0.4641961

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept) 5.21384 0.9346700 12 5.578268  0.0001
cofactor    0.84298 0.5160489 12 1.633527  0.1283
 Correlation:
         (Intr)
cofactor -0.975

Standardized Within-Group Residuals:
```

```
        Min          Q1         Med          Q3         Max
-1.56461685 -0.50594577 -0.08848169  0.14488667  2.26842990

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1366435 -1.359744 greater  0.941

--------------------------------------------------------------------------------


Moran's I


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.2013167 -1.449279 greater  0.954

--------------------------------------------------------------------------------


Pagel's lambda


--------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -30.19343

$logL0
[1] -30.19304

$P
[1] 1

--------------------------------------------------------------------------------


Blomberg's kappa


--------------------------------------------------------------------------------
$K
[1] 0.3732806

$P
[1] 0.992

--------------------------------------------------------------------------------


R2 hypothesis testing


```

```
--------------------------------------------------------------------------------
   Effect        F               v1          v2          ncp             Rsq
 Model:1   Min.   :8.686   Min.   :1   Min.   :18   Min.   :8.686   Min.   :0.3255
           1st Qu.:8.686   1st Qu.:1   1st Qu.:18   1st Qu.:8.686   1st Qu.:0.3255
           Median :8.686   Median :1   Median :18   Median :8.686   Median :0.3255
           Mean   :8.686   Mean   :1   Mean   :18   Mean   :8.686   Mean   :0.3255
           3rd Qu.:8.686   3rd Qu.:1   3rd Qu.:18   3rd Qu.:8.686   3rd Qu.:0.3255
           Max.   :8.686   Max.   :1   Max.   :18   Max.   :8.686   Max.   :0.3255
    upper.CL          lower.CL
 Min.   :0.6417   Min.   :0.05026
 1st Qu.:0.6417   1st Qu.:0.05026
 Median :0.6417   Median :0.05026
 Mean   :0.6417   Mean   :0.05026
 3rd Qu.:0.6417   3rd Qu.:0.05026
 Max.   :0.6417   Max.   :0.05026
   Effect        F               v1          v2             ncp             Rsq
 Model:1   Min.   :12.28   Min.   :1   Min.   :10.24   Min.   :12.28   Min.   :0.5453
           1st Qu.:12.28   1st Qu.:1   1st Qu.:10.24   1st Qu.:12.28   1st Qu.:0.5453
           Median :12.28   Median :1   Median :10.24   Median :12.28   Median :0.5453
           Mean   :12.28   Mean   :1   Mean   :10.24   Mean   :12.28   Mean   :0.5453
           3rd Qu.:12.28   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:12.28   3rd Qu.:0.5453
           Max.   :12.28   Max.   :1   Max.   :10.24   Max.   :12.28   Max.   :0.5453
    upper.CL          lower.CL
 Min.   :0.8349   Min.   :0.1757
 1st Qu.:0.8349   1st Qu.:0.1757
 Median :0.8349   Median :0.1757
 Mean   :0.8349   Mean   :0.1757
 3rd Qu.:0.8349   3rd Qu.:0.1757
 Max.   :0.8349   Max.   :0.1757
================================================================================
================================================================================
Model 3b: log(Esec) ~ log(length)
================================================================================
================================================================================
--------------------------------------------------------------------------------


Redundant readout of chosen model, see above


--------------------------------------------------------------------------------
Linear mixed-effects model fit by maximum likelihood
 Data: raw.data
       AIC      BIC    logLik
  21.82962 25.60737 -6.914808

Random effects:
 Formula: ~1 | species
        (Intercept)  Residual
StdDev:   0.2997113 0.4010905

Correlation Structure: corBrownian
 Formula: ~1 | species
 Parameter estimate(s):
numeric(0)
Fixed effects: phenotype ~ cofactor
               Value Std.Error DF  t-value p-value
(Intercept) 5.636584 0.7250005 12 7.774593  0.0000
cofactor    0.749311 0.4014293 12 1.866607  0.0866
 Correlation:
         (Intr)
cofactor -0.976

Standardized Within-Group Residuals:
        Min          Q1         Med          Q3         Max
-1.18046327 -0.36667996 -0.15086541 -0.05279163  2.36567818

Number of Observations: 19
Number of Groups: 6
--------------------------------------------------------------------------------


Abouheif's Cmean


--------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

```

```
Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs   Std.Obs   Alter Pvalue
1   dt -0.1302653 -1.340364 greater  0.952

------------------------------------------------------------------------------


Moran's I


------------------------------------------------------------------------------
class: krandtest lightkrandtest
Monte-Carlo tests
Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
    obs = res$obs, alter = alter, names = test.names)

Number of tests:   1

Adjustment method for multiple comparisons:   none
Permutation number:   999
  Test        Obs  Std.Obs   Alter Pvalue
1   dt -0.1950242 -1.31925 greater  0.951

------------------------------------------------------------------------------


Pagel's lambda


------------------------------------------------------------------------------
$lambda
[1] 6.610696e-05

$logL
[1] -30.70119

$logL0
[1] -30.70082

$P
[1] 1

------------------------------------------------------------------------------


Blomberg's kappa


------------------------------------------------------------------------------
$K
[1] 0.3765127

$P
[1] 0.994

------------------------------------------------------------------------------


R2 hypothesis testing


------------------------------------------------------------------------------
   Effect        F              v1          v2          ncp            Rsq
 Model:1   Min.   :12.2   Min.   :1   Min.   :18   Min.   :12.2   Min.   :0.4041
           1st Qu.:12.2   1st Qu.:1   1st Qu.:18   1st Qu.:12.2   1st Qu.:0.4041
           Median :12.2   Median :1   Median :18   Median :12.2   Median :0.4041
           Mean   :12.2   Mean   :1   Mean   :18   Mean   :12.2   Mean   :0.4041
           3rd Qu.:12.2   3rd Qu.:1   3rd Qu.:18   3rd Qu.:12.2   3rd Qu.:0.4041
           Max.   :12.2   Max.   :1   Max.   :18   Max.   :12.2   Max.   :0.4041
    upper.CL         lower.CL
 Min.   :0.6938   Min.   :0.1103
 1st Qu.:0.6938   1st Qu.:0.1103
 Median :0.6938   Median :0.1103
 Mean   :0.6938   Mean   :0.1103
 3rd Qu.:0.6938   3rd Qu.:0.1103
 Max.   :0.6938   Max.   :0.1103
   Effect        F              v1          v2            ncp            Rsq
 Model:1   Min.   :81.51   Min.   :1   Min.   :10.24   Min.   :81.51   Min.   :0.8884
```

```
           1st Qu.:81.51   1st Qu.:1   1st Qu.:10.24   1st Qu.:81.51   1st Qu.:0.8884
           Median :81.51   Median :1   Median :10.24   Median :81.51   Median :0.8884
           Mean   :81.51   Mean   :1   Mean   :10.24   Mean   :81.51   Mean   :0.8884
           3rd Qu.:81.51   3rd Qu.:1   3rd Qu.:10.24   3rd Qu.:81.51   3rd Qu.:0.8884
           Max.   :81.51   Max.   :1   Max.   :10.24   Max.   :81.51   Max.   :0.8884
    upper.CL         lower.CL
 Min.   :0.9627   Min.   :0.7723
 1st Qu.:0.9627   1st Qu.:0.7723
 Median :0.9627   Median :0.7723
 Mean   :0.9627   Mean   :0.7723
 3rd Qu.:0.9627   3rd Qu.:0.7723
 Max.   :0.9627   Max.   :0.7723
```

R code 1.1: Output