

# 1 R Output - Phylogenetic Regression

## R code 1.1: Output

```
1 [1] "PHYLOGENETIC REGRESSION OUTPUT"
2 =====
3 =====
4 Comparison 1a: fmax vs. endo
5 =====
6 =====
7 -----
8
9
10 No transformation of variables
11
12
13 -----
14 Linear mixed-effects model fit by maximum likelihood
15 Data: raw.data
16      AIC      BIC    logLik
17  48.304  52.08176  -20.152
18
19 Random effects:
20 Formula: ~1 | species
21      (Intercept)  Residual
22 StdDev:  1.47222e-05  0.6988585
23
24 Fixed effects: phenotype ~ cofactor
25              Value Std.Error DF   t-value p-value
26 (Intercept)  -0.69401   0.484474 12  -1.432500  0.1775
27 cofactor     204.67365  27.443213 12   7.458079  0.0000
28 Correlation:
29      (Intr)
30 cofactor -0.937
31
32 Standardized Within-Group Residuals:
33      Min      Q1      Med      Q3      Max
34 -1.5631828 -0.4547487 -0.3134237  0.1820794  2.8729745
35
36 Number of Observations: 19
37 Number of Groups: 6
38      numDF denDF    F-value p-value
39 (Intercept)    1    12 252.03527  <.0001
40 cofactor       1    12  55.62294  <.0001
41 Levene's Test for Homogeneity of Variance (center = median)
42      Df F value Pr(>F)
43 group  5  2.3348 0.1013
44      13
45
46 Shapiro-Wilk normality test
47
48 data: residuals(simple.model, type = "normalized")
49 W = 0.86287, p-value = 0.01094
50
51      Effect    Rsq upper.CL lower.CL
52 1      Model 0.859    0.952    0.712
53 2 cofactor 0.859    0.952    0.712
54 Linear mixed-effects model fit by maximum likelihood
55 Data: raw.data
56      AIC      BIC    logLik
57  46.49261  50.27037  -19.24631
58
59 Random effects:
60 Formula: ~1 | species
61      (Intercept)  Residual
62 StdDev:   0.3346582  0.8549784
63
64 Correlation Structure: corBrownian
65 Formula: ~1 | species
66 Parameter estimate(s):
67 numeric(0)
68 Fixed effects: phenotype ~ cofactor
69              Value Std.Error DF   t-value p-value
70 (Intercept)  -0.60848   0.67523 12  -0.901154  0.3852
71 cofactor     209.23572  38.30416 12   5.462480  0.0001
72 Correlation:
73      (Intr)
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74 cofactor -0.936
75
76 Standardized Within-Group Residuals:
77      Min      Q1      Med      Q3      Max
78 -1.27751384 -0.48680663 -0.23909253  0.07758264  1.62808300
79
80 Number of Observations: 19
81 Number of Groups: 6
82      numDF denDF  F-value p-value
83 (Intercept)      1      12 144.36488 <.0001
84 cofactor          1      12  29.83869 1e-04
85 Levene's Test for Homogeneity of Variance (center = median)
86      Df F value Pr(>F)
87 group    5    2.237 0.1125
88      13
89
90 Shapiro-Wilk normality test
91
92 data: residuals(simple.brownian, type = "normalized")
93 W = 0.92528, p-value = 0.1417
94
95      Effect      Rsq upper.CL lower.CL
96 1      Model 0.933    0.978    0.862
97 2 cofactor 0.933    0.978    0.862
98 $d
99 [1] -0.07391626
100
101 $ci
102 [1] -0.15497447 -0.02182315
103
104 $p
105 [1] 5e-04
106
107 -----
108
109 Natural log transformation of independent variable
110
111 -----
112
113 Linear mixed-effects model fit by maximum likelihood
114 Data: raw.data
115      AIC      BIC      logLik
116 9.304364 13.08212 -0.6521818
117
118 Random effects:
119 Formula: ~1 | species
120      (Intercept) Residual
121 StdDev: 1.880546e-06 0.2504206
122
123 Fixed effects: log(phenotype) ~ cofactor
124      Value Std.Error DF   t-value p-value
125 (Intercept) -0.19651  0.173601 12  -1.131970  0.2798
126 cofactor    64.51922  9.833675 12  6.561049  0.0000
127 Correlation:
128 (Intr)
129 cofactor -0.937
130
131 Standardized Within-Group Residuals:
132      Min      Q1      Med      Q3      Max
133 -1.59532233 -0.78561202 -0.00728833  0.35425967  2.46096554
134
135 Number of Observations: 19
136 Number of Groups: 6
137      numDF denDF  F-value p-value
138 (Intercept)      1      12 205.42599 <.0001
139 cofactor          1      12  43.04736 <.0001
140 Levene's Test for Homogeneity of Variance (center = median)
141      Df F value Pr(>F)
142 group    5    1.0314 0.4394
143      13
144
145 Shapiro-Wilk normality test
146
147 data: residuals(y.transformed, type = "normalized")
148 W = 0.95651, p-value = 0.5058
149
150      Effect      Rsq upper.CL lower.CL
151 1      Model 0.825    0.941    0.644
152 2 cofactor 0.825    0.941    0.644
153
154 Linear mixed-effects model fit by maximum likelihood

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155 Data: raw.data
156      AIC      BIC    logLik
157 4.849454 8.62721 1.575273
158
159 Random effects:
160 Formula: ~1 | species
161      (Intercept) Residual
162 StdDev: 0.1230478 0.2818893
163
164 Correlation Structure: corBrownian
165 Formula: ~1 | species
166 Parameter estimate(s):
167 numeric(0)
168 Fixed effects: log(phenotype) ~ cofactor
169      Value Std.Error DF t-value p-value
170 (Intercept) -0.12742 0.228645 12 -0.557279 0.5876
171 cofactor 63.85621 12.946157 12 4.932445 0.0003
172 Correlation:
173      (Intr)
174 cofactor -0.934
175
176 Standardized Within-Group Residuals:
177      Min      Q1      Med      Q3      Max
178 -1.3569143 -0.7514013 -0.1263181 0.2601205 1.3879102
179
180 Number of Observations: 19
181 Number of Groups: 6
182      numDF denDF F-value p-value
183 (Intercept) 1 12 128.83823 <.0001
184 cofactor 1 12 24.32901 3e-04
185 Levene's Test for Homogeneity of Variance (center = median)
186      Df F value Pr(>F)
187 group 5 0.5647 0.7257
188      13
189
190 Shapiro-Wilk normality test
191
192 data: residuals(y.brownian, type = "normalized")
193 W = 0.96527, p-value = 0.6794
194
195      Effect Rsq upper.CL lower.CL
196 1 Model 0.915 0.972 0.827
197 2 cofactor 0.915 0.972 0.827
198 $d
199 [1] -0.0907978
200
201 $ci
202 [1] -0.19543805 -0.02849268
203
204 $p
205 [1] 5e-04
206
207 -----
208
209 Natural log transformation of dependent variable
210
211 -----
212
213 Linear mixed-effects model fit by maximum likelihood
214 Data: raw.data
215      AIC      BIC    logLik
216 49.95519 53.73295 -20.9776
217
218 Random effects:
219 Formula: ~1 | species
220      (Intercept) Residual
221 StdDev: 1.41364e-05 0.7298951
222
223 Fixed effects: phenotype ~ log(cofactor)
224      Value Std.Error DF t-value p-value
225 (Intercept) 18.699576 2.280464 12 8.199899 0
226 log(cofactor) 3.849191 0.546669 12 7.041173 0
227 Correlation:
228      (Intr)
229 log(cofactor) 0.997
230
231 Standardized Within-Group Residuals:
232      Min      Q1      Med      Q3      Max
233 -1.7978797 -0.6493403 -0.1094924 0.4539460 2.4098949
234
235

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236 Number of Observations: 19
237 Number of Groups: 6
238      numDF denDF    F-value p-value
239 (Intercept)      1      12 231.05693 <.0001
240 log(cofactor)      1      12 49.57811 <.0001
241 Levene's Test for Homogeneity of Variance (center = median)
242      Df F value Pr(>F)
243 group      5  1.6972 0.2045
244      13
245
246      Shapiro-Wilk normality test
247
248 data: residuals(x.transformed, type = "normalized")
249 W = 0.96049, p-value = 0.5821
250
251      Effect    Rsq upper.CL lower.CL
252 1      Model 0.844    0.947    0.683
253 2 log(cofactor) 0.844    0.947    0.683
254 Linear mixed-effects model fit by maximum likelihood
255 Data: raw.data
256      AIC      BIC      logLik
257 46.14852 49.92627 -19.07426
258
259 Random effects:
260 Formula: ~1 | species
261      (Intercept) Residual
262 StdDev: 6.531427e-05 0.9121923
263
264 Correlation Structure: corBrownian
265 Formula: ~1 | species
266 Parameter estimate(s):
267 numeric(0)
268 Fixed effects: phenotype ~ log(cofactor)
269      Value Std.Error DF   t-value p-value
270 (Intercept) 20.166636 2.7680561 12  7.285487      0
271 log(cofactor) 4.170849 0.6654833 12  6.267398      0
272 Correlation:
273      (Intr)
274 log(cofactor) 0.997
275
276 Standardized Within-Group Residuals:
277      Min      Q1      Med      Q3      Max
278 -1.6010423 -0.6570865 -0.1916801  0.1478170  1.7149799
279
280 Number of Observations: 19
281 Number of Groups: 6
282      numDF denDF    F-value p-value
283 (Intercept)      1      12 207.12307 <.0001
284 log(cofactor)      1      12 39.28028 <.0001
285 Levene's Test for Homogeneity of Variance (center = median)
286      Df F value Pr(>F)
287 group      5  1.2595 0.3381
288      13
289
290      Shapiro-Wilk normality test
291
292 data: residuals(x.brownian, type = "normalized")
293 W = 0.96646, p-value = 0.7041
294
295      Effect Rsq upper.CL lower.CL
296 1      Model      1      1      1
297 2 log(cofactor)      1      1      1
298 $d
299 [1] -0.1558688
300
301 $ci
302 [1] -0.31380301 -0.05493487
303
304 $p
305 [1] 0
306
307 -----
308
309 Natural log transformation of both variables
310
311 -----
312
313 Linear mixed-effects model fit by maximum likelihood
314 Data: raw.data
315      AIC      BIC      logLik
316

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317 6.269717 10.04747 0.8651414
318
319 Random effects:
320 Formula: ~1 | species
321 (Intercept) Residual
322 StdDev: 4.330228e-07 0.2312
323
324 Fixed effects: log(phenotype) ~ log(cofactor)
325 Value Std.Error DF t-value p-value
326 (Intercept) 6.135496 0.7223549 12 8.493742 0
327 log(cofactor) 1.265934 0.1731617 12 7.310703 0
328 Correlation:
329 (Intr)
330 log(cofactor) 0.997
331
332 Standardized Within-Group Residuals:
333 Min Q1 Med Q3 Max
334 -2.0410211 -0.6670324 -0.2487904 0.3847870 2.2801485
335
336 Number of Observations: 19
337 Number of Groups: 6
338 numDF denDF F-value p-value
339 (Intercept) 1 12 241.00172 <.0001
340 log(cofactor) 1 12 53.44638 <.0001
341 Levene's Test for Homogeneity of Variance (center = median)
342 Df F value Pr(>F)
343 group 5 0.8055 0.5657
344 13
345
346 Shapiro-Wilk normality test
347
348 data: residuals(xy.transformed, type = "normalized")
349 W = 0.94321, p-value = 0.301
350
351 Effect Rsq upper.CL lower.CL
352 1 Model 0.854 0.951 0.702
353 2 log(cofactor) 0.854 0.951 0.702
354 Linear mixed-effects model fit by maximum likelihood
355 Data: raw.data
356 AIC BIC logLik
357 1.415069 5.192825 3.292466
358
359 Random effects:
360 Formula: ~1 | species
361 (Intercept) Residual
362 StdDev: 0.05787534 0.2740456
363
364 Correlation Structure: corBrownian
365 Formula: ~1 | species
366 Parameter estimate(s):
367 numeric(0)
368 Fixed effects: log(phenotype) ~ log(cofactor)
369 Value Std.Error DF t-value p-value
370 (Intercept) 6.464760 0.8801017 12 7.345469 0
371 log(cofactor) 1.333644 0.2114985 12 6.305691 0
372 Correlation:
373 (Intr)
374 log(cofactor) 0.997
375
376 Standardized Within-Group Residuals:
377 Min Q1 Med Q3 Max
378 -1.8313788 -0.6059318 -0.4628514 0.1919480 1.5309202
379
380 Number of Observations: 19
381 Number of Groups: 6
382 numDF denDF F-value p-value
383 (Intercept) 1 12 205.32862 <.0001
384 log(cofactor) 1 12 39.76175 <.0001
385 Levene's Test for Homogeneity of Variance (center = median)
386 Df F value Pr(>F)
387 group 5 0.9296 0.4931
388 13
389
390 Shapiro-Wilk normality test
391
392 data: residuals(xy.brownian, type = "normalized")
393 W = 0.95073, p-value = 0.4067
394
395 Effect Rsq upper.CL lower.CL
396 1 Model 0.989 0.996 0.977
397 2 log(cofactor) 0.989 0.996 0.977

```

```

398 $d
399 [1] -0.1352321
400
401 $ci
402 [1] -0.2817255 -0.0448665
403
404 $p
405 [1] 0
406
407 Likelihood ratio test
408
409 Model 1: phenotype ~ cofactor
410 Model 2: phenotype ~ log(cofactor)
411 Model 3: log(phenotype) ~ cofactor
412 Model 4: log(phenotype) ~ log(cofactor)
413 #Df LogLik Df Chisq Pr(>Chisq)
414 1 4 -19.2463
415 2 4 -19.0743 0 0.3441 < 2.2e-16 ***
416 3 4 1.5753 0 41.2991 < 2.2e-16 ***
417 4 4 3.2925 0 3.4344 < 2.2e-16 ***
418 ---
419 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
420 df AIC
421 simple.brownian 4 46.492611
422 x.brownian 4 46.148516
423 y.brownian 4 4.849454
424 xy.brownian 4 1.415069
425 =====
426 =====
427 Comparison 1b: fmax vs. exo
428 =====
429 =====
430 -----
431
432
433 No transformation of variables
434
435
436 -----
437 Linear mixed-effects model fit by maximum likelihood
438 Data: raw.data
439 AIC BIC logLik
440 63.57557 67.35333 -27.78779
441
442 Random effects:
443 Formula: ~1 | species
444 (Intercept) Residual
445 StdDev: 0.8685932 0.8342239
446
447 Fixed effects: phenotype ~ cofactor
448 Value Std.Error DF t-value p-value
449 (Intercept) 2.07256 0.51079 12 4.057550 0.0016
450 cofactor 103.20205 41.64541 12 2.478114 0.0291
451 Correlation:
452 (Intr)
453 cofactor -0.521
454
455 Standardized Within-Group Residuals:
456 Min Q1 Med Q3 Max
457 -1.5680120 -0.4978605 -0.1559111 0.3849042 2.1076104
458
459 Number of Observations: 19
460 Number of Groups: 6
461 numDF denDF F-value p-value
462 (Intercept) 1 12 39.30857 <.0001
463 cofactor 1 12 6.14105 0.0291
464 Levene's Test for Homogeneity of Variance (center = median)
465 Df F value Pr(>F)
466 group 5 2.0028 0.1452
467 13
468
469 Shapiro-Wilk normality test
470
471 data: residuals(simple.model, type = "normalized")
472 W = 0.94554, p-value = 0.3309
473
474 Effect Rsq upper.CL lower.CL
475 1 Model 0.335 0.735 0.014
476 2 cofactor 0.335 0.735 0.014
477 Linear mixed-effects model fit by maximum likelihood
478 Data: raw.data

```

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479      AIC      BIC      logLik
480      58.83548 62.61323 -25.41774
481
482 Random effects:
483 Formula: ~1 | species
484 (Intercept) Residual
485 StdDev:      1.005648 0.9878792
486
487 Correlation Structure: corBrownian
488 Formula: ~1 | species
489 Parameter estimate(s):
490 numeric(0)
491 Fixed effects: phenotype ~ cofactor
492 Value Std.Error DF t-value p-value
493 (Intercept) 2.17406 0.58257 12 3.731858 0.0029
494 cofactor 98.16527 49.02419 12 2.002384 0.0684
495 Correlation:
496 (Intr)
497 cofactor -0.552
498
499 Standardized Within-Group Residuals:
500 Min Q1 Med Q3 Max
501 -1.5373104 -0.3707125 -0.1589185 0.3578723 1.4948318
502
503 Number of Observations: 19
504 Number of Groups: 6
505 numDF denDF F-value p-value
506 (Intercept) 1 12 33.61175 0.0001
507 cofactor 1 12 4.00954 0.0684
508 Levene's Test for Homogeneity of Variance (center = median)
509 Df F value Pr(>F)
510 group 5 1.7887 0.1844
511 13
512
513 Shapiro-Wilk normality test
514
515 data: residuals(simple.brownian, type = "normalized")
516 W = 0.97362, p-value = 0.8458
517
518 Effect Rsq upper.CL lower.CL
519 1 Model 0.372 0.754 0.026
520 2 cofactor 0.372 0.754 0.026
521 $d
522 [1] -0.03639469
523
524 $ci
525 [1] -0.069084298 0.001431907
526
527 $p
528 [1] 0.022
529
530 -----
531
532
533 Natural log transformation of independent variable
534
535 -----
536
537 Linear mixed-effects model fit by maximum likelihood
538 Data: raw.data
539 AIC BIC logLik
540 24.3744 28.15216 -8.187201
541
542 Random effects:
543 Formula: ~1 | species
544 (Intercept) Residual
545 StdDev: 0.3036321 0.2990984
546
547 Fixed effects: log(phenotype) ~ cofactor
548 Value Std.Error DF t-value p-value
549 (Intercept) 0.759157 0.180514 12 4.205536 0.0012
550 cofactor 20.617830 14.911724 12 1.382659 0.1920
551 Correlation:
552 (Intr)
553 cofactor -0.528
554
555 Standardized Within-Group Residuals:
556 Min Q1 Med Q3 Max
557 -2.06801806 -0.37426269 -0.09008912 0.53497612 1.67140135
558
559 Number of Observations: 19

```

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560 Number of Groups: 6
561      numDF denDF  F-value p-value
562 (Intercept)      1      12 33.76569 0.0001
563 cofactor        1      12  1.91175 0.1920
564 Levene's Test for Homogeneity of Variance (center = median)
565      Df F value Pr(>F)
566 group    5  0.6402 0.6734
567      13
568
569      Shapiro-Wilk normality test
570
571 data: residuals(y.transformed, type = "normalized")
572 W = 0.98366, p-value = 0.9762
573
574      Effect      Rsq upper.CL lower.CL
575 1      Model 0.137      0.598      0.001
576 2 cofactor 0.137      0.598      0.001
577 Linear mixed-effects model fit by maximum likelihood
578 Data: raw.data
579      AIC      BIC      logLik
580 17.27526 21.05301 -4.637629
581
582 Random effects:
583 Formula: ~1 | species
584 (Intercept) Residual
585 StdDev:      0.3346907 0.3316403
586
587 Correlation Structure: corBrownian
588 Formula: ~1 | species
589 Parameter estimate(s):
590 numeric(0)
591 Fixed effects: log(phenotype) ~ cofactor
592      Value Std.Error DF  t-value p-value
593 (Intercept)  0.79237   0.194599 12  4.071807  0.0015
594 cofactor    19.27667  16.448798 12  1.171920  0.2640
595 Correlation:
596 (Intr)
597 cofactor -0.554
598
599 Standardized Within-Group Residuals:
600      Min      Q1      Med      Q3      Max
601 -1.8696489 -0.3152334 -0.1113084  0.4627267  1.1321901
602
603 Number of Observations: 19
604 Number of Groups: 6
605      numDF denDF  F-value p-value
606 (Intercept)      1      12 32.15243 0.0001
607 cofactor        1      12  1.37340 0.2640
608 Levene's Test for Homogeneity of Variance (center = median)
609      Df F value Pr(>F)
610 group    5  0.5405 0.7426
611      13
612
613      Shapiro-Wilk normality test
614
615 data: residuals(y.brownian, type = "normalized")
616 W = 0.9306, p-value = 0.1776
617
618      Effect      Rsq upper.CL lower.CL
619 1      Model 0.509      0.819      0.133
620 2 cofactor 0.509      0.819      0.133
621 $d
622 [1] -0.3717984
623
624 $ci
625 [1] -0.3797103 -0.1287814
626
627 $p
628 [1] 0
629
630 -----
631
632 Natural log transformation of dependent variable
633
634 -----
635
636 Linear mixed-effects model fit by maximum likelihood
637 Data: raw.data
638      AIC      BIC      logLik
639 65.58087 69.35863 -28.79044
640

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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

```

```

722 [1] -0.3908348
723
724 $ci
725 [1] -0.4413065 -0.1758217
726
727 $p
728 [1] 0
729
730 -----
731
732
733 Natural log transformation of both variables
734
735 -----
736
737 Linear mixed-effects model fit by maximum likelihood
738 Data: raw.data
739      AIC      BIC      logLik
740 25.39804 29.1758 -8.699021
741
742 Random effects:
743 Formula: ~1 | species
744      (Intercept)  Residual
745 StdDev:    0.3090393 0.3081185
746
747 Fixed effects: log(phenotype) ~ log(cofactor)
748              Value Std.Error DF   t-value p-value
749 (Intercept)  1.7724119 0.9264961 12  1.9130270  0.0799
750 log(cofactor) 0.1689497 0.1750016 12  0.9654181  0.3534
751 Correlation:
752              (Intr)
753 log(cofactor) 0.986
754
755 Standardized Within-Group Residuals:
756      Min      Q1      Med      Q3      Max
757 -2.0986505 -0.3851319 -0.1063804  0.7137330  1.6186842
758
759 Number of Observations: 19
760 Number of Groups: 6
761      numDF denDF  F-value p-value
762 (Intercept)      1      12 32.38886  0.0001
763 log(cofactor)      1      12  0.93203  0.3534
764 Levene's Test for Homogeneity of Variance (center = median)
765      Df F value Pr(>F)
766 group  5  0.6205  0.687
767      13
768
769 Shapiro-Wilk normality test
770
771 data: residuals(xy.transformed, type = "normalized")
772 W = 0.98072, p-value = 0.9504
773
774      Effect  Rsq upper.CL lower.CL
775 1      Model 0.078  0.535      0
776 2 log(cofactor) 0.078  0.535      0
777 Linear mixed-effects model fit by maximum likelihood
778 Data: raw.data
779      AIC      BIC      logLik
780 18.12153 21.89929 -5.060765
781
782 Random effects:
783 Formula: ~1 | species
784      (Intercept)  Residual
785 StdDev:    0.3394365 0.3400382
786
787 Correlation Structure: corBrownian
788 Formula: ~1 | species
789 Parameter estimate(s):
790 numeric(0)
791 Fixed effects: log(phenotype) ~ log(cofactor)
792              Value Std.Error DF   t-value p-value
793 (Intercept)  1.6688690 0.9993473 12  1.6699590  0.1208
794 log(cofactor) 0.1446179 0.1900393 12  0.7609894  0.4614
795 Correlation:
796              (Intr)
797 log(cofactor) 0.986
798
799 Standardized Within-Group Residuals:
800      Min      Q1      Med      Q3      Max
801 -1.8808224 -0.3494617 -0.1224661  0.6225276  0.9803464
802

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803 Number of Observations: 19
804 Number of Groups: 6
805      numDF denDF    F-value p-value
806 (Intercept)      1      12 31.124953 0.0001
807 log(cofactor)      1      12 0.579105 0.4614
808 Levene's Test for Homogeneity of Variance (center = median)
809      Df F value Pr(>F)
810 group    5 0.4872 0.78
811      13
812
813 Shapiro-Wilk normality test
814
815 data: residuals(xy.brownian, type = "normalized")
816 W = 0.92254, p-value = 0.1261
817
818      Effect Rsq upper.CL lower.CL
819 1      Model 0.26      0.691      0.004
820 2 log(cofactor) 0.26      0.691      0.004
821 $d
822 [1] -0.1825349
823
824 $ci
825 [1] -0.203174837 -0.002306132
826
827 $p
828 [1] 0
829
830 Likelihood ratio test
831
832 Model 1: phenotype ~ cofactor
833 Model 2: phenotype ~ log(cofactor)
834 Model 3: log(phenotype) ~ cofactor
835 Model 4: log(phenotype) ~ log(cofactor)
836 #Df LogLik Df Chisq Pr(>Chisq)
837 1 4 -25.4177
838 2 4 -26.2160 0 1.5965 < 2.2e-16 ***
839 3 4 -4.6376 0 43.1568 < 2.2e-16 ***
840 4 4 -5.0608 0 0.8463 < 2.2e-16 ***
841 ---
842 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
843 df AIC
844 simple.brownian 4 58.83548
845 x.brownian 4 60.43202
846 y.brownian 4 17.27526
847 xy.brownian 4 18.12153
848 =====
849 =====
850 Comparison 1c: uts vs. ratio
851 =====
852 =====
853 -----
854
855 No transformation of variables
856
857 -----
858
859 Linear mixed-effects model fit by maximum likelihood
860 Data: raw.data
861      AIC BIC logLik
862 194.0458 197.8235 -93.02289
863
864 Random effects:
865 Formula: ~1 | species
866 (Intercept) Residual
867 StdDev: 7.042817 31.63451
868
869 Fixed effects: phenotype ~ cofactor
870      Value Std.Error DF t-value p-value
871 (Intercept) 152.03812 17.34116 12 8.767469 0.0000
872 cofactor -92.10914 41.55221 12 -2.216708 0.0467
873
874 Correlation:
875 (Intr)
876 cofactor -0.877
877
878 Standardized Within-Group Residuals:
879      Min Q1 Med Q3 Max
880 -1.5405259 -0.5494926 -0.3351262 0.2717919 2.6697140
881
882 Number of Observations: 19
883 Number of Groups: 6

```

```

884          numDF denDF F-value p-value
885 (Intercept)      1    12 201.1767 <.0001
886 cofactor         1    12  4.9138  0.0467
887 Levene's Test for Homogeneity of Variance (center = median)
888   Df F value Pr(>F)
889 group  5  1.6676 0.2115
890      13
891
892 Shapiro-Wilk normality test
893
894 data: residuals(simple.model, type = "normalized")
895 W = 0.90022, p-value = 0.04911
896
897   Effect    Rsq upper.CL lower.CL
898 1   Model 0.342    0.739    0.016
899 2 cofactor 0.342    0.739    0.016
900 Linear mixed-effects model fit by maximum likelihood
901 Data: raw.data
902      AIC      BIC    logLik
903 190.5304 194.3082 -91.26522
904
905 Random effects:
906 Formula: ~1 | species
907 (Intercept) Residual
908 StdDev:    18.89843 36.39991
909
910 Correlation Structure: corBrownian
911 Formula: ~1 | species
912 Parameter estimate(s):
913 numeric(0)
914 Fixed effects: phenotype ~ cofactor
915              Value Std.Error DF   t-value p-value
916 (Intercept) 164.0498  21.10093 12   7.774532  0.0000
917 cofactor    -104.6264  44.78069 12  -2.336417  0.0376
918 Correlation:
919 (Intr)
920 cofactor -0.841
921
922 Standardized Within-Group Residuals:
923      Min      Q1      Med      Q3      Max
924 -1.2884595 -0.5371885 -0.2097447  0.1254340  1.4675818
925
926 Number of Observations: 19
927 Number of Groups: 6
928          numDF denDF F-value p-value
929 (Intercept)      1    12 115.02394 <.0001
930 cofactor         1    12  5.45884  0.0376
931 Levene's Test for Homogeneity of Variance (center = median)
932   Df F value Pr(>F)
933 group  5  1.533 0.2467
934      13
935
936 Shapiro-Wilk normality test
937
938 data: residuals(simple.brownian, type = "normalized")
939 W = 0.95778, p-value = 0.5295
940
941   Effect    Rsq upper.CL lower.CL
942 1   Model 0.576    0.847    0.215
943 2 cofactor 0.576    0.847    0.215
944 $d
945 [1] -0.2331407
946
947 $ci
948 [1] -0.28520145 -0.09514151
949
950 $p
951 [1] 0
952
953 -----
954
955 Natural log transformation of independent variable
956
957 -----
958
959 Linear mixed-effects model fit by maximum likelihood
960 Data: raw.data
961      AIC      BIC    logLik
962  8.428849 12.20661 -0.2144247
963
964

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```

965 Random effects:
966 Formula: ~1 | species
967 (Intercept) Residual
968 StdDev: 0.06725742 0.2361867
969
970 Fixed effects: log(phenotype) ~ cofactor
971 Value Std.Error DF t-value p-value
972 (Intercept) 5.035068 0.1317531 12 38.21593 0.0000
973 cofactor -0.828383 0.3116388 12 -2.65815 0.0209
974 Correlation:
975 (Intr)
976 cofactor -0.869
977
978 Standardized Within-Group Residuals:
979 Min Q1 Med Q3 Max
980 -1.8463467 -0.6455644 -0.2025454 0.3954217 2.2170884
981
982 Number of Observations: 19
983 Number of Groups: 6
984 numDF denDF F-value p-value
985 (Intercept) 1 12 5261.338 <.0001
986 cofactor 1 12 7.066 0.0209
987 Levene's Test for Homogeneity of Variance (center = median)
988 Df F value Pr(>F)
989 group 5 0.9534 0.4801
990 13
991
992 Shapiro-Wilk normality test
993
994 data: residuals(y.transformed, type = "normalized")
995 W = 0.96789, p-value = 0.7336
996
997 Effect Rsq upper.CL lower.CL
998 1 Model 0.424 0.78 0.056
999 2 cofactor 0.424 0.78 0.056
1000 Linear mixed-effects model fit by maximum likelihood
1001 Data: raw.data
1002 AIC BIC logLik
1003 2.810292 6.588048 2.594854
1004
1005 Random effects:
1006 Formula: ~1 | species
1007 (Intercept) Residual
1008 StdDev: 0.1301822 0.2622733
1009
1010 Correlation Structure: corBrownian
1011 Formula: ~1 | species
1012 Parameter estimate(s):
1013 numeric(0)
1014 Fixed effects: log(phenotype) ~ cofactor
1015 Value Std.Error DF t-value p-value
1016 (Intercept) 5.109458 0.1502024 12 34.01715 0.0000
1017 cofactor -0.895151 0.3204555 12 -2.79337 0.0162
1018 Correlation:
1019 (Intr)
1020 cofactor -0.844
1021
1022 Standardized Within-Group Residuals:
1023 Min Q1 Med Q3 Max
1024 -1.6278476 -0.6515780 -0.2232015 0.2460866 1.4129775
1025
1026 Number of Observations: 19
1027 Number of Groups: 6
1028 numDF denDF F-value p-value
1029 (Intercept) 1 12 3486.505 <.0001
1030 cofactor 1 12 7.803 0.0162
1031 Levene's Test for Homogeneity of Variance (center = median)
1032 Df F value Pr(>F)
1033 group 5 0.8493 0.5391
1034 13
1035
1036 Shapiro-Wilk normality test
1037
1038 data: residuals(y.brownian, type = "normalized")
1039 W = 0.97844, p-value = 0.9227
1040
1041 Effect Rsq upper.CL lower.CL
1042 1 Model 0.873 0.957 0.741
1043 2 cofactor 0.873 0.957 0.741
1044 $d
1045 [1] -0.4492521

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```

1046 $ci
1047 [1] -0.681241 -0.174659
1048
1049 $p
1050 [1] 0
1051
1052 -----
1053
1054 Natural log transformation of dependent variable
1055
1056 -----
1057
1058 Linear mixed-effects model fit by maximum likelihood
1059 Data: raw.data
1060      AIC      BIC      logLik
1061 194.0135 197.7913 -93.00677
1062
1063 Random effects:
1064 Formula: ~1 | species
1065 (Intercept) Residual
1066 StdDev: 0.02709782 32.33513
1067
1068 Fixed effects: phenotype ~ log(cofactor)
1069      Value Std.Error DF   t-value p-value
1070 (Intercept)  72.72636  22.15322 12   3.282879  0.0065
1071 log(cofactor) -40.70467  18.59877 12  -2.188568  0.0491
1072 Correlation:
1073 (Intr)
1074 log(cofactor) 0.935
1075
1076 Standardized Within-Group Residuals:
1077      Min      Q1      Med      Q3      Max
1078 -1.6589770 -0.6043978 -0.1484124  0.3139587  2.7581105
1079
1080 Number of Observations: 19
1081 Number of Groups: 6
1082
1083      numDF denDF   F-value p-value
1084 (Intercept)    1    12 226.66336 <.0001
1085 log(cofactor)    1    12  4.78983  0.0491
1086 Levene's Test for Homogeneity of Variance (center = median)
1087      Df F value Pr(>F)
1088 group  5  1.4771 0.2631
1089      13
1090
1091 Shapiro-Wilk normality test
1092
1093 data: residuals(x.transformed, type = "normalized")
1094 W = 0.90489, p-value = 0.05969
1095
1096      Effect    Rsq upper.CL lower.CL
1097 1      Model 0.343    0.74    0.016
1098 2 log(cofactor) 0.343    0.74    0.016
1099
1100 Linear mixed-effects model fit by maximum likelihood
1101 Data: raw.data
1102      AIC      BIC      logLik
1103 190.5585 194.3362 -91.27923
1104
1105 Random effects:
1106 Formula: ~1 | species
1107 (Intercept) Residual
1108 StdDev: 18.86352 36.44478
1109
1110 Correlation Structure: corBrownian
1111 Formula: ~1 | species
1112 Parameter estimate(s):
1113 numeric(0)
1114 Fixed effects: phenotype ~ log(cofactor)
1115      Value Std.Error DF   t-value p-value
1116 (Intercept)  74.44184  23.62761 12   3.150629  0.0084
1117 log(cofactor) -46.29474  19.87290 12  -2.329541  0.0381
1118 Correlation:
1119 (Intr)
1120 log(cofactor) 0.875
1121
1122 Standardized Within-Group Residuals:
1123      Min      Q1      Med      Q3      Max
1124 -1.3754723 -0.5145437 -0.2837832  0.1665598  1.4606935
1125
1126 Number of Observations: 19

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```

1127 Number of Groups: 6
1128      numDF denDF  F-value p-value
1129 (Intercept)      1    12 115.11139 <.0001
1130 log(cofactor)      1    12  5.42676  0.0381
1131 Levene's Test for Homogeneity of Variance (center = median)
1132      Df F value Pr(>F)
1133 group    5  1.3381 0.3088
1134      13
1135
1136 Shapiro-Wilk normality test
1137
1138 data: residuals(x.brownian, type = "normalized")
1139 W = 0.95637, p-value = 0.5032
1140
1141      Effect      Rsq upper.CL lower.CL
1142 1      Model 0.868      0.956      0.731
1143 2 log(cofactor) 0.868      0.956      0.731
1144 $d
1145 [1] -0.5245993
1146
1147 $ci
1148 [1] -0.7156531 -0.2106114
1149
1150 $p
1151 [1] 0
1152
1153 -----
1154
1155 Natural log transformation of both variables
1156
1157 -----
1158
1159 Linear mixed-effects model fit by maximum likelihood
1160 Data: raw.data
1161      AIC      BIC      logLik
1162 8.575684 12.35344 -0.2878421
1163
1164 Random effects:
1165 Formula: ~1 | species
1166      (Intercept) Residual
1167 StdDev:  0.03565122 0.2431368
1168
1169 Fixed effects: log(phenotype) ~ log(cofactor)
1170      Value Std.Error DF  t-value p-value
1171 (Intercept)  4.328228 0.1674943 12 25.841048  0.0000
1172 log(cofactor) -0.360636 0.1403007 12 -2.570451  0.0245
1173 Correlation:
1174      (Intr)
1175 log(cofactor) 0.931
1176
1177 Standardized Within-Group Residuals:
1178      Min      Q1      Med      Q3      Max
1179 -1.96721576 -0.64841399 -0.04926403  0.44828512  2.30131602
1180
1181 Number of Observations: 19
1182 Number of Groups: 6
1183      numDF denDF  F-value p-value
1184 (Intercept)      1    12 5955.627 <.0001
1185 log(cofactor)      1    12  6.607  0.0245
1186 Levene's Test for Homogeneity of Variance (center = median)
1187      Df F value Pr(>F)
1188 group    5  0.7229 0.6181
1189      13
1190
1191 Shapiro-Wilk normality test
1192
1193 data: residuals(xy.transformed, type = "normalized")
1194 W = 0.97352, p-value = 0.844
1195
1196      Effect      Rsq upper.CL lower.CL
1197 1      Model 0.416      0.776      0.05
1198 2 log(cofactor) 0.416      0.776      0.05
1199
1200 Linear mixed-effects model fit by maximum likelihood
1201 Data: raw.data
1202      AIC      BIC      logLik
1203 3.002342 6.780098 2.498829
1204
1205 Random effects:
1206 Formula: ~1 | species
1207      (Intercept) Residual

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1208 StdDev: 0.1273762 0.264866
1209
1210 Correlation Structure: corBrownian
1211 Formula: ~1 | species
1212 Parameter estimate(s):
1213 numeric(0)
1214 Fixed effects: log(phenotype) ~ log(cofactor)
1215 Value Std.Error DF t-value p-value
1216 (Intercept) 4.346042 0.1691788 12 25.689045 0.0000
1217 log(cofactor) -0.392986 0.1429984 12 -2.748183 0.0177
1218 Correlation:
1219 (Intr)
1220 log(cofactor) 0.881
1221
1222 Standardized Within-Group Residuals:
1223 Min Q1 Med Q3 Max
1224 -1.7211974 -0.6327484 -0.2639773 0.3271246 1.4433133
1225
1226 Number of Observations: 19
1227 Number of Groups: 6
1228 numDF denDF F-value p-value
1229 (Intercept) 1 12 3525.181 <.0001
1230 log(cofactor) 1 12 7.553 0.0177
1231 Levene's Test for Homogeneity of Variance (center = median)
1232 Df F value Pr(>F)
1233 group 5 0.7154 0.623
1234 13
1235
1236 Shapiro-Wilk normality test
1237
1238 data: residuals(xy.brownian, type = "normalized")
1239 W = 0.97472, p-value = 0.8653
1240
1241 Effect Rsq upper.CL lower.CL
1242 1 Model 0.666 0.883 0.352
1243 2 log(cofactor) 0.666 0.883 0.352
1244 $d
1245 [1] -0.2505032
1246
1247 $ci
1248 [1] -0.33698304 -0.09825795
1249
1250 $p
1251 [1] 0
1252
1253 Likelihood ratio test
1254
1255 Model 1: phenotype ~ cofactor
1256 Model 2: phenotype ~ log(cofactor)
1257 Model 3: log(phenotype) ~ cofactor
1258 Model 4: log(phenotype) ~ log(cofactor)
1259 #Df LogLik Df Chisq Pr(>Chisq)
1260 1 4 -91.265
1261 2 4 -91.279 0 0.028 < 2.2e-16 ***
1262 3 4 2.595 0 187.748 < 2.2e-16 ***
1263 4 4 2.499 0 0.192 < 2.2e-16 ***
1264 ---
1265 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
1266 df AIC
1267 simple.brownian 4 190.530446
1268 x.brownian 4 190.558463
1269 y.brownian 4 2.810292
1270 xy.brownian 4 3.002342
1271 =====
1272 Comparison 2a: ufs vs. Etanl
1273 =====
1274 =====
1275 -----
1276
1277
1278 No transformation of variables
1279
1280
1281
1282 -----
1283 Linear mixed-effects model fit by maximum likelihood
1284 Data: raw.data
1285 AIC BIC logLik
1286 -51.56084 -47.78308 29.78042
1287
1288 Random effects:

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1289 Formula: ~1 | species
1290 (Intercept) Residual
1291 StdDev: 0.02815979 0.04458408
1292
1293 Fixed effects: phenotype ~ cofactor
1294 Value Std.Error DF t-value p-value
1295 (Intercept) 0.2051013 0.02560626 12 8.009810 0.0000
1296 cofactor -0.0000783 0.00002071 12 -3.780517 0.0026
1297 Correlation:
1298 (Intr)
1299 cofactor -0.757
1300
1301 Standardized Within-Group Residuals:
1302 Min Q1 Med Q3 Max
1303 -0.77148088 -0.58123261 -0.29139007 0.09768854 2.77660161
1304
1305 Number of Observations: 19
1306 Number of Groups: 6
1307 numDF denDF F-value p-value
1308 (Intercept) 1 12 62.11110 <.0001
1309 cofactor 1 12 14.29231 0.0026
1310 Levene's Test for Homogeneity of Variance (center = median)
1311 Df F value Pr(>F)
1312 group 5 1.7548 0.1916
1313 13
1314
1315 Shapiro-Wilk normality test
1316
1317 data: residuals(simple.model, type = "normalized")
1318 W = 0.75473, p-value = 0.0002699
1319
1320 Effect Rsq upper.CL lower.CL
1321 1 Model 0.596 0.856 0.243
1322 2 cofactor 0.596 0.856 0.243
1323 Linear mixed-effects model fit by maximum likelihood
1324 Data: raw.data
1325 AIC BIC logLik
1326 -54.74435 -50.96659 31.37217
1327
1328 Random effects:
1329 Formula: ~1 | species
1330 (Intercept) Residual
1331 StdDev: 0.04460047 0.0517933
1332
1333 Correlation Structure: corBrownian
1334 Formula: ~1 | species
1335 Parameter estimate(s):
1336 numeric(0)
1337 Fixed effects: phenotype ~ cofactor
1338 Value Std.Error DF t-value p-value
1339 (Intercept) 0.21814616 0.03260680 12 6.690205 0.0000
1340 cofactor -0.00008203 0.00002356 12 -3.481655 0.0045
1341 Correlation:
1342 (Intr)
1343 cofactor -0.727
1344
1345 Standardized Within-Group Residuals:
1346 Min Q1 Med Q3 Max
1347 -1.37847567 -0.58544760 -0.20762764 0.02956975 1.52514653
1348
1349 Number of Observations: 19
1350 Number of Groups: 6
1351 numDF denDF F-value p-value
1352 (Intercept) 1 12 36.67848 0.0001
1353 cofactor 1 12 12.12192 0.0045
1354 Levene's Test for Homogeneity of Variance (center = median)
1355 Df F value Pr(>F)
1356 group 5 1.5067 0.2543
1357 13
1358
1359 Shapiro-Wilk normality test
1360
1361 data: residuals(simple.brownian, type = "normalized")
1362 W = 0.90829, p-value = 0.06888
1363
1364 Effect Rsq upper.CL lower.CL
1365 1 Model 0.692 0.893 0.395
1366 2 cofactor 0.692 0.893 0.395
1367 $d
1368 [1] -0.0959109
1369

```

```

1370 $sci
1371 [1] -0.18233666 -0.02384673
1372
1373 $p
1374 [1] 0.003
1375
1376 -----
1377
1378 Natural log transformation of independent variable
1379
1380 -----
1381
1382 Linear mixed-effects model fit by maximum likelihood
1383 Data: raw.data
1384      AIC      BIC      logLik
1385 12.38489 16.16265 -2.192445
1386
1387 Random effects:
1388 Formula: ~1 | species
1389      (Intercept) Residual
1390 StdDev:  0.07151349 0.2628217
1391
1392 Fixed effects: log(phenotype) ~ cofactor
1393      Value Std.Error DF   t-value p-value
1394 (Intercept) -1.4684205 0.12547924 12 -11.702497      0
1395 cofactor -0.0007727 0.00011331 12  -6.819404      0
1396 Correlation:
1397 (Intr)
1398 cofactor -0.82
1399
1400 Standardized Within-Group Residuals:
1401      Min      Q1      Med      Q3      Max
1402 -1.4499680 -0.6965377 -0.2328735  0.3747247  2.3455009
1403
1404 Number of Observations: 19
1405 Number of Groups: 6
1406      numDF denDF  F-value p-value
1407 (Intercept)    1    12 911.7196 <.0001
1408 cofactor      1    12  46.5043 <.0001
1409 Levene's Test for Homogeneity of Variance (center = median)
1410      Df F value Pr(>F)
1411 group  5  0.8735 0.5249
1412      13
1413
1414 Shapiro-Wilk normality test
1415
1416 data: residuals(y.transformed, type = "normalized")
1417 W = 0.90776, p-value = 0.06734
1418
1419 Effect    Rsq upper.CL lower.CL
1420 1 Model 0.834  0.944  0.663
1421 2 cofactor 0.834  0.944  0.663
1422
1423 Linear mixed-effects model fit by maximum likelihood
1424 Data: raw.data
1425      AIC      BIC      logLik
1426 6.191188 9.968944 0.9044059
1427
1428 Random effects:
1429 Formula: ~1 | species
1430      (Intercept) Residual
1431 StdDev:  0.1885115 0.2694933
1432
1433 Correlation Structure: corBrownian
1434 Formula: ~1 | species
1435 Parameter estimate(s):
1436 numeric(0)
1437 Fixed effects: log(phenotype) ~ cofactor
1438      Value Std.Error DF   t-value p-value
1439 (Intercept) -1.4157131 0.15350742 12 -9.222441      0
1440 cofactor -0.0007884 0.00011586 12  -6.804755      0
1441 Correlation:
1442 (Intr)
1443 cofactor -0.754
1444
1445 Standardized Within-Group Residuals:
1446      Min      Q1      Med      Q3      Max
1447 -1.0360812 -0.6804104 -0.1424531  0.2023267  1.6915638
1448
1449 Number of Observations: 19
1450 Number of Groups: 6

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1451          numDF denDF F-value p-value
1452 (Intercept)      1   12 478.1721 <.0001
1453 cofactor         1   12 46.3047 <.0001
1454 Levene's Test for Homogeneity of Variance (center = median)
1455      Df F value Pr(>F)
1456 group  5  0.7182 0.6212
1457      13
1458
1459      Shapiro-Wilk normality test
1460
1461 data: residuals(y.brownian, type = "normalized")
1462 W = 0.95698, p-value = 0.5144
1463
1464      Effect      Rsq upper.CL lower.CL
1465 1      Model 0.972      0.991      0.943
1466 2 cofactor 0.972      0.991      0.943
1467 $d
1468 [1] -0.1379773
1469
1470 $ci
1471 [1] -0.27431647 -0.04594893
1472
1473 $p
1474 [1] 0
1475
1476 -----
1477
1478 Natural log transformation of dependent variable
1479
1480 -----
1481
1482 Linear mixed-effects model fit by maximum likelihood
1483 Data: raw.data
1484      AIC      BIC      logLik
1485 -57.85369 -54.07594 32.92685
1486
1487 Random effects:
1488 Formula: ~1 | species
1489      (Intercept)      Residual
1490 StdDev: 2.001908e-06 0.04276948
1491
1492 Fixed effects: phenotype ~ log(cofactor)
1493      Value      Std.Error DF      t-value p-value
1494 (Intercept)  0.8052986 0.12410788 12  6.488699 0e+00
1495 log(cofactor) -0.1016204 0.01864817 12 -5.449347 1e-04
1496 Correlation:
1497      (Intr)
1498 log(cofactor) -0.997
1499
1500 Standardized Within-Group Residuals:
1501      Min      Q1      Med      Q3      Max
1502 -1.3205869 -0.5917912 -0.2349009  0.3380640  3.1187707
1503
1504 Number of Observations: 19
1505 Number of Groups: 6
1506
1507          numDF denDF F-value p-value
1508 (Intercept)      1   12 160.35949 <.0001
1509 log(cofactor)      1   12 29.69539 1e-04
1510 Levene's Test for Homogeneity of Variance (center = median)
1511      Df F value Pr(>F)
1512 group  5  3.3353 0.03713 *
1513      13
1514 ---
1515 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
1516
1517      Shapiro-Wilk normality test
1518
1519 data: residuals(x.transformed, type = "normalized")
1520 W = 0.87595, p-value = 0.01827
1521
1522      Effect      Rsq upper.CL lower.CL
1523 1      Model 0.764      0.919      0.527
1524 2 log(cofactor) 0.764      0.919      0.527
1525 Linear mixed-effects model fit by maximum likelihood
1526 Data: raw.data
1527      AIC      BIC      logLik
1528 -60.0769 -56.29914 34.03845
1529
1530 Random effects:
1531 Formula: ~1 | species

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1532      (Intercept)  Residual
1533 StdDev:  0.02913352 0.0485437
1534
1535 Correlation Structure: corBrownian
1536 Formula: ~1 | species
1537 Parameter estimate(s):
1538 numeric(0)
1539 Fixed effects: phenotype ~ log(cofactor)
1540               Value Std.Error DF   t-value p-value
1541 (Intercept)   0.8466590 0.14235429 12   5.947548   1e-04
1542 log(cofactor) -0.1060653 0.02113983 12  -5.017322   3e-04
1543 Correlation:
1544               (Intr)
1545 log(cofactor) -0.993
1546
1547 Standardized Within-Group Residuals:
1548      Min      Q1      Med      Q3      Max
1549 -1.2841949 -0.5921565 -0.2549534  0.2175715  1.4677682
1550
1551 Number of Observations: 19
1552 Number of Groups: 6
1553      numDF denDF  F-value p-value
1554 (Intercept)      1    12 69.11011  <.0001
1555 log(cofactor)      1    12 25.17352   3e-04
1556 Levene's Test for Homogeneity of Variance (center = median)
1557      Df F value  Pr(>F)
1558 group  5   2.763 0.06492 .
1559      13
1560 ---
1561 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1  1
1562
1563 Shapiro-Wilk normality test
1564
1565 data:  residuals(x.brownian, type = "normalized")
1566 W = 0.95557, p-value = 0.4886
1567
1568      Effect    Rsq upper.CL lower.CL
1569 1      Model 0.857   0.952   0.708
1570 2 log(cofactor) 0.857   0.952   0.708
1571 $d
1572 [1] -0.09245828
1573
1574 $ci
1575 [1] -0.1871376 -0.0277520
1576
1577 $p
1578 [1] 0.002
1579
1580 -----
1581
1582 Natural log transformation of both variables
1583
1584 -----
1585
1586 Linear mixed-effects model fit by maximum likelihood
1587 Data: raw.data
1588      AIC      BIC    logLik
1589 4.469895 8.247651 1.765053
1590
1591 Random effects:
1592 Formula: ~1 | species
1593      (Intercept)  Residual
1594 StdDev: 1.362137e-06 0.2205048
1595
1596 Fixed effects: log(phenotype) ~ log(cofactor)
1597               Value Std.Error DF   t-value p-value
1598 (Intercept)   3.546772 0.6398575 12   5.543065   1e-04
1599 log(cofactor) -0.861265 0.0961436 12  -8.958117   0e+00
1600 Correlation:
1601               (Intr)
1602 log(cofactor) -0.997
1603
1604 Standardized Within-Group Residuals:
1605      Min      Q1      Med      Q3      Max
1606 -1.55630426 -0.75893355  0.05923759  0.70968471  1.96768544
1607
1608 Number of Observations: 19
1609 Number of Groups: 6
1610      numDF denDF  F-value p-value
1611 (Intercept)      1    12 1638.9478  <.0001
1612

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1613 log(cofactor)      1      12      80.2479 <.0001
1614 Levene's Test for Homogeneity of Variance (center = median)
1615      Df F value Pr(>F)
1616 group    5  1.2147 0.3561
1617      13
1618
1619      Shapiro-Wilk normality test
1620
1621 data: residuals(xy.transformed, type = "normalized")
1622 W = 0.96483, p-value = 0.6703
1623
1624      Effect      Rsq upper.CL lower.CL
1625 1      Model 0.898      0.966      0.791
1626 2 log(cofactor) 0.898      0.966      0.791
1627 Linear mixed-effects model fit by maximum likelihood
1628 Data: raw.data
1629      AIC      BIC      logLik
1630 -2.418591 1.359165 5.209295
1631
1632 Random effects:
1633 Formula: ~1 | species
1634 (Intercept) Residual
1635 StdDev: 0.02805075 0.2522209
1636
1637 Correlation Structure: corBrownian
1638 Formula: ~1 | species
1639 Parameter estimate(s):
1640 numeric(0)
1641 Fixed effects: log(phenotype) ~ log(cofactor)
1642      Value Std.Error DF      t-value p-value
1643 (Intercept) 4.266436 0.5865901 12      7.273284      0
1644 log(cofactor) -0.965919 0.0878050 12     -11.000734      0
1645 Correlation:
1646      (Intr)
1647 log(cofactor) -0.995
1648
1649 Standardized Within-Group Residuals:
1650      Min      Q1      Med      Q3      Max
1651 -1.7031611 -0.4646712 -0.1828606 0.4454772 1.7546710
1652
1653 Number of Observations: 19
1654 Number of Groups: 6
1655      numDF denDF      F-value p-value
1656 (Intercept)      1      12 1463.9878 <.0001
1657 log(cofactor)      1      12 121.0162 <.0001
1658 Levene's Test for Homogeneity of Variance (center = median)
1659      Df F value Pr(>F)
1660 group    5  1.4087 0.2846
1661      13
1662
1663      Shapiro-Wilk normality test
1664
1665 data: residuals(xy.brownian, type = "normalized")
1666 W = 0.97491, p-value = 0.8684
1667
1668      Effect      Rsq upper.CL lower.CL
1669 1      Model 0.987      0.996      0.974
1670 2 log(cofactor) 0.987      0.996      0.974
1671 $d
1672 [1] -0.08983634
1673
1674 $ci
1675 [1] -0.1825432 -0.0296269
1676
1677 $p
1678 [1] 0
1679
1680 Likelihood ratio test
1681
1682 Model 1: phenotype ~ cofactor
1683 Model 2: phenotype ~ log(cofactor)
1684 Model 3: log(phenotype) ~ cofactor
1685 Model 4: log(phenotype) ~ log(cofactor)
1686 #Df LogLik Df      Chisq Pr(>Chisq)
1687 1      4 31.372
1688 2      4 34.038 0 5.3326 < 2.2e-16 ***
1689 3      4 0.904 0 66.2681 < 2.2e-16 ***
1690 4      4 5.209 0 8.6098 < 2.2e-16 ***
1691 ---
1692 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
1693 df      AIC

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```

1694 simple.brownian 4 -54.744345
1695 x.brownian 4 -60.076898
1696 y.brownian 4 6.191188
1697 xy.brownian 4 -2.418591
1698 =====
1699 =====
1700 Comparison 2b: ufs vs. Esec
1701 =====
1702 =====
1703 -----
1704
1705
1706 No transformation of variables
1707
1708
1709 -----
1710 Linear mixed-effects model fit by maximum likelihood
1711 Data: raw.data
1712 AIC BIC logLik
1713 -49.00714 -45.22939 28.50357
1714
1715 Random effects:
1716 Formula: ~1 | species
1717 (Intercept) Residual
1718 StdDev: 0.02104012 0.05046461
1719
1720 Fixed effects: phenotype ~ cofactor
1721 Value Std.Error DF t-value p-value
1722 (Intercept) 0.20779950 0.027626784 12 7.521668 0.0000
1723 cofactor -0.00006622 0.000019859 12 -3.334494 0.0059
1724 Correlation:
1725 (Intr)
1726 cofactor -0.825
1727
1728 Standardized Within-Group Residuals:
1729 Min Q1 Med Q3 Max
1730 -1.00422359 -0.42692837 -0.26493741 0.02240183 2.98719132
1731
1732 Number of Observations: 19
1733 Number of Groups: 6
1734 numDF denDF F-value p-value
1735 (Intercept) 1 12 71.37454 <.0001
1736 cofactor 1 12 11.11885 0.0059
1737 Levene's Test for Homogeneity of Variance (center = median)
1738 Df F value Pr(>F)
1739 group 5 1.4089 0.2846
1740 13
1741
1742 Shapiro-Wilk normality test
1743
1744 data: residuals(simple.model, type = "normalized")
1745 W = 0.75744, p-value = 0.0002931
1746
1747 Effect Rsq upper.CL lower.CL
1748 1 Model 0.548 0.836 0.179
1749 2 cofactor 0.548 0.836 0.179
1750 Linear mixed-effects model fit by maximum likelihood
1751 Data: raw.data
1752 AIC BIC logLik
1753 -51.88769 -48.10993 29.94384
1754
1755 Random effects:
1756 Formula: ~1 | species
1757 (Intercept) Residual
1758 StdDev: 0.0471779 0.05615786
1759
1760 Correlation Structure: corBrownian
1761 Formula: ~1 | species
1762 Parameter estimate(s):
1763 numeric(0)
1764 Fixed effects: phenotype ~ cofactor
1765 Value Std.Error DF t-value p-value
1766 (Intercept) 0.2165749 0.03698667 12 5.855486 0.0001
1767 cofactor -0.0000659 0.00002305 12 -2.859225 0.0144
1768 Correlation:
1769 (Intr)
1770 cofactor -0.764
1771
1772 Standardized Within-Group Residuals:
1773 Min Q1 Med Q3 Max
1774 -1.33035455 -0.46335635 -0.22920685 0.08273405 1.56587426

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1775
1776 Number of Observations: 19
1777 Number of Groups: 6
1778      numDF denDF  F-value p-value
1779 (Intercept)      1    12 32.40174  0.0001
1780 cofactor        1    12  8.17516  0.0144
1781 Levene's Test for Homogeneity of Variance (center = median)
1782      Df F value Pr(>F)
1783 group    5  1.2398 0.3459
1784      13
1785
1786      Shapiro-Wilk normality test
1787
1788 data: residuals(simple.brownian, type = "normalized")
1789 W = 0.91289, p-value = 0.08366
1790
1791      Effect      Rsq upper.CL lower.CL
1792 1      Model 0.625      0.867      0.286
1793 2 cofactor 0.625      0.867      0.286
1794 $d
1795 [1] -0.0768038
1796
1797 $ci
1798 [1] -0.15205793 -0.01206271
1799
1800 $p
1801 [1] 0.007
1802
1803 -----
1804
1805 Natural log transformation of independent variable
1806
1807 -----
1808
1809 Linear mixed-effects model fit by maximum likelihood
1810 Data: raw.data
1811      AIC      BIC      logLik
1812 17.52411 21.30186 -4.762053
1813
1814 Random effects:
1815 Formula: ~1 | species
1816      (Intercept) Residual
1817 StdDev: 6.097648e-06 0.3108937
1818
1819 Fixed effects: log(phenotype) ~ cofactor
1820      Value Std.Error DF   t-value p-value
1821 (Intercept) -1.4363538 0.14940678 12 -9.613712  0e+00
1822 cofactor    -0.0006453 0.00011422 12 -5.649834  1e-04
1823 Correlation:
1824 (Intr)
1825 cofactor -0.863
1826
1827 Standardized Within-Group Residuals:
1828      Min      Q1      Med      Q3      Max
1829 -1.2371984 -0.7471713 -0.1255163  0.2506925  2.4783811
1830
1831 Number of Observations: 19
1832 Number of Groups: 6
1833      numDF denDF  F-value p-value
1834 (Intercept)      1    12 824.4743  <.0001
1835 cofactor        1    12  31.9206  1e-04
1836 Levene's Test for Homogeneity of Variance (center = median)
1837      Df F value Pr(>F)
1838 group    5  0.4975 0.7729
1839      13
1840
1841      Shapiro-Wilk normality test
1842
1843 data: residuals(y.transformed, type = "normalized")
1844 W = 0.89633, p-value = 0.04178
1845
1846      Effect      Rsq upper.CL lower.CL
1847 1      Model 0.777      0.924      0.552
1848 2 cofactor 0.777      0.924      0.552
1849
1850 Linear mixed-effects model fit by maximum likelihood
1851 Data: raw.data
1852      AIC      BIC      logLik
1853 12.63414 16.4119 -2.31707
1854
1855 Random effects:

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1856 Formula: ~1 | species
1857 (Intercept) Residual
1858 StdDev: 0.2271345 0.3178858
1859
1860 Correlation Structure: corBrownian
1861 Formula: ~1 | species
1862 Parameter estimate(s):
1863 numeric(0)
1864 Fixed effects: log(phenotype) ~ cofactor
1865 Value Std.Error DF t-value p-value
1866 (Intercept) -1.3933812 0.19536883 12 -7.132055 0e+00
1867 cofactor -0.0006638 0.00012583 12 -5.275548 2e-04
1868 Correlation:
1869 (Intr)
1870 cofactor -0.787
1871
1872 Standardized Within-Group Residuals:
1873 Min Q1 Med Q3 Max
1874 -1.1292980 -0.6707851 -0.2094629 0.2240394 1.7022697
1875
1876 Number of Observations: 19
1877 Number of Groups: 6
1878 numDF denDF F-value p-value
1879 (Intercept) 1 12 334.4147 <.0001
1880 cofactor 1 12 27.8314 2e-04
1881 Levene's Test for Homogeneity of Variance (center = median)
1882 Df F value Pr(>F)
1883 group 5 0.3859 0.8497
1884 13
1885
1886 Shapiro-Wilk normality test
1887
1888 data: residuals(y.brownian, type = "normalized")
1889 W = 0.94401, p-value = 0.311
1890
1891 Effect Rsq upper.CL lower.CL
1892 1 Model 0.864 0.954 0.723
1893 2 cofactor 0.864 0.954 0.723
1894 $d
1895 [1] -0.08726104
1896
1897 $ci
1898 [1] -0.18669133 -0.02351407
1899
1900 $p
1901 [1] 0.002
1902
1903 -----
1904
1905 Natural log transformation of dependent variable
1906
1907 -----
1908
1909 Linear mixed-effects model fit by maximum likelihood
1910 Data: raw.data
1911 AIC BIC logLik
1912 -51.49826 -47.7205 29.74913
1913
1914 Random effects:
1915 Formula: ~1 | species
1916 (Intercept) Residual
1917 StdDev: 2.142245e-06 0.05055557
1918
1919 Fixed effects: phenotype ~ log(cofactor)
1920 Value Std.Error DF t-value p-value
1921 (Intercept) 0.8208047 0.1705852 12 4.811699 0.0004
1922 log(cofactor) -0.1000201 0.0246833 12 -4.052137 0.0016
1923 Correlation:
1924 (Intr)
1925 log(cofactor) -0.997
1926
1927 Standardized Within-Group Residuals:
1928 Min Q1 Med Q3 Max
1929 -1.43427914 -0.45453044 -0.17842557 0.09785261 3.28771082
1930
1931 Number of Observations: 19
1932 Number of Groups: 6
1933 numDF denDF F-value p-value
1934 (Intercept) 1 12 114.76903 <.0001
1935 log(cofactor) 1 12 16.41981 0.0016

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1937 Levene's Test for Homogeneity of Variance (center = median)
1938   Df F value Pr(>F)
1939 group 5  2.0619 0.1361
1940      13
1941
1942   Shapiro-Wilk normality test
1943
1944 data: residuals(x.transformed, type = "normalized")
1945 W = 0.80386, p-value = 0.001301
1946
1947           Effect   Rsq upper.CL lower.CL
1948 1           Model 0.642   0.874   0.313
1949 2 log(cofactor) 0.642   0.874   0.313
1950 Linear mixed-effects model fit by maximum likelihood
1951 Data: raw.data
1952       AIC       BIC    logLik
1953 -53.11564 -49.33788 30.55782
1954
1955 Random effects:
1956 Formula: ~1 | species
1957 (Intercept) Residual
1958 StdDev: 0.03855116 0.05697417
1959
1960 Correlation Structure: corBrownian
1961 Formula: ~1 | species
1962 Parameter estimate(s):
1963 numeric(0)
1964 Fixed effects: phenotype ~ log(cofactor)
1965               Value Std.Error DF   t-value p-value
1966 (Intercept)  0.8501186 0.21356799 12  3.980553  0.0018
1967 log(cofactor) -0.1025800 0.03056028 12 -3.356643  0.0057
1968 Correlation:
1969 (Intr)
1970 log(cofactor) -0.995
1971
1972 Standardized Within-Group Residuals:
1973      Min      Q1      Med      Q3      Max
1974 -1.27582772 -0.56008950 -0.12280955  0.07839771  1.50344246
1975
1976 Number of Observations: 19
1977 Number of Groups: 6
1978      numDF denDF F-value p-value
1979 (Intercept)    1    12 42.96045 <.0001
1980 log(cofactor)    1    12 11.26705  0.0057
1981 Levene's Test for Homogeneity of Variance (center = median)
1982   Df F value Pr(>F)
1983 group 5  1.732 0.1966
1984      13
1985
1986   Shapiro-Wilk normality test
1987
1988 data: residuals(x.brownian, type = "normalized")
1989 W = 0.92694, p-value = 0.1521
1990
1991           Effect   Rsq upper.CL lower.CL
1992 1           Model 0.74   0.911   0.482
1993 2 log(cofactor) 0.74   0.911   0.482
1994 $d
1995 [1] -0.09790378
1996
1997 $ci
1998 [1] -0.19044628 -0.02355222
1999
2000 $p
2001 [1] 0.0035
2002
2003 -----
2004
2005 Natural log transformation of both variables
2006
2007 -----
2008
2009 Linear mixed-effects model fit by maximum likelihood
2010 Data: raw.data
2011       AIC       BIC    logLik
2012 14.11168 17.88943 -3.055838
2013
2014 Random effects:
2015 Formula: ~1 | species
2016 (Intercept) Residual
2017

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2018 StdDev: 4.143324e-06 0.2841921
2019
2020 Fixed effects: log(phenotype) ~ log(cofactor)
2021      Value Std.Error DF   t-value p-value
2022 (Intercept)   3.999730 0.9589243 12   4.171059  0.0013
2023 log(cofactor) -0.894349 0.1387542 12  -6.445564  0.0000
2024 Correlation:
2025      (Intr)
2026 log(cofactor) -0.997
2027
2028 Standardized Within-Group Residuals:
2029      Min      Q1      Med      Q3      Max
2030 -1.7574903 -0.8477933  0.1041812  0.3234646  2.4316692
2031
2032 Number of Observations: 19
2033 Number of Groups: 6
2034      numDF denDF  F-value p-value
2035 (Intercept)      1    12 986.6818 <.0001
2036 log(cofactor)      1    12 41.5453 <.0001
2037 Levene's Test for Homogeneity of Variance (center = median)
2038      Df F value Pr(>F)
2039 group    5  0.4581 0.8004
2040      13
2041
2042 Shapiro-Wilk normality test
2043
2044 data: residuals(xy.transformed, type = "normalized")
2045 W = 0.95941, p-value = 0.5608
2046
2047      Effect    Rsq upper.CL lower.CL
2048 1      Model 0.819   0.939   0.634
2049 2 log(cofactor) 0.819   0.939   0.634
2050 Linear mixed-effects model fit by maximum likelihood
2051 Data: raw.data
2052      AIC      BIC      logLik
2053 9.986502 13.76426 -0.9932511
2054
2055 Random effects:
2056 Formula: ~1 | species
2057      (Intercept) Residual
2058 StdDev:    0.1548211 0.3176725
2059
2060 Correlation Structure: corBrownian
2061 Formula: ~1 | species
2062 Parameter estimate(s):
2063 numeric(0)
2064 Fixed effects: log(phenotype) ~ log(cofactor)
2065      Value Std.Error DF   t-value p-value
2066 (Intercept)   4.747137 1.0914751 12   4.349285 9e-04
2067 log(cofactor) -0.998803 0.1565428 12  -6.380379 0e+00
2068 Correlation:
2069      (Intr)
2070 log(cofactor) -0.996
2071
2072 Standardized Within-Group Residuals:
2073      Min      Q1      Med      Q3      Max
2074 -1.62993737 -0.68552312 -0.03623807  0.34605876  1.30483946
2075
2076 Number of Observations: 19
2077 Number of Groups: 6
2078      numDF denDF  F-value p-value
2079 (Intercept)      1    12 512.8830 <.0001
2080 log(cofactor)      1    12 40.7092 <.0001
2081 Levene's Test for Homogeneity of Variance (center = median)
2082      Df F value Pr(>F)
2083 group    5  0.3787 0.8545
2084      13
2085
2086 Shapiro-Wilk normality test
2087
2088 data: residuals(xy.brownian, type = "normalized")
2089 W = 0.96083, p-value = 0.5889
2090
2091      Effect    Rsq upper.CL lower.CL
2092 1      Model 0.984   0.995   0.966
2093 2 log(cofactor) 0.984   0.995   0.966
2094 $d
2095 [1] -0.1641459
2096
2097 $ci
2098 [1] -0.3300582 -0.0547161

```

```

2099 $p
2100 [1] 0
2101
2102 Likelihood ratio test
2103
2104 Model 1: phenotype ~ cofactor
2105 Model 2: phenotype ~ log(cofactor)
2106 Model 3: log(phenotype) ~ cofactor
2107 Model 4: log(phenotype) ~ log(cofactor)
2108 #Df LogLik Df Chisq Pr(>Chisq)
2109 1 4 29.9438
2110 2 4 30.5578 0 1.2279 < 2.2e-16 ***
2111 3 4 -2.3171 0 65.7498 < 2.2e-16 ***
2112 4 4 -0.9933 0 2.6476 < 2.2e-16 ***
2113 ---
2114 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2115 df AIC
2116 simple.brownian 4 -51.887688
2117 x.brownian 4 -53.115637
2118 y.brownian 4 12.634139
2119 xy.brownian 4 9.986502
2120 =====
2121 Comparison 2c: U vs. Etanl
2122 =====
2123 -----
2124
2125 No transformation of variables
2126
2127 -----
2128 Linear mixed-effects model fit by maximum likelihood
2129 Data: raw.data
2130 AIC BIC logLik
2131 125.0551 128.8328 -58.52754
2132
2133 Random effects:
2134 Formula: ~1 | species
2135 (Intercept) Residual
2136 StdDev: 0.0003629403 5.266987
2137
2138 Fixed effects: phenotype ~ cofactor
2139 Value Std.Error DF t-value p-value
2140 (Intercept) 11.933327 2.3575577 12 5.061733 0.0003
2141 cofactor -0.004886 0.0022058 12 -2.215116 0.0468
2142 Correlation:
2143 (Intr)
2144 cofactor -0.84
2145
2146 Standardized Within-Group Residuals:
2147 Min Q1 Med Q3 Max
2148 -0.84812188 -0.68402892 -0.19214439 0.09053415 3.39477118
2149
2150 Number of Observations: 19
2151 Number of Groups: 6
2152 numDF denDF F-value p-value
2153 (Intercept) 1 12 34.87728 0.0001
2154 cofactor 1 12 4.90674 0.0468
2155 Levene's Test for Homogeneity of Variance (center = median)
2156 Df F value Pr(>F)
2157 group 5 3.3006 0.03837 *
2158 13
2159 ---
2160 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2161
2162 Shapiro-Wilk normality test
2163
2164 data: residuals(simple.model, type = "normalized")
2165 W = 0.74208, p-value = 0.0001846
2166
2167 Effect Rsq upper.CL lower.CL
2168 1 Model 0.349 0.742 0.018
2169 2 cofactor 0.349 0.742 0.018
2170 Linear mixed-effects model fit by maximum likelihood
2171 Data: raw.data
2172 AIC BIC logLik
2173 124.305 128.0828 -58.15252
2174

```

```

2180 Random effects:
2181 Formula: ~1 | species
2182 (Intercept) Residual
2183 StdDev: 3.865977 6.16339
2184
2185 Correlation Structure: corBrownian
2186 Formula: ~1 | species
2187 Parameter estimate(s):
2188 numeric(0)
2189 Fixed effects: phenotype ~ cofactor
2190 Value Std.Error DF t-value p-value
2191 (Intercept) 13.834942 3.345289 12 4.135649 0.0014
2192 cofactor -0.005417 0.002572 12 -2.106145 0.0569
2193 Correlation:
2194 (Intr)
2195 cofactor -0.766
2196
2197 Standardized Within-Group Residuals:
2198 Min Q1 Med Q3 Max
2199 -1.34729423 -0.61800386 -0.13958869 0.04661893 1.56766761
2200
2201 Number of Observations: 19
2202 Number of Groups: 6
2203 numDF denDF F-value p-value
2204 (Intercept) 1 12 15.385591 0.0020
2205 cofactor 1 12 4.435846 0.0569
2206 Levene's Test for Homogeneity of Variance (center = median)
2207 Df F value Pr(>F)
2208 group 5 2.8833 0.05754 .
2209 13
2210 ---
2211 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2212
2213 Shapiro-Wilk normality test
2214
2215 data: residuals(simple.brownian, type = "normalized")
2216 W = 0.92583, p-value = 0.1451
2217
2218 Effect Rsq upper.CL lower.CL
2219 1 Model 0.5 0.815 0.123
2220 2 cofactor 0.5 0.815 0.123
2221 $d
2222 [1] -0.1511442
2223
2224 $ci
2225 [1] -0.19376424 -0.05814492
2226
2227 $p
2228 [1] 0
2229
2230 -----
2231
2232 Natural log transformation of independent variable
2233
2234 -----
2235
2236 Linear mixed-effects model fit by maximum likelihood
2237 Data: raw.data
2238 AIC BIC logLik
2239 34.8345 38.61226 -13.41725
2240
2241 Random effects:
2242 Formula: ~1 | species
2243 (Intercept) Residual
2244 StdDev: 1.358494e-05 0.4902855
2245
2246 Fixed effects: log(phenotype) ~ cofactor
2247 Value Std.Error DF t-value p-value
2248 (Intercept) 2.4376844 0.21945684 12 11.107808 0.0000
2249 cofactor -0.0007102 0.00020533 12 -3.458869 0.0047
2250 Correlation:
2251 (Intr)
2252 cofactor -0.84
2253
2254 Standardized Within-Group Residuals:
2255 Min Q1 Med Q3 Max
2256 -1.3744654 -0.7802765 -0.1065462 0.4195502 2.3419200
2257
2258 Number of Observations: 19
2259 Number of Groups: 6

```

```

2261          numDF denDF    F-value p-value
2262 (Intercept)      1    12 229.06113 <.0001
2263 cofactor        1    12 11.96377 0.0047
2264 Levene's Test for Homogeneity of Variance (center = median)
2265      Df F value Pr(>F)
2266 group  5  0.6553 0.6631
2267      13
2268
2269      Shapiro-Wilk normality test
2270
2271 data: residuals(y.transformed, type = "normalized")
2272 W = 0.91352, p-value = 0.08592
2273
2274      Effect      Rsq upper.CL lower.CL
2275 1      Model 0.566    0.844    0.203
2276 2 cofactor 0.566    0.844    0.203
2277 Linear mixed-effects model fit by maximum likelihood
2278 Data: raw.data
2279      AIC      BIC      logLik
2280 29.64701 33.42477 -10.82351
2281
2282 Random effects:
2283 Formula: ~1 | species
2284 (Intercept) Residual
2285 StdDev:      0.2240331 0.545658
2286
2287 Correlation Structure: corBrownian
2288 Formula: ~1 | species
2289 Parameter estimate(s):
2290 numeric(0)
2291 Fixed effects: log(phenotype) ~ cofactor
2292      Value Std.Error DF   t-value p-value
2293 (Intercept) 2.6266347 0.25361058 12 10.356960 0.0000
2294 cofactor    -0.0008395 0.00020541 12 -4.086889 0.0015
2295 Correlation:
2296 (Intr)
2297 cofactor -0.795
2298
2299 Standardized Within-Group Residuals:
2300      Min      Q1      Med      Q3      Max
2301 -1.1185498 -0.7651380 -0.2273898  0.2702607  1.7203484
2302
2303 Number of Observations: 19
2304 Number of Groups: 6
2305          numDF denDF    F-value p-value
2306 (Intercept)      1    12 137.11698 <.0001
2307 cofactor        1    12 16.70266 0.0015
2308 Levene's Test for Homogeneity of Variance (center = median)
2309      Df F value Pr(>F)
2310 group  5  0.6249 0.6839
2311      13
2312
2313      Shapiro-Wilk normality test
2314
2315 data: residuals(y.brownian, type = "normalized")
2316 W = 0.96145, p-value = 0.6013
2317
2318      Effect      Rsq upper.CL lower.CL
2319 1      Model 0.958    0.986    0.914
2320 2 cofactor 0.958    0.986    0.914
2321 $d
2322 [1] -0.3915156
2323
2324 $ci
2325 [1] -0.6997467 -0.1421896
2326
2327 $p
2328 [1] 0
2329
2330 -----
2331
2332 Natural log transformation of dependent variable
2333
2334 -----
2335
2336 Linear mixed-effects model fit by maximum likelihood
2337 Data: raw.data
2338      AIC      BIC      logLik
2339 121.9524 125.7301 -56.97618
2340
2341

```

```

2342 Random effects:
2343 Formula: ~1 | species
2344 (Intercept) Residual
2345 StdDev: 0.0002050665 4.854021
2346
2347 Fixed effects: phenotype ~ log(cofactor)
2348 Value Std.Error DF t-value p-value
2349 (Intercept) 49.16477 14.08533 12 3.490495 0.0045
2350 log(cofactor) -6.27578 2.11643 12 -2.965268 0.0118
2351 Correlation:
2352 (Intr)
2353 log(cofactor) -0.997
2354
2355 Standardized Within-Group Residuals:
2356 Min Q1 Med Q3 Max
2357 -1.2011535 -0.5552337 -0.2167575 0.1658472 3.2418965
2358
2359 Number of Observations: 19
2360 Number of Groups: 6
2361 numDF denDF F-value p-value
2362 (Intercept) 1 12 41.06424 <.0001
2363 log(cofactor) 1 12 8.79282 0.0118
2364 Levene's Test for Homogeneity of Variance (center = median)
2365 Df F value Pr(>F)
2366 group 5 4.4779 0.0136 *
2367 13
2368 ---
2369 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2370
2371 Shapiro-Wilk normality test
2372
2373 data: residuals(x.transformed, type = "normalized")
2374 W = 0.83886, p-value = 0.004442
2375
2376 Effect Rsq upper.CL lower.CL
2377 1 Model 0.49 0.811 0.113
2378 2 log(cofactor) 0.49 0.811 0.113
2379 Linear mixed-effects model fit by maximum likelihood
2380 Data: raw.data
2381 AIC BIC logLik
2382 121.2069 124.9847 -56.60345
2383
2384 Random effects:
2385 Formula: ~1 | species
2386 (Intercept) Residual
2387 StdDev: 2.57411 6.043852
2388
2389 Correlation Structure: corBrownian
2390 Formula: ~1 | species
2391 Parameter estimate(s):
2392 numeric(0)
2393 Fixed effects: phenotype ~ log(cofactor)
2394 Value Std.Error DF t-value p-value
2395 (Intercept) 59.96916 16.252241 12 3.689901 0.0031
2396 log(cofactor) -7.69861 2.420614 12 -3.180436 0.0079
2397 Correlation:
2398 (Intr)
2399 log(cofactor) -0.994
2400
2401 Standardized Within-Group Residuals:
2402 Min Q1 Med Q3 Max
2403 -1.1858622 -0.6269642 -0.2745641 0.1751270 1.6238763
2404
2405 Number of Observations: 19
2406 Number of Groups: 6
2407 numDF denDF F-value p-value
2408 (Intercept) 1 12 24.52754 0.0003
2409 log(cofactor) 1 12 10.11518 0.0079
2410 Levene's Test for Homogeneity of Variance (center = median)
2411 Df F value Pr(>F)
2412 group 5 3.875 0.02271 *
2413 13
2414 ---
2415 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2416
2417 Shapiro-Wilk normality test
2418
2419 data: residuals(x.brownian, type = "normalized")
2420 W = 0.94704, p-value = 0.3515
2421
2422 Effect Rsq upper.CL lower.CL

```

```

2423 1          Model 0.739      0.91      0.48
2424 2 log(cofactor) 0.739      0.91      0.48
2425 $d
2426 [1] -0.2491792
2427
2428 $ci
2429 [1] -0.37749672 -0.09236574
2430
2431 $p
2432 [1] 0
2433
2434 -----
2435
2436
2437 Natural log transformation of both variables
2438
2439 -----
2440
2441 Linear mixed-effects model fit by maximum likelihood
2442 Data: raw.data
2443      AIC      BIC      logLik
2444 31.62811 35.40587 -11.81406
2445
2446 Random effects:
2447 Formula: ~1 | species
2448          (Intercept) Residual
2449 StdDev: 8.561358e-06 0.4506131
2450
2451 Fixed effects: log(phenotype) ~ log(cofactor)
2452              Value Std.Error DF   t-value p-value
2453 (Intercept)   7.217496 1.3075827 12   5.519725  0.0001
2454 log(cofactor) -0.816924 0.1964745 12  -4.157916  0.0013
2455 Correlation:
2456              (Intr)
2457 log(cofactor) -0.997
2458
2459 Standardized Within-Group Residuals:
2460      Min      Q1      Med      Q3      Max
2461 -1.25683743 -0.87357768 -0.01821886  0.56103207  2.01858789
2462
2463 Number of Observations: 19
2464 Number of Groups: 6
2465      numDF denDF    F-value p-value
2466 (Intercept)      1      12 271.17009 <.0001
2467 log(cofactor)      1      12 17.28827 0.0013
2468 Levene's Test for Homogeneity of Variance (center = median)
2469      Df F value Pr(>F)
2470 group  5  0.9858 0.4628
2471      13
2472
2473 Shapiro-Wilk normality test
2474
2475 data: residuals(xy.transformed, type = "normalized")
2476 W = 0.92872, p-value = 0.164
2477
2478      Effect      Rsq upper.CL lower.CL
2479 1          Model 0.654      0.878      0.332
2480 2 log(cofactor) 0.654      0.878      0.332
2481 Linear mixed-effects model fit by maximum likelihood
2482 Data: raw.data
2483      AIC      BIC      logLik
2484 25.04395 28.82171 -8.521976
2485
2486 Random effects:
2487 Formula: ~1 | species
2488          (Intercept) Residual
2489 StdDev: 2.617516e-05 0.5234637
2490
2491 Correlation Structure: corBrownian
2492 Formula: ~1 | species
2493 Parameter estimate(s):
2494 numeric(0)
2495 Fixed effects: log(phenotype) ~ log(cofactor)
2496              Value Std.Error DF   t-value p-value
2497 (Intercept)   8.777962 1.1989234 12   7.321537  0e+00
2498 log(cofactor) -1.044415 0.1795643 12  -5.816384  1e-04
2499 Correlation:
2500              (Intr)
2501 log(cofactor) -0.995
2502
2503 Standardized Within-Group Residuals:

```

```

2504      Min      Q1      Med      Q3      Max
2505 -1.4767651 -0.6639426 -0.2856563  0.3301078  1.8975712
2506
2507 Number of Observations: 19
2508 Number of Groups: 6
2509      numDF denDF    F-value p-value
2510 (Intercept)      1      12 258.73313  <.0001
2511 log(cofactor)      1      12 33.83032  1e-04
2512 Levene's Test for Homogeneity of Variance (center = median)
2513      Df F value Pr(>F)
2514 group      5  1.2732 0.3328
2515      13
2516
2517 Shapiro-Wilk normality test
2518
2519 data: residuals(xy.brownian, type = "normalized")
2520 W = 0.97892, p-value = 0.9291
2521
2522      Effect Rsq upper.CL lower.CL
2523 1      Model      1      1      1
2524 2 log(cofactor)      1      1      1
2525 $d
2526 [1] -0.3462261
2527
2528 $ci
2529 [1] -0.6701083 -0.1268263
2530
2531 $p
2532 [1] 0
2533
2534 Likelihood ratio test
2535
2536 Model 1: phenotype ~ cofactor
2537 Model 2: phenotype ~ log(cofactor)
2538 Model 3: log(phenotype) ~ cofactor
2539 Model 4: log(phenotype) ~ log(cofactor)
2540      #Df LogLik Df Chisq Pr(>Chisq)
2541 1      4 -58.153
2542 2      4 -56.603 0 3.0981 < 2.2e-16 ***
2543 3      4 -10.824 0 91.5599 < 2.2e-16 ***
2544 4      4 -8.522 0 4.6031 < 2.2e-16 ***
2545 ---
2546 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2547      df      AIC
2548 simple.brownian 4 124.30503
2549 x.brownian      4 121.20689
2550 y.brownian      4 29.64701
2551 xy.brownian     4 25.04395
2552 =====
2553 =====
2554 Comparison 2d: U vs. Esec
2555 =====
2556 =====
2557 -----
2558
2559 No transformation of variables
2560
2561 -----
2562
2563 Linear mixed-effects model fit by maximum likelihood
2564 Data: raw.data
2565      AIC      BIC      logLik
2566 126.3748 130.1526 -59.18742
2567
2568 Random effects:
2569 Formula: ~1 | species
2570      (Intercept) Residual
2571 StdDev: 0.0003748676 5.453125
2572
2573 Fixed effects: phenotype ~ cofactor
2574      Value Std.Error DF t-value p-value
2575 (Intercept) 11.738246 2.6206187 12 4.479189 0.0008
2576 cofactor -0.003714 0.0020034 12 -1.853839 0.0885
2577 Correlation:
2578 (Intr)
2579 cofactor -0.863
2580
2581 Standardized Within-Group Residuals:
2582      Min      Q1      Med      Q3      Max
2583 -1.01584496 -0.55339602 -0.24946191  0.02249022  3.42638767
2584

```



```

2585
2586 Number of Observations: 19
2587 Number of Groups: 6
2588           numDF denDF  F-value p-value
2589 (Intercept)      1   12 32.53690 0.0001
2590 cofactor         1   12  3.43672 0.0885
2591 Levene's Test for Homogeneity of Variance (center = median)
2592      Df F value  Pr(>F)
2593 group  5  2.7146 0.06819 .
2594      13
2595 ---
2596 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2597
2598 Shapiro-Wilk normality test
2599
2600 data: residuals(simple.model, type = "normalized")
2601 W = 0.7325, p-value = 0.0001393
2602
2603      Effect      Rsq upper.CL lower.CL
2604 1      Model 0.273      0.699      0.004
2605 2 cofactor 0.273      0.699      0.004
2606 Linear mixed-effects model fit by maximum likelihood
2607 Data: raw.data
2608      AIC      BIC      logLik
2609 125.8396 129.6174 -58.9198
2610
2611 Random effects:
2612 Formula: ~1 | species
2613      (Intercept) Residual
2614 StdDev:      4.192503 6.354968
2615
2616 Correlation Structure: corBrownian
2617 Formula: ~1 | species
2618 Parameter estimate(s):
2619 numeric(0)
2620 Fixed effects: phenotype ~ cofactor
2621           Value Std.Error DF   t-value p-value
2622 (Intercept) 13.303300  3.782724 12   3.516857  0.0042
2623 cofactor    -0.004003  0.002470 12  -1.620378  0.1311
2624 Correlation:
2625      (Intr)
2626 cofactor -0.796
2627
2628 Standardized Within-Group Residuals:
2629           Min           Q1           Med           Q3           Max
2630 -1.36374968 -0.55062928 -0.18163356  0.06925084  1.56687876
2631
2632 Number of Observations: 19
2633 Number of Groups: 6
2634           numDF denDF  F-value p-value
2635 (Intercept)      1   12 13.543743 0.0031
2636 cofactor         1   12  2.625624 0.1311
2637 Levene's Test for Homogeneity of Variance (center = median)
2638      Df F value  Pr(>F)
2639 group  5  2.2596 0.1098
2640      13
2641
2642 Shapiro-Wilk normality test
2643
2644 data: residuals(simple.brownian, type = "normalized")
2645 W = 0.91596, p-value = 0.09529
2646
2647      Effect      Rsq upper.CL lower.CL
2648 1      Model 0.692      0.893      0.395
2649 2 cofactor 0.692      0.893      0.395
2650 $d
2651 [1] -0.4187542
2652
2653 $ci
2654 [1] -0.4832450 -0.1947424
2655
2656 $p
2657 [1] 0
2658
2659 -----
2660
2661 Natural log transformation of independent variable
2662
2663 -----
2664
2665

```

```

2666 Linear mixed-effects model fit by maximum likelihood
2667 Data: raw.data
2668      AIC      BIC      logLik
2669 37.76083 41.53858 -14.88041
2670
2671 Random effects:
2672 Formula: ~1 | species
2673 (Intercept) Residual
2674 StdDev: 1.344276e-05 0.5295335
2675
2676 Fixed effects: log(phenotype) ~ cofactor
2677      Value Std.Error DF   t-value p-value
2678 (Intercept)  2.4144256 0.25447889 12   9.487724  0.0000
2679 cofactor    -0.0005443 0.00019454 12  -2.798108  0.0161
2680 Correlation:
2681 (Intr)
2682 cofactor -0.863
2683
2684 Standardized Within-Group Residuals:
2685      Min      Q1      Med      Q3      Max
2686 -1.32777017 -0.74632111 -0.06930007  0.37229784  2.38484538
2687
2688 Number of Observations: 19
2689 Number of Groups: 6
2690      numDF denDF   F-value p-value
2691 (Intercept)    1    12 196.36434 <.0001
2692 cofactor       1    12  7.82941  0.0161
2693 Levene's Test for Homogeneity of Variance (center = median)
2694      Df F value Pr(>F)
2695 group  5  0.4934 0.7757
2696      13
2697
2698 Shapiro-Wilk normality test
2699
2700 data: residuals(y.transformed, type = "normalized")
2701 W = 0.92624, p-value = 0.1476
2702
2703      Effect   Rsq upper.CL lower.CL
2704 1      Model 0.461    0.798    0.085
2705 2 cofactor 0.461    0.798    0.085
2706 Linear mixed-effects model fit by maximum likelihood
2707 Data: raw.data
2708      AIC      BIC      logLik
2709 33.41863 37.19638 -12.70931
2710
2711 Random effects:
2712 Formula: ~1 | species
2713 (Intercept) Residual
2714 StdDev: 0.3088905 0.5804384
2715
2716 Correlation Structure: corBrownian
2717 Formula: ~1 | species
2718 Parameter estimate(s):
2719 numeric(0)
2720 Fixed effects: log(phenotype) ~ cofactor
2721      Value Std.Error DF   t-value p-value
2722 (Intercept)  2.5734390 0.319359 12   8.058139  0.0000
2723 cofactor    -0.0006453 0.000215 12  -3.000534  0.0111
2724 Correlation:
2725 (Intr)
2726 cofactor -0.816
2727
2728 Standardized Within-Group Residuals:
2729      Min      Q1      Med      Q3      Max
2730 -1.2558376 -0.6419893 -0.2367171  0.3301011  1.6106204
2731
2732 Number of Observations: 19
2733 Number of Groups: 6
2734      numDF denDF   F-value p-value
2735 (Intercept)    1    12  94.13641 <.0001
2736 cofactor       1    12  9.00320  0.0111
2737 Levene's Test for Homogeneity of Variance (center = median)
2738      Df F value Pr(>F)
2739 group  5  0.4156 0.8297
2740      13
2741
2742 Shapiro-Wilk normality test
2743
2744 data: residuals(y.brownian, type = "normalized")
2745 W = 0.95336, p-value = 0.4499
2746

```

```

2747      Effect      Rsq upper.CL lower.CL
2748  1      Model 0.713      0.901      0.433
2749  2 cofactor 0.713      0.901      0.433
2750 $d
2751 [1] -0.2520836
2752
2753 $ci
2754 [1] -0.3658758 -0.1024814
2755
2756 $p
2757 [1] 0
2758
2759 -----
2760
2761 Natural log transformation of dependent variable
2762
2763 -----
2764
2765 Linear mixed-effects model fit by maximum likelihood
2766 Data: raw.data
2767      AIC      BIC      logLik
2768 125.4409 129.2186 -58.72043
2769
2770 Random effects:
2771 Formula: ~1 | species
2772 (Intercept) Residual
2773 StdDev: 0.000251299 5.32073
2774
2775 Fixed effects: phenotype ~ log(cofactor)
2776      Value Std.Error DF   t-value p-value
2777 (Intercept) 45.38827 17.953272 12  2.528134 0.0265
2778 log(cofactor) -5.49016  2.597798 12 -2.113391 0.0562
2779 Correlation:
2780 (Intr)
2781 log(cofactor) -0.997
2782
2783 Standardized Within-Group Residuals:
2784      Min      Q1      Med      Q3      Max
2785 -1.1995484 -0.4652645 -0.1972934  0.0168710  3.3966701
2786
2787 Number of Observations: 19
2788 Number of Groups: 6
2789      numDF denDF F-value p-value
2790 (Intercept)      1      12 34.17627 0.0001
2791 log(cofactor)      1      12  4.46642 0.0562
2792 Levene's Test for Homogeneity of Variance (center = median)
2793      Df F value Pr(>F)
2794 group  5  3.2036 0.04208 *
2795      13
2796
2797 ---
2798 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2799
2800 Shapiro-Wilk normality test
2801
2802 data: residuals(x.transformed, type = "normalized")
2803 W = 0.76994, p-value = 0.0004318
2804
2805      Effect      Rsq upper.CL lower.CL
2806  1      Model 0.328      0.731      0.012
2807  2 log(cofactor) 0.328      0.731      0.012
2808 Linear mixed-effects model fit by maximum likelihood
2809 Data: raw.data
2810      AIC      BIC      logLik
2811 125.2964 129.0741 -58.64819
2812
2813 Random effects:
2814 Formula: ~1 | species
2815 (Intercept) Residual
2816 StdDev: 3.632877 6.45151
2817
2818 Correlation Structure: corBrownian
2819 Formula: ~1 | species
2820 Parameter estimate(s):
2821 numeric(0)
2822 Fixed effects: phenotype ~ log(cofactor)
2823      Value Std.Error DF   t-value p-value
2824 (Intercept) 52.64466 23.00411 12  2.288489 0.0410
2825 log(cofactor) -6.35548  3.29617 12 -1.928140 0.0778
2826 Correlation:
2827 (Intr)

```

```

2828 log(cofactor) -0.996
2829
2830 Standardized Within-Group Residuals:
2831      Min      Q1      Med      Q3      Max
2832 -1.30970873 -0.51280949 -0.12929097  0.07024106  1.62131710
2833
2834 Number of Observations: 19
2835 Number of Groups: 6
2836      numDF denDF    F-value p-value
2837 (Intercept)      1      12 16.051808  0.0017
2838 log(cofactor)      1      12  3.717722  0.0778
2839 Levene's Test for Homogeneity of Variance (center = median)
2840      Df F value Pr(>F)
2841 group    5  2.8298 0.0607 .
2842      13
2843 ---
2844 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2845
2846 Shapiro-Wilk normality test
2847
2848 data: residuals(x.brownian, type = "normalized")
2849 W = 0.93245, p-value = 0.1921
2850
2851      Effect    Rsq upper.CL lower.CL
2852 1      Model 0.51      0.82      0.134
2853 2 log(cofactor) 0.51      0.82      0.134
2854 $d
2855 [1] -0.1817028
2856
2857 $ci
2858 [1] -0.21736888 -0.07931652
2859
2860 $p
2861 [1] 0
2862
2863 -----
2864
2865 Natural log transformation of both variables
2866
2867 -----
2868
2869 Linear mixed-effects model fit by maximum likelihood
2870 Data: raw.data
2871      AIC      BIC      logLik
2872 36.50711 40.28487 -14.25356
2873
2874 Random effects:
2875 Formula: ~1 | species
2876 (Intercept) Residual
2877 StdDev: 9.817237e-06 0.5123479
2878
2879 Fixed effects: log(phenotype) ~ log(cofactor)
2880      Value Std.Error DF   t-value p-value
2881 (Intercept)  7.120786 1.7287706 12   4.118989  0.0014
2882 log(cofactor) -0.771946 0.2501492 12  -3.085942  0.0094
2883 Correlation:
2884 (Intr)
2885 log(cofactor) -0.997
2886
2887 Standardized Within-Group Residuals:
2888      Min      Q1      Med      Q3      Max
2889 -1.5801002 -0.9202651 -0.0195231  0.4077265  2.3186217
2890
2891 Number of Observations: 19
2892 Number of Groups: 6
2893      numDF denDF    F-value p-value
2894 (Intercept)      1      12 209.75845 <.0001
2895 log(cofactor)      1      12  9.52304  0.0094
2896 Levene's Test for Homogeneity of Variance (center = median)
2897      Df F value Pr(>F)
2898 group    5  0.4041 0.8375
2899      13
2900
2901 Shapiro-Wilk normality test
2902
2903 data: residuals(xy.transformed, type = "normalized")
2904 W = 0.95525, p-value = 0.4828
2905
2906      Effect    Rsq upper.CL lower.CL
2907 1      Model 0.51      0.82      0.134
2908

```

```

2909 2 log(cofactor) 0.51      0.82      0.134
2910 Linear mixed-effects model fit by maximum likelihood
2911 Data: raw.data
2912      AIC      BIC      logLik
2913 32.16724 35.94499 -12.08362
2914
2915 Random effects:
2916 Formula: ~1 | species
2917 (Intercept) Residual
2918 StdDev:      0.2284927 0.5868126
2919
2920 Correlation Structure: corBrownian
2921 Formula: ~1 | species
2922 Parameter estimate(s):
2923 numeric(0)
2924 Fixed effects: log(phenotype) ~ log(cofactor)
2925                Value Std.Error DF   t-value p-value
2926 (Intercept)      8.651421 1.9158831 12   4.515631  0.0007
2927 log(cofactor) -0.986726 0.2751413 12  -3.586251  0.0037
2928 Correlation:
2929 (Intr)
2930 log(cofactor) -0.996
2931
2932 Standardized Within-Group Residuals:
2933      Min      Q1      Med      Q3      Max
2934 -1.5349111 -0.6038602 -0.1151023  0.3642676  1.4312340
2935
2936 Number of Observations: 19
2937 Number of Groups: 6
2938      numDF denDF   F-value p-value
2939 (Intercept)      1      12 123.82611 <.0001
2940 log(cofactor)      1      12 12.86119  0.0037
2941 Levene's Test for Homogeneity of Variance (center = median)
2942      Df F value Pr(>F)
2943 group  5  0.3869 0.8491
2944      13
2945
2946 Shapiro-Wilk normality test
2947
2948 data: residuals(xy.brownian, type = "normalized")
2949 W = 0.95941, p-value = 0.5608
2950
2951      Effect      Rsq upper.CL lower.CL
2952 1      Model 0.809      0.935      0.614
2953 2 log(cofactor) 0.809      0.935      0.614
2954 $d
2955 [1] -0.2994071
2956
2957 $ci
2958 [1] -0.4850053 -0.1102824
2959
2960 $p
2961 [1] 0
2962
2963 Likelihood ratio test
2964
2965 Model 1: phenotype ~ cofactor
2966 Model 2: phenotype ~ log(cofactor)
2967 Model 3: log(phenotype) ~ cofactor
2968 Model 4: log(phenotype) ~ log(cofactor)
2969      #Df LogLik Df   Chisq Pr(>Chisq)
2970 1      4 -58.920
2971 2      4 -58.648 0  0.5432 < 2.2e-16 ***
2972 3      4 -12.709 0 91.8778 < 2.2e-16 ***
2973 4      4 -12.084 0  1.2514 < 2.2e-16 ***
2974 ---
2975 Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
2976                df      AIC
2977 simple.brownian 4 125.83961
2978 x.brownian      4 125.29638
2979 y.brownian      4  33.41863
2980 xy.brownian     4  32.16724
2981 =====
2982 =====
2983 Comparison 3a: Etan low vs. length
2984 =====
2985 =====
2986 -----
2987
2988
2989 No transformation of variables

```

```

2990 -----
2991
2992 Linear mixed-effects model fit by maximum likelihood
2993 Data: raw.data
2994      AIC      BIC      logLik
2995 300.7297 304.5074 -146.3648
2996
2997 Random effects:
2998 Formula: ~1 | species
2999 (Intercept) Residual
3000 StdDev: 0.03491519 536.1818
3001
3002 Fixed effects: phenotype ~ cofactor
3003      Value Std.Error DF t-value p-value
3004 (Intercept) 379.1867 334.7871 12 1.132621 0.2795
3005 cofactor 80.4656 47.8203 12 1.682668 0.1183
3006 Correlation:
3007 (Intr)
3008 cofactor -0.921
3009
3010 Standardized Within-Group Residuals:
3011      Min      Q1      Med      Q3      Max
3012 -1.1489570 -0.5502091 -0.2340353 -0.1043322 2.6271731
3013
3014 Number of Observations: 19
3015 Number of Groups: 6
3016      numDF denDF F-value p-value
3017 (Intercept) 1 12 47.71497 <.0001
3018 cofactor 1 12 2.83137 0.1183
3019 Levene's Test for Homogeneity of Variance (center = median)
3020      Df F value Pr(>F)
3021 group 5 0.903 0.508
3022 13
3023
3024 Shapiro-Wilk normality test
3025
3026 data: residuals(simple.model, type = "normalized")
3027 W = 0.73548, p-value = 0.0001519
3028
3029      Effect Rsq upper.CL lower.CL
3030 1 Model 0.236 0.675 0.002
3031 2 cofactor 0.236 0.675 0.002
3032
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

```

```

3071 data: residuals(simple.brownian, type = "normalized")
3072 W = 0.71902, p-value = 9.452e-05
3073
3074      Effect    Rsq upper.CL lower.CL
3075 1      Model 0.313    0.723    0.009
3076 2 cofactor 0.313    0.723    0.009
3077 $d
3078 [1] -0.07672868
3079
3080 $ci
3081 [1] -0.09645834 -0.00772503
3082
3083 $p
3084 [1] 0
3085
3086 -----
3087
3088 Natural log transformation of independent variable
3089
3090 -----
3091
3092 Linear mixed-effects model fit by maximum likelihood
3093 Data: raw.data
3094      AIC      BIC    logLik
3095 34.93394 38.71169 -13.46697
3096
3097 Random effects:
3098 Formula: ~1 | species
3099 (Intercept) Residual
3100 StdDev: 8.194989e-06 0.4915701
3101
3102 Fixed effects: log(phenotype) ~ cofactor
3103      Value Std.Error DF   t-value p-value
3104 (Intercept) 6.014342 0.3069320 12 19.595033 0.0000
3105 cofactor    0.095734 0.0438415 12  2.183643 0.0496
3106
3107 Correlation:
3108 (Intr)
3109 cofactor -0.921
3110
3111 Standardized Within-Group Residuals:
3112      Min      Q1      Med      Q3      Max
3113 -1.49832494 -0.72112189 -0.04657175  0.11881827  2.39490378
3114
3115 Number of Observations: 19
3116 Number of Groups: 6
3117      numDF denDF   F-value p-value
3118 (Intercept)    1    12 3094.2788 <.0001
3119 cofactor      1    12   4.7683 0.0496
3120 Levene's Test for Homogeneity of Variance (center = median)
3121      Df F value Pr(>F)
3122 group  5  1.0845 0.4136
3123      13
3124
3125 Shapiro-Wilk normality test
3126
3127 data: residuals(y.transformed, type = "normalized")
3128 W = 0.88625, p-value = 0.02763
3129
3130      Effect    Rsq upper.CL lower.CL
3131 1      Model 0.342    0.739    0.016
3132 2 cofactor 0.342    0.739    0.016
3133 Linear mixed-effects model fit by maximum likelihood
3134 Data: raw.data
3135      AIC      BIC    logLik
3136 29.35466 33.13241 -10.67733
3137
3138 Random effects:
3139 Formula: ~1 | species
3140 (Intercept) Residual
3141 StdDev:    0.4380807 0.4631044
3142
3143 Correlation Structure: corBrownian
3144 Formula: ~1 | species
3145 Parameter estimate(s):
3146 numeric(0)
3147 Fixed effects: log(phenotype) ~ cofactor
3148      Value Std.Error DF   t-value p-value
3149 (Intercept) 6.000517 0.5067892 12 11.840263 0.0000
3150 cofactor    0.112173 0.0732463 12  1.531449 0.1516
3151 Correlation:

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```

3152      (Intr)
3153 cofactor -0.906
3154
3155 Standardized Within-Group Residuals:
3156      Min      Q1      Med      Q3      Max
3157 -1.41942841 -0.53136978 -0.05726218  0.17645387  2.29997731
3158
3159 Number of Observations: 19
3160 Number of Groups: 6
3161      numDF denDF  F-value p-value
3162 (Intercept)      1    12 971.7983  <.0001
3163 cofactor          1    12  2.3453  0.1516
3164 Levene's Test for Homogeneity of Variance (center = median)
3165      Df F value Pr(>F)
3166 group    5  0.6729 0.6513
3167      13
3168
3169      Shapiro-Wilk normality test
3170
3171 data: residuals(y.brownian, type = "normalized")
3172 W = 0.77277, p-value = 0.0004719
3173
3174      Effect      Rsq upper.CL lower.CL
3175 1      Model 0.499      0.815      0.123
3176 2 cofactor 0.499      0.815      0.123
3177 $d
3178 [1] -0.1568262
3179
3180 $ci
3181 [1] -0.19927487 -0.05992435
3182
3183 $p
3184 [1] 0
3185
3186 -----
3187
3188 Natural log transformation of dependent variable
3189
3190 -----
3191
3192 Linear mixed-effects model fit by maximum likelihood
3193 Data: raw.data
3194      AIC      BIC      logLik
3195 300.5687 304.3465 -146.2843
3196
3197 Random effects:
3198 Formula: ~1 | species
3199      (Intercept) Residual
3200 StdDev:  0.03494555 533.9156
3201
3202 Fixed effects: phenotype ~ log(cofactor)
3203      Value Std.Error DF      t-value p-value
3204 (Intercept) -142.9108  614.9173 12 -0.2324065  0.8201
3205 log(cofactor)  583.0716  336.6322 12  1.7320732  0.1089
3206 Correlation:
3207      (Intr)
3208 log(cofactor) -0.978
3209
3210 Standardized Within-Group Residuals:
3211      Min      Q1      Med      Q3      Max
3212 -1.2348005 -0.5342622 -0.3032046 -0.1022325  2.5903320
3213
3214 Number of Observations: 19
3215 Number of Groups: 6
3216      numDF denDF  F-value p-value
3217 (Intercept)      1    12 48.12089  <.0001
3218 log(cofactor)      1    12  3.00008  0.1089
3219 Levene's Test for Homogeneity of Variance (center = median)
3220      Df F value Pr(>F)
3221 group    5  0.9338 0.4908
3222      13
3223
3224      Shapiro-Wilk normality test
3225
3226 data: residuals(x.transformed, type = "normalized")
3227 W = 0.73116, p-value = 0.0001339
3228
3229      Effect      Rsq upper.CL lower.CL
3230 1      Model 0.247      0.682      0.003
3231 2 log(cofactor) 0.247      0.682      0.003

```



```

3233 Linear mixed-effects model fit by maximum likelihood
3234 Data: raw.data
3235      AIC      BIC      logLik
3236 294.8685 298.6462 -143.4342
3237
3238 Random effects:
3239 Formula: ~1 | species
3240 (Intercept) Residual
3241 StdDev:      485.3901 497.6382
3242
3243 Correlation Structure: corBrownian
3244 Formula: ~1 | species
3245 Parameter estimate(s):
3246 numeric(0)
3247 Fixed effects: phenotype ~ log(cofactor)
3248      Value Std.Error DF   t-value p-value
3249 (Intercept) -147.0639 1044.4910 12 -0.1407996 0.8904
3250 log(cofactor) 654.6475 575.9849 12 1.1365706 0.2779
3251 Correlation:
3252 (Intr)
3253 log(cofactor) -0.974
3254
3255 Standardized Within-Group Residuals:
3256      Min      Q1      Med      Q3      Max
3257 -1.33846723 -0.41346335 -0.18200122 -0.07378411 2.14405047
3258
3259 Number of Observations: 19
3260 Number of Groups: 6
3261      numDF denDF   F-value p-value
3262 (Intercept)      1      12 18.185989 0.0011
3263 log(cofactor)      1      12 1.291793 0.2779
3264 Levene's Test for Homogeneity of Variance (center = median)
3265      Df F value Pr(>F)
3266 group    5 0.6383 0.6747
3267      13
3268
3269 Shapiro-Wilk normality test
3270
3271 data: residuals(x.brownian, type = "normalized")
3272 W = 0.72553, p-value = 0.0001138
3273
3274      Effect      Rsq upper.CL lower.CL
3275 1      Model 0.359      0.748      0.021
3276 2 log(cofactor) 0.359      0.748      0.021
3277 $d
3278 [1] -0.1124292
3279
3280 $ci
3281 [1] -0.1336216 -0.0196849
3282
3283 $p
3284 [1] 0
3285
3286 -----
3287
3288 Natural log transformation of both variables
3289
3290 -----
3291
3292 Linear mixed-effects model fit by maximum likelihood
3293 Data: raw.data
3294      AIC      BIC      logLik
3295 34.58107 38.35883 -13.29054
3296
3297 Random effects:
3298 Formula: ~1 | species
3299 (Intercept) Residual
3300 StdDev: 7.847956e-06 0.4870266
3301
3302 Fixed effects: log(phenotype) ~ log(cofactor)
3303      Value Std.Error DF   t-value p-value
3304 (Intercept) 5.384390 0.5609146 12 9.599304 0.000
3305 log(cofactor) 0.698631 0.3070688 12 2.275160 0.042
3306 Correlation:
3307 (Intr)
3308 log(cofactor) -0.978
3309
3310 Standardized Within-Group Residuals:
3311      Min      Q1      Med      Q3      Max
3312 -1.62133169 -0.64027301 -0.05199606 0.10723778 2.35572431
3313

```

```

3314
3315 Number of Observations: 19
3316 Number of Groups: 6
3317          numDF denDF    F-value p-value
3318 (Intercept)      1    12 3152.2825  <.0001
3319 log(cofactor)      1    12   5.1764   0.042
3320 Levene's Test for Homogeneity of Variance (center = median)
3321      Df F value Pr(>F)
3322 group  5  0.9238 0.4963
3323      13
3324
3325     Shapiro-Wilk normality test
3326
3327 data: residuals(xy.transformed, type = "normalized")
3328 W = 0.88444, p-value = 0.02567
3329
3330          Effect    Rsq upper.CL lower.CL
3331          Model 0.361    0.749    0.022
3332 2 log(cofactor) 0.361    0.749    0.022
3333 Linear mixed-effects model fit by maximum likelihood
3334 Data: raw.data
3335      AIC      BIC    logLik
3336 29.05284 32.8306 -10.52642
3337
3338 Random effects:
3339 Formula: ~1 | species
3340 (Intercept) Residual
3341 StdDev:    0.4208043 0.4641961
3342
3343 Correlation Structure: corBrownian
3344 Formula: ~1 | species
3345 Parameter estimate(s):
3346 numeric(0)
3347 Fixed effects: log(phenotype) ~ log(cofactor)
3348          Value Std.Error DF   t-value p-value
3349 (Intercept)  5.21384 0.9346700 12 5.578268  0.0001
3350 log(cofactor) 0.84298 0.5160489 12 1.633527  0.1283
3351 Correlation:
3352              (Intr)
3353 log(cofactor) -0.975
3354
3355 Standardized Within-Group Residuals:
3356      Min      Q1      Med      Q3      Max
3357 -1.56461685 -0.50594577 -0.08848169  0.14488667  2.26842990
3358
3359 Number of Observations: 19
3360 Number of Groups: 6
3361          numDF denDF    F-value p-value
3362 (Intercept)      1    12 1032.1867  <.0001
3363 log(cofactor)      1    12   2.6684   0.1283
3364 Levene's Test for Homogeneity of Variance (center = median)
3365      Df F value Pr(>F)
3366 group  5  0.6475 0.6685
3367      13
3368
3369     Shapiro-Wilk normality test
3370
3371 data: residuals(xy.brownian, type = "normalized")
3372 W = 0.78051, p-value = 0.0006037
3373
3374          Effect    Rsq upper.CL lower.CL
3375          Model 0.545    0.835    0.176
3376 2 log(cofactor) 0.545    0.835    0.176
3377 $d
3378 [1] -0.1842249
3379
3380 $ci
3381 [1] -0.23252792 -0.07522848
3382
3383 $p
3384 [1] 0
3385
3386 Likelihood ratio test
3387
3388 Model 1: phenotype ~ cofactor
3389 Model 2: phenotype ~ log(cofactor)
3390 Model 3: log(phenotype) ~ cofactor
3391 Model 4: log(phenotype) ~ log(cofactor)
3392 #Df  LogLik Df   Chisq Pr(>Chisq)
3393 1    4 -143.533
3394 2    4 -143.434 0    0.1968 < 2.2e-16 ***

```

```

3395 3 4 -10.677 0 265.5138 < 2.2e-16 ***
3396 4 4 -10.526 0 0.3018 < 2.2e-16 ***
3397 ---
3398 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
3399 df AIC
3400 simple.brownian 4 295.06530
3401 x.brownian 4 294.86846
3402 y.brownian 4 29.35466
3403 xy.brownian 4 29.05284
3404 =====
3405 =====
3406 Comparison 3b: Esec vs. length
3407 =====
3408 =====
3409 -----
3410
3411 No transformation of variables
3412
3413 -----
3414
3415 Linear mixed-effects model fit by maximum likelihood
3416 Data: raw.data
3417 AIC BIC logLik
3418 303.9805 307.7582 -147.9902
3419
3420 Random effects:
3421 Formula: ~1 | species
3422 (Intercept) Residual
3423 StdDev: 0.0276538 584.0699
3424
3425 Fixed effects: phenotype ~ cofactor
3426 Value Std.Error DF t-value p-value
3427 (Intercept) 399.3009 364.6880 12 1.094911 0.2950
3428 cofactor 113.1550 52.0912 12 2.172246 0.0506
3429
3430 Correlation:
3431 (Intr)
3432 cofactor -0.921
3433
3434 Standardized Within-Group Residuals:
3435 Min Q1 Med Q3 Max
3436 -1.2494641 -0.4929929 -0.2912915 -0.1452860 2.2409932
3437
3438 Number of Observations: 19
3439 Number of Groups: 6
3440 numDF denDF F-value p-value
3441 (Intercept) 1 12 63.55179 <.0001
3442 cofactor 1 12 4.71865 0.0506
3443 Levene's Test for Homogeneity of Variance (center = median)
3444 Df F value Pr(>F)
3445 group 5 0.9666 0.473
3446 13
3447
3448 Shapiro-Wilk normality test
3449
3450 data: residuals(simple.model, type = "normalized")
3451 W = 0.69333, p-value = 4.635e-05
3452
3453 Effect Rsq upper.CL lower.CL
3454 1 Model 0.34 0.738 0.015
3455 2 cofactor 0.34 0.738 0.015
3456 Linear mixed-effects model fit by maximum likelihood
3457 Data: raw.data
3458 AIC BIC logLik
3459 298.3049 302.0827 -145.1525
3460
3461 Random effects:
3462 Formula: ~1 | species
3463 (Intercept) Residual
3464 StdDev: 396.1075 593.1031
3465
3466 Correlation Structure: corBrownian
3467 Formula: ~1 | species
3468 Parameter estimate(s):
3469 numeric(0)
3470 Fixed effects: phenotype ~ cofactor
3471 Value Std.Error DF t-value p-value
3472 (Intercept) 579.3534 535.0546 12 1.082793 0.3002
3473 cofactor 102.5534 78.4654 12 1.306989 0.2157
3474 Correlation:
3475 (Intr)

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```

3476 cofactor -0.915
3477
3478 Standardized Within-Group Residuals:
3479      Min      Q1      Med      Q3      Max
3480 -1.2247009 -0.3758167 -0.2459776 -0.1204433  2.1572007
3481
3482 Number of Observations: 19
3483 Number of Groups: 6
3484      numDF denDF  F-value p-value
3485 (Intercept)      1      12 32.09562  0.0001
3486 cofactor          1      12  1.70822  0.2157
3487 Levene's Test for Homogeneity of Variance (center = median)
3488      Df F value Pr(>F)
3489 group    5  0.6681 0.6545
3490      13
3491
3492      Shapiro-Wilk normality test
3493
3494 data: residuals(simple.brownian, type = "normalized")
3495 W = 0.69571, p-value = 4.944e-05
3496
3497      Effect      Rsq upper.CL lower.CL
3498 1      Model 0.444      0.79      0.071
3499 2 cofactor 0.444      0.79      0.071
3500 $d
3501 [1] -0.1035667
3502
3503 $ci
3504 [1] -0.13760080 -0.03763911
3505
3506 $p
3507 [1] 0
3508
3509 -----
3510
3511 Natural log transformation of independent variable
3512
3513 -----
3514
3515 Linear mixed-effects model fit by maximum likelihood
3516 Data: raw.data
3517      AIC      BIC      logLik
3518 28.32492 32.10268 -10.16246
3519
3520 Random effects:
3521 Formula: ~1 | species
3522 (Intercept) Residual
3523 StdDev: 6.940895e-06 0.4130973
3524
3525 Fixed effects: log(phenotype) ~ cofactor
3526      Value Std.Error DF   t-value p-value
3527 (Intercept) 6.238594 0.25793422 12 24.186764  0.0000
3528 cofactor    0.101452 0.03684277 12  2.753643  0.0175
3529 Correlation:
3530 (Intr)
3531 cofactor -0.921
3532
3533 Standardized Within-Group Residuals:
3534      Min      Q1      Med      Q3      Max
3535 -1.2543842 -0.6753521 -0.2267047  0.1142197  2.4128349
3536
3537 Number of Observations: 19
3538 Number of Groups: 6
3539      numDF denDF  F-value p-value
3540 (Intercept)      1      12 4733.375  <.0001
3541 cofactor          1      12   7.583  0.0175
3542 Levene's Test for Homogeneity of Variance (center = median)
3543      Df F value Pr(>F)
3544 group    5  1.1441 0.3862
3545      13
3546
3547      Shapiro-Wilk normality test
3548
3549 data: residuals(y.transformed, type = "normalized")
3550 W = 0.82165, p-value = 0.002399
3551
3552      Effect      Rsq upper.CL lower.CL
3553 1      Model 0.453      0.794      0.079
3554 2 cofactor 0.453      0.794      0.079
3555 Linear mixed-effects model fit by maximum likelihood

```

```

3557 Data: raw.data
3558     AIC      BIC    logLik
3559 22.60047 26.37822 -7.300234
3560
3561 Random effects:
3562 Formula: ~1 | species
3563         (Intercept) Residual
3564 StdDev:   0.3169837 0.4052492
3565
3566 Correlation Structure: corBrownian
3567 Formula: ~1 | species
3568 Parameter estimate(s):
3569 numeric(0)
3570 Fixed effects: log(phenotype) ~ cofactor
3571                Value Std.Error DF   t-value p-value
3572 (Intercept)  6.375506 0.3982145 12 16.010233   0.000
3573 cofactor    0.093319 0.0580616 12  1.607247   0.134
3574 Correlation:
3575         (Intr)
3576 cofactor -0.912
3577
3578 Standardized Within-Group Residuals:
3579      Min      Q1      Med      Q3      Max
3580 -1.178363702 -0.492482099 -0.084912398  0.007026298  2.359475835
3581
3582 Number of Observations: 19
3583 Number of Groups: 6
3584      numDF denDF   F-value p-value
3585 (Intercept)    1    12 1811.9807 <.0001
3586 cofactor       1    12  2.5832  0.134
3587 Levene's Test for Homogeneity of Variance (center = median)
3588      Df F value Pr(>F)
3589 group  5  0.7827 0.5799
3590      13
3591
3592 Shapiro-Wilk normality test
3593
3594 data: residuals(y.brownian, type = "normalized")
3595 W = 0.72312, p-value = 0.0001062
3596
3597      Effect   Rsq upper.CL lower.CL
3598 1      Model 0.853    0.95    0.7
3599 2 cofactor 0.853    0.95    0.7
3600 $d
3601 [1] -0.3996034
3602
3603 $ci
3604 [1] -0.6182587 -0.1539103
3605
3606 $p
3607 [1] 0
3608
3609 -----
3610
3611 Natural log transformation of dependent variable
3612
3613 -----
3614
3615 Linear mixed-effects model fit by maximum likelihood
3616 Data: raw.data
3617     AIC      BIC    logLik
3618 303.622 307.3997 -147.811
3619
3620 Random effects:
3621 Formula: ~1 | species
3622         (Intercept) Residual
3623 StdDev:   0.02775285  578.586
3624
3625 Fixed effects: phenotype ~ log(cofactor)
3626                Value Std.Error DF   t-value p-value
3627 (Intercept)  -346.4829  666.3648 12 -0.5199598  0.6125
3628 log(cofactor)  826.4324  364.7967 12  2.2654601  0.0428
3629 Correlation:
3630         (Intr)
3631 log(cofactor) -0.978
3632
3633 Standardized Within-Group Residuals:
3634      Min      Q1      Med      Q3      Max
3635 -1.0946330 -0.4624484 -0.2697732 -0.1418463  2.2615134
3636
3637

```

```

3638 Number of Observations: 19
3639 Number of Groups: 6
3640      numDF denDF F-value p-value
3641 (Intercept)      1      12 64.76220 <.0001
3642 log(cofactor)      1      12  5.13231  0.0428
3643 Levene's Test for Homogeneity of Variance (center = median)
3644      Df F value Pr(>F)
3645 group      5  0.9494 0.4822
3646      13
3647
3648      Shapiro-Wilk normality test
3649
3650 data: residuals(x.transformed, type = "normalized")
3651 W = 0.67924, p-value = 3.178e-05
3652
3653      Effect      Rsq upper.CL lower.CL
3654 1      Model 0.359      0.748      0.021
3655 2 log(cofactor) 0.359      0.748      0.021
3656 Linear mixed-effects model fit by maximum likelihood
3657 Data: raw.data
3658      AIC      BIC      logLik
3659 297.8556 301.6333 -144.9278
3660
3661 Random effects:
3662 Formula: ~1 | species
3663 (Intercept) Residual
3664 StdDev:      379.3614 590.6387
3665
3666 Correlation Structure: corBrownian
3667 Formula: ~1 | species
3668 Parameter estimate(s):
3669 numeric(0)
3670 Fixed effects: phenotype ~ log(cofactor)
3671      Value Std.Error DF      t-value p-value
3672 (Intercept) -210.6503  985.2387 12 -0.2138064  0.8343
3673 log(cofactor)  811.2431  546.6065 12  1.4841445  0.1636
3674 Correlation:
3675      (Intr)
3676 log(cofactor) -0.977
3677
3678 Standardized Within-Group Residuals:
3679      Min      Q1      Med      Q3      Max
3680 -1.1343335 -0.3066469 -0.2385625 -0.1778877  2.1492706
3681
3682 Number of Observations: 19
3683 Number of Groups: 6
3684      numDF denDF F-value p-value
3685 (Intercept)      1      12 33.90797  0.0001
3686 log(cofactor)      1      12  2.20268  0.1636
3687 Levene's Test for Homogeneity of Variance (center = median)
3688      Df F value Pr(>F)
3689 group      5  0.6817 0.6454
3690      13
3691
3692      Shapiro-Wilk normality test
3693
3694 data: residuals(x.brownian, type = "normalized")
3695 W = 0.68737, p-value = 3.946e-05
3696
3697      Effect      Rsq upper.CL lower.CL
3698 1      Model 0.512      0.821      0.137
3699 2 log(cofactor) 0.512      0.821      0.137
3700 $d
3701 [1] -0.1530767
3702
3703 $ci
3704 [1] -0.19606936 -0.06164361
3705
3706 $p
3707 [1] 0
3708
3709 -----
3710
3711 Natural log transformation of both variables
3712
3713 -----
3714
3715 Linear mixed-effects model fit by maximum likelihood
3716 Data: raw.data
3717      AIC      BIC      logLik

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```

3719 27.46575 31.2435 -9.732873
3720
3721 Random effects:
3722 Formula: ~1 | species
3723 (Intercept) Residual
3724 StdDev: 6.805997e-06 0.403862
3725
3726 Fixed effects: log(phenotype) ~ log(cofactor)
3727 Value Std.Error DF t-value p-value
3728 (Intercept) 5.550385 0.4651329 12 11.932900 0.0000
3729 log(cofactor) 0.751911 0.2546338 12 2.952911 0.0121
3730 Correlation:
3731 (Intr)
3732 log(cofactor) -0.978
3733
3734 Standardized Within-Group Residuals:
3735 Min Q1 Med Q3 Max
3736 -1.09009121 -0.62709908 -0.14881241 0.02841992 2.48751678
3737
3738 Number of Observations: 19
3739 Number of Groups: 6
3740 numDF denDF F-value p-value
3741 (Intercept) 1 12 4952.331 <.0001
3742 log(cofactor) 1 12 8.720 0.0121
3743 Levene's Test for Homogeneity of Variance (center = median)
3744 Df F value Pr(>F)
3745 group 5 1.2405 0.3456
3746 13
3747
3748 Shapiro-Wilk normality test
3749
3750 data: residuals(xy.transformed, type = "normalized")
3751 W = 0.79377, p-value = 0.0009293
3752
3753 Effect Rsq upper.CL lower.CL
3754 1 Model 0.488 0.81 0.111
3755 2 log(cofactor) 0.488 0.81 0.111
3756 Linear mixed-effects model fit by maximum likelihood
3757 Data: raw.data
3758 AIC BIC logLik
3759 21.82962 25.60737 -6.914808
3760
3761 Random effects:
3762 Formula: ~1 | species
3763 (Intercept) Residual
3764 StdDev: 0.2997113 0.4010905
3765
3766 Correlation Structure: corBrownian
3767 Formula: ~1 | species
3768 Parameter estimate(s):
3769 numeric(0)
3770 Fixed effects: log(phenotype) ~ log(cofactor)
3771 Value Std.Error DF t-value p-value
3772 (Intercept) 5.636584 0.7250005 12 7.774593 0.0000
3773 log(cofactor) 0.749311 0.4014293 12 1.866607 0.0866
3774 Correlation:
3775 (Intr)
3776 log(cofactor) -0.976
3777
3778 Standardized Within-Group Residuals:
3779 Min Q1 Med Q3 Max
3780 -1.18046327 -0.36667996 -0.15086541 -0.05279163 2.36567818
3781
3782 Number of Observations: 19
3783 Number of Groups: 6
3784 numDF denDF F-value p-value
3785 (Intercept) 1 12 1970.0555 <.0001
3786 log(cofactor) 1 12 3.4842 0.0866
3787 Levene's Test for Homogeneity of Variance (center = median)
3788 Df F value Pr(>F)
3789 group 5 0.8571 0.5345
3790 13
3791
3792 Shapiro-Wilk normality test
3793
3794 data: residuals(xy.brownian, type = "normalized")
3795 W = 0.70971, p-value = 7.272e-05
3796
3797 Effect Rsq upper.CL lower.CL
3798 1 Model 0.622 0.866 0.283
3799 2 log(cofactor) 0.622 0.866 0.283

```

```

3800 $d
3801 [1] -0.1347552
3802
3803 $ci
3804 [1] -0.21175705 -0.04638704
3805
3806 $p
3807 [1] 5e-04
3808
3809 Likelihood ratio test
3810
3811 Model 1: phenotype ~ cofactor
3812 Model 2: phenotype ~ log(cofactor)
3813 Model 3: log(phenotype) ~ cofactor
3814 Model 4: log(phenotype) ~ log(cofactor)
3815 #Df LogLik Df Chisq Pr(>Chisq)
3816 1 4 -145.152
3817 2 4 -144.928 0 0.4494 < 2.2e-16 ***
3818 3 4 -7.300 0 275.2551 < 2.2e-16 ***
3819 4 4 -6.915 0 0.7709 < 2.2e-16 ***
3820 ---
3821 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
3822 df AIC
3823 simple.brownian 4 298.30494
3824 x.brownian 4 297.85556
3825 y.brownian 4 22.60047
3826 xy.brownian 4 21.82962
3827 =====
3828 =====
3829 Comparison 5: log(fmax) ~ endo + exo
3830 =====
3831 =====
3832 -----
3833
3834
3835 Compare with and without phylogenetic covariance
3836
3837 -----
3838
3839 Linear mixed-effects model fit by maximum likelihood
3840 Data: raw.data
3841 AIC BIC logLik
3842 5.66673 11.33336 3.166635
3843
3844 Random effects:
3845 Formula: ~1 | species
3846 (Intercept) Residual
3847 StdDev: 0.06743306 0.2736036
3848
3849 Correlation Structure: corBrownian
3850 Formula: ~1 | species
3851 Parameter estimate(s):
3852 numeric(0)
3853 Fixed effects: log(fmax) ~ endo * exo
3854 Value Std.Error DF t-value p-value
3855 (Intercept) -0.6067 0.4446 10 -1.364548 0.2023
3856 endo 96.5246 22.9684 10 4.202497 0.0018
3857 exo 20.7277 52.6154 10 0.393947 0.7019
3858 endo:exo -1553.0660 1702.5213 10 -0.912215 0.3831
3859 Correlation:
3860 (Intr) endo exo
3861 endo -0.928
3862 exo -0.784 0.554
3863 endo:exo 0.870 -0.732 -0.947
3864
3865 Standardized Within-Group Residuals:
3866 Min Q1 Med Q3 Max
3867 -1.7367597 -0.5657005 -0.1560286 0.2538354 1.5036870
3868
3869 Number of Observations: 19
3870 Number of Groups: 6
3871 numDF denDF F-value p-value
3872 (Intercept) 1 10 172.09226 <.0001
3873 endo 1 10 30.43283 0.0003
3874 exo 1 10 2.15226 0.1731
3875 endo:exo 1 10 0.83214 0.3831
3876 Levene's Test for Homogeneity of Variance (center = median)
3877 Df F value Pr(>F)
3878 group 5 0.5022 0.7696
3879 13
3880

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3881 Shapiro-Wilk normality test
3882
3883 data: residuals(full.model, type = "normalized")
3884 W = 0.97016, p-value = 0.7796
3885
3886      Effect    Rsq upper.CL lower.CL
3887 1      Model 0.991    0.997    0.982
3888 2       endo 0.982    0.994    0.963
3889 4 endo:exo 0.640    0.873    0.311
3890 3       exo 0.228    0.669    0.002
3891 Linear mixed-effects model fit by maximum likelihood
3892 Data: raw.data
3893      AIC      BIC    logLik
3894 10.49148 16.15811 0.75426
3895
3896 Random effects:
3897 Formula: ~1 | species
3898 (Intercept) Residual
3899 StdDev: 5.543289e-07 0.2325532
3900
3901 Fixed effects: log(fmax) ~ endo * exo
3902              Value Std.Error DF   t-value p-value
3903 (Intercept)  -0.4705   0.3858 10  -1.219617  0.2506
3904 endo         85.9107  19.3208 10  4.446533  0.0012
3905 exo          5.3193   56.2980 10  0.094485  0.9266
3906 endo:exo    -898.9555 1716.4641 10 -0.523725  0.6119
3907 Correlation:
3908 (Intr) endo   exo
3909 endo   -0.911
3910 exo    -0.796  0.527
3911 endo:exo 0.879 -0.698 -0.960
3912
3913 Standardized Within-Group Residuals:
3914      Min      Q1      Med      Q3      Max
3915 -1.90587184 -0.63727389 -0.04530068  0.49910917  2.33208358
3916
3917 Number of Observations: 19
3918 Number of Groups: 6
3919      numDF denDF   F-value p-value
3920 (Intercept)    1    10 210.18103 <.0001
3921 endo           1    10  44.04378  0.0001
3922 exo            1    10  2.11921  0.1761
3923 endo:exo       1    10  0.27429  0.6119
3924 Levene's Test for Homogeneity of Variance (center = median)
3925      Df F value Pr(>F)
3926 group  5  0.6688  0.654
3927      13
3928
3929 Shapiro-Wilk normality test
3930
3931 data: residuals(full.simple, type = "normalized")
3932 W = 0.9821, p-value = 0.9638
3933
3934      Effect    Rsq upper.CL lower.CL
3935 1      Model 0.852    0.951    0.707
3936 2       endo 0.710    0.900    0.427
3937 4 endo:exo 0.033    0.470    0.000
3938 3       exo 0.001    0.405    0.000
3939 $d
3940 [1] 0.1393233
3941
3942 $ci
3943 [1] 0.0444742 0.2757189
3944
3945 $p
3946 [1] 0
3947
3948 -----
3949
3950 R2 calculation for hypothesis testing
3951
3952 -----
3953      Effect      F      v1      v2      ncp
3954 endo      :1  Min.      : 0.4049  Min.      :1.0  Min.      :18  Min.      : 0.4049
3955 endo:exo:1 1st Qu.: 1.9352  1st Qu.:1.0  1st Qu.:18  1st Qu.: 1.9352
3956 exo      :1  Median :26.6915  Median :1.0  Median :18  Median : 38.4986
3957 Model     :1  Mean    :32.0849  Mean    :1.5  Mean    :18  Mean     : 57.5537
3958           3rd Qu.:56.8412  3rd Qu.:1.5  3rd Qu.:18  3rd Qu.: 94.1171
3959           Max.    :74.5519  Max.     :3.0  Max.     :18  Max.     :152.8128

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3962      Rsq      upper.CL      lower.CL
3963      Min.    :0.0220      Min.    :0.3112      Min.    :0.0000841
3964      1st Qu.:0.0952      1st Qu.:0.4253      1st Qu.:0.0005030
3965      Median :0.4626      Median :0.6864      Median :0.3310785
3966      Mean   :0.4604      Mean   :0.6590      Mean   :0.3699272
3967      3rd Qu.:0.8278      3rd Qu.:0.9200      3rd Qu.:0.7005026
3968      Max.    :0.8946      Max.    :0.9520      Max.    :0.8174677
3969      Effect    F          v1          v2          ncp          Rsq
3970      endo :1      Min.    :85.27      Min.    :1      Min.    :18      Min.    :85.27      Min.    :0.8257
3971      Model:1      1st Qu.:85.27      1st Qu.:1      1st Qu.:18      1st Qu.:85.27      1st Qu.:0.8257
3972      Median :85.27      Median :1      Median :18      Median :85.27      Median :0.8257
3973      Mean   :85.27      Mean   :1      Mean   :18      Mean   :85.27      Mean   :0.8257
3974      3rd Qu.:85.27      3rd Qu.:1      3rd Qu.:18      3rd Qu.:85.27      3rd Qu.:0.8257
3975      Max.    :85.27      Max.    :1      Max.    :18      Max.    :85.27      Max.    :0.8257
3976      upper.CL      lower.CL
3977      Min.    :0.919      Min.    :0.6959
3978      1st Qu.:0.919      1st Qu.:0.6959
3979      Median :0.919      Median :0.6959
3980      Mean   :0.919      Mean   :0.6959
3981      3rd Qu.:0.919      3rd Qu.:0.6959
3982      Max.    :0.919      Max.    :0.6959
3983      Effect    F          v1          v2          ncp          Rsq
3984      exo :1      Min.    :1.487      Min.    :1      Min.    :18      Min.    :1.487      Min.    :0.07633
3985      Model:1      1st Qu.:1.487      1st Qu.:1      1st Qu.:18      1st Qu.:1.487      1st Qu.:0.07633
3986      Median :1.487      Median :1      Median :18      Median :1.487      Median :0.07633
3987      Mean   :1.487      Mean   :1      Mean   :18      Mean   :1.487      Mean   :0.07633
3988      3rd Qu.:1.487      3rd Qu.:1      3rd Qu.:18      3rd Qu.:1.487      3rd Qu.:0.07633
3989      Max.    :1.487      Max.    :1      Max.    :18      Max.    :1.487      Max.    :0.07633
3990      upper.CL      lower.CL
3991      Min.    :0.4085      Min.    :0.0002479
3992      1st Qu.:0.4085      1st Qu.:0.0002479
3993      Median :0.4085      Median :0.0002479
3994      Mean   :0.4085      Mean   :0.0002479
3995      3rd Qu.:0.4085      3rd Qu.:0.0002479
3996      Max.    :0.4085      Max.    :0.0002479
3997      $d
3998      [1] 0.06891381
3999
4000      $ci
4001      [1] 0.02669818 0.13002662
4002
4003      $p
4004      [1] 0
4005
4006      $d
4007      [1] 0.8182919
4008
4009      $ci
4010      [1] 0.5320081 0.8527663
4011
4012      $p
4013      [1] 0
4014
4015      $d
4016      [1] 0.7493781
4017
4018      $ci
4019      [1] 0.3943781 0.8893781
4020
4021      $p
4022      [1] 4.88154e-12
4023
4024      Model df      AIC      BIC      logLik      Test      L.Ratio p-value
4025      full.model      1      6 5.666730 11.33336 3.166635
4026      endo.model      2      4 4.849454 8.62721 1.575273 1 vs 2 3.182724 0.2036
4027      Likelihood ratio test
4028
4029      Model 1: log(fmax) ~ endo * exo
4030      Model 2: log(fmax) ~ endo
4031      #Df LogLik Df Chisq Pr(>Chisq)
4032      1      6 3.1666
4033      2      4 1.5753 -2 3.1827 0.2036
4034      Model df      AIC      BIC      logLik      Test      L.Ratio p-value
4035      full.model      1      6 5.66673 11.33336 3.166635
4036      exo.model      2      4 17.27526 21.05301 -4.637629 1 vs 2 15.60853 4e-04
4037      Likelihood ratio test
4038
4039      Model 1: log(fmax) ~ endo * exo
4040      Model 2: log(fmax) ~ exo
4041      #Df LogLik Df Chisq Pr(>Chisq)
4042      1      6 3.1666

```

```

4043 2 4 -4.6376 -2 15.608 0.000408 ***
4044 ---
4045 Signif. codes: 0 *** 0.001 ** 0.01 * 0.05 . 0.1 1
4046 =====
4047 Model 1a: log(fmax) ~ log(endo)
4048 =====
4049 -----
4050 -----
4051 -----
4052 -----
4053 -----
4054 Redundant readout of chosen model, see above
4055 -----
4056 -----
4057 -----
4058 Linear mixed-effects model fit by maximum likelihood
4059 Data: raw.data
4060 AIC BIC logLik
4061 1.415069 5.192825 3.292466
4062 -----
4063 Random effects:
4064 Formula: ~1 | species
4065 (Intercept) Residual
4066 StdDev: 0.05787534 0.2740456
4067 -----
4068 Correlation Structure: corBrownian
4069 Formula: ~1 | species
4070 Parameter estimate(s):
4071 numeric(0)
4072 Fixed effects: phenotype ~ cofactor
4073 Value Std.Error DF t-value p-value
4074 (Intercept) 6.464760 0.8801017 12 7.345469 0
4075 cofactor 1.333644 0.2114985 12 6.305691 0
4076 Correlation:
4077 (Intr)
4078 cofactor 0.997
4079 -----
4080 Standardized Within-Group Residuals:
4081 Min Q1 Med Q3 Max
4082 -1.8313788 -0.6059318 -0.4628514 0.1919480 1.5309202
4083 -----
4084 Number of Observations: 19
4085 Number of Groups: 6
4086 -----
4087 -----
4088 -----
4089 Abouheif's Cmean
4090 -----
4091 -----
4092 -----
4093 class: krantest lightkrantest
4094 Monte-Carlo tests
4095 Call: as.krantest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4096 obs = res$obs, alter = alter, names = test.names)
4097 -----
4098 Number of tests: 1
4099 -----
4100 Adjustment method for multiple comparisons: none
4101 Permutation number: 999
4102 Test Obs Std.Obs Alter Pvalue
4103 1 dt -0.1378843 -1.027828 greater 0.867
4104 -----
4105 -----
4106 -----
4107 -----
4108 Moran's I
4109 -----
4110 -----
4111 -----
4112 class: krantest lightkrantest
4113 Monte-Carlo tests
4114 Call: as.krantest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4115 obs = res$obs, alter = alter, names = test.names)
4116 -----
4117 Number of tests: 1
4118 -----
4119 Adjustment method for multiple comparisons: none
4120 Permutation number: 999
4121 Test Obs Std.Obs Alter Pvalue
4122 1 dt -0.2006249 -1.071713 greater 0.867
4123 -----

```

```

4124 -----
4125
4126
4127 Pagel's lambda
4128
4129 -----
4130
4131 $lambda
4132 [1] 6.610696e-05
4133
4134 $logL
4135 [1] -24.75061
4136
4137 $logL0
4138 [1] -24.75028
4139
4140 $P
4141 [1] 1
4142
4143 -----
4144
4145
4146 Blomberg's kappa
4147
4148 -----
4149
4150 $K
4151 [1] 0.3945796
4152
4153 $P
4154 [1] 0.898
4155
4156 -----
4157
4158
4159 R2 hypothesis testing
4160
4161 -----
4162
4163      Effect      F      v1      v2      ncp      Rsq
4164 Model:1  Min.    :162.6  Min.    :1  Min.    :18  Min.    :162.6  Min.    :0.9003
4165      1st Qu.:162.6  1st Qu.:1  1st Qu.:18  1st Qu.:162.6  1st Qu.:0.9003
4166      Median :162.6  Median :1  Median :18  Median :162.6  Median :0.9003
4167      Mean    :162.6  Mean    :1  Mean    :18  Mean    :162.6  Mean    :0.9003
4168      3rd Qu.:162.6  3rd Qu.:1  3rd Qu.:18  3rd Qu.:162.6  3rd Qu.:0.9003
4169      Max.    :162.6  Max.    :1  Max.    :18  Max.    :162.6  Max.    :0.9003
4170      upper.CL      lower.CL
4171 Min.    :0.9541  Min.    :0.8252
4172 1st Qu.:0.9541  1st Qu.:0.8252
4173 Median :0.9541  Median :0.8252
4174 Mean    :0.9541  Mean    :0.8252
4175 3rd Qu.:0.9541  3rd Qu.:0.8252
4176 Max.    :0.9541  Max.    :0.8252
4177      Effect      F      v1      v2      ncp      Rsq
4178 Model:1  Min.    :915.3  Min.    :1  Min.    :10.24  Min.    :915.3  Min.    :0.9889
4179      1st Qu.:915.3  1st Qu.:1  1st Qu.:10.24  1st Qu.:915.3  1st Qu.:0.9889
4180      Median :915.3  Median :1  Median :10.24  Median :915.3  Median :0.9889
4181      Mean    :915.3  Mean    :1  Mean    :10.24  Mean    :915.3  Mean    :0.9889
4182      3rd Qu.:915.3  3rd Qu.:1  3rd Qu.:10.24  3rd Qu.:915.3  3rd Qu.:0.9889
4183      Max.    :915.3  Max.    :1  Max.    :10.24  Max.    :915.3  Max.    :0.9889
4184      upper.CL      lower.CL
4185 Min.    :0.9963  Min.    :0.9775
4186 1st Qu.:0.9963  1st Qu.:0.9775
4187 Median :0.9963  Median :0.9775
4188 Mean    :0.9963  Mean    :0.9775
4189 3rd Qu.:0.9963  3rd Qu.:0.9775
4190 Max.    :0.9963  Max.    :0.9775
4191 =====
4192 =====
4193 Model 1b: log(fmax) ~ exo
4194 =====
4195 =====
4196 -----
4197
4198
4199 Redundant readout of chosen model, see above
4200
4201 -----
4202
4203 Linear mixed-effects model fit by maximum likelihood
4204 Data: raw.data

```

```

4205      AIC      BIC      logLik
4206      18.12153 21.89929 -5.060765
4207
4208 Random effects:
4209 Formula: ~1 | species
4210 (Intercept) Residual
4211 StdDev:      0.3394365 0.3400382
4212
4213 Correlation Structure: corBrownian
4214 Formula: ~1 | species
4215 Parameter estimate(s):
4216 numeric(0)
4217 Fixed effects: phenotype ~ cofactor
4218 Value Std.Error DF t-value p-value
4219 (Intercept) 1.6688690 0.9993473 12 1.6699590 0.1208
4220 cofactor 0.1446179 0.1900393 12 0.7609894 0.4614
4221 Correlation:
4222 (Intr)
4223 cofactor 0.986
4224
4225 Standardized Within-Group Residuals:
4226 Min Q1 Med Q3 Max
4227 -1.8808224 -0.3494617 -0.1224661 0.6225276 0.9803464
4228
4229 Number of Observations: 19
4230 Number of Groups: 6
4231 -----
4232
4233 Abouheif's Cmean
4234
4235 -----
4236
4237 class: krantest lightkrantest
4238 Monte-Carlo tests
4239 Call: as.krantest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4240 obs = res$obs, alter = alter, names = test.names)
4241
4242 Number of tests: 1
4243
4244 Adjustment method for multiple comparisons: none
4245 Permutation number: 999
4246 Test Obs Std.Obs Alter Pvalue
4247 1 dt -0.1664261 -1.272207 greater 0.93
4248
4249 -----
4250
4251 Moran's I
4252
4253 -----
4254
4255 class: krantest lightkrantest
4256 Monte-Carlo tests
4257 Call: as.krantest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4258 obs = res$obs, alter = alter, names = test.names)
4259
4260 Number of tests: 1
4261
4262 Adjustment method for multiple comparisons: none
4263 Permutation number: 999
4264 Test Obs Std.Obs Alter Pvalue
4265 1 dt -0.2229836 -1.210614 greater 0.918
4266
4267 -----
4268
4269 Pagel's lambda
4270
4271 -----
4272
4273 $lambda
4274 [1] 6.610696e-05
4275
4276 $logL
4277 [1] -23.18127
4278
4279 $logL0
4280 [1] -23.18096
4281
4282 $P
4283
4284
4285

```

```

4286 [1] 1
4287
4288 -----
4289
4290
4291 Blomberg's kappa
4292
4293 -----
4294
4295 $K
4296 [1] 0.3929312
4297
4298 $P
4299 [1] 0.889
4300
4301 -----
4302
4303
4304 R2 hypothesis testing
4305
4306 -----
4307
4308      Effect      F      v1      v2      ncp      Rsq
4309 Model:1  Min.    :0.673  Min.    :1  Min.    :18  Min.    :0.673  Min.    :0.03604
4310      1st Qu.:0.673  1st Qu.:1  1st Qu.:18  1st Qu.:0.673  1st Qu.:0.03604
4311      Median :0.673  Median :1  Median :18  Median :0.673  Median :0.03604
4312      Mean   :0.673  Mean   :1  Mean   :18  Mean   :0.673  Mean   :0.03604
4313      3rd Qu.:0.673  3rd Qu.:1  3rd Qu.:18  3rd Qu.:0.673  3rd Qu.:0.03604
4314      Max.   :0.673  Max.   :1  Max.   :18  Max.   :0.673  Max.   :0.03604
4315      upper.CL      lower.CL
4316 Min.    :0.3415  Min.    :0.0001099
4317 1st Qu.:0.3415  1st Qu.:0.0001099
4318 Median :0.3415  Median :0.0001099
4319 Mean   :0.3415  Mean   :0.0001099
4320 3rd Qu.:0.3415  3rd Qu.:0.0001099
4321 Max.   :0.3415  Max.   :0.0001099
4322      Effect      F      v1      v2      ncp      Rsq
4323 Model:1  Min.    :3.597  Min.    :1  Min.    :10.24  Min.    :3.597  Min.    :0.26
4324      1st Qu.:3.597  1st Qu.:1  1st Qu.:10.24  1st Qu.:3.597  1st Qu.:0.26
4325      Median :3.597  Median :1  Median :10.24  Median :3.597  Median :0.26
4326      Mean   :3.597  Mean   :1  Mean   :10.24  Mean   :3.597  Mean   :0.26
4327      3rd Qu.:3.597  3rd Qu.:1  3rd Qu.:10.24  3rd Qu.:3.597  3rd Qu.:0.26
4328      Max.   :3.597  Max.   :1  Max.   :10.24  Max.   :3.597  Max.   :0.26
4329      upper.CL      lower.CL
4330 Min.    :0.6908  Min.    :0.00354
4331 1st Qu.:0.6908  1st Qu.:0.00354
4332 Median :0.6908  Median :0.00354
4333 Mean   :0.6908  Mean   :0.00354
4334 3rd Qu.:0.6908  3rd Qu.:0.00354
4335 Max.   :0.6908  Max.   :0.00354
4336 =====
4337 =====
4338 Model 1c:log(uts) ~ log(ratio)
4339 =====
4340 =====
4341 -----
4342
4343
4344 Redundant readout of chosen model, see above
4345
4346 -----
4347
4348 Linear mixed-effects model fit by maximum likelihood
4349 Data: raw.data
4350      AIC      BIC      logLik
4351      3.002342 6.780098 2.498829
4352
4353 Random effects:
4354 Formula: ~1 | species
4355      (Intercept) Residual
4356 StdDev:    0.1273762 0.264866
4357
4358 Correlation Structure: corBrownian
4359 Formula: ~1 | species
4360 Parameter estimate(s):
4361 numeric(0)
4362 Fixed effects: phenotype ~ cofactor
4363      Value Std.Error DF   t-value p-value
4364 (Intercept)  4.346042 0.1691788 12 25.689045 0.0000
4365 cofactor    -0.392986 0.1429984 12 -2.748183 0.0177
4366 Correlation:

```

```

4367      (Intr)
4368      cofactor 0.881
4369
4370      Standardized Within-Group Residuals:
4371      Min      Q1      Med      Q3      Max
4372      -1.7211974 -0.6327484 -0.2639773  0.3271246  1.4433133
4373
4374      Number of Observations: 19
4375      Number of Groups: 6
4376      -----
4377
4378      Abouheif's Cmean
4379
4380
4381      -----
4382
4383      class: krandtest lightkrandtest
4384      Monte-Carlo tests
4385      Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4386      obs = res$obs, alter = alter, names = test.names)
4387
4388      Number of tests: 1
4389
4390      Adjustment method for multiple comparisons: none
4391      Permutation number: 999
4392      Test      Obs      Std.Obs      Alter Pvalue
4393      1      dt -0.1531006 -1.218296 greater  0.919
4394
4395      -----
4396
4397      Moran's I
4398
4399
4400      -----
4401
4402      class: krandtest lightkrandtest
4403      Monte-Carlo tests
4404      Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4405      obs = res$obs, alter = alter, names = test.names)
4406
4407      Number of tests: 1
4408
4409      Adjustment method for multiple comparisons: none
4410      Permutation number: 999
4411      Test      Obs      Std.Obs      Alter Pvalue
4412      1      dt -0.2160349 -1.203095 greater  0.923
4413
4414      -----
4415
4416      Pagel's lambda
4417
4418
4419      -----
4420
4421      $lambda
4422      [1] 6.610696e-05
4423
4424      $logL
4425      [1] -24.74211
4426
4427      $logL0
4428      [1] -24.74177
4429
4430      $P
4431      [1] 1
4432
4433      -----
4434
4435      Blomberg's kappa
4436
4437
4438      -----
4439
4440      $K
4441      [1] 0.3934738
4442
4443      $P
4444      [1] 0.907
4445
4446      -----
4447

```

```

4448 R2 hypothesis testing
4449
4450 -----
4451
4452
4453      Effect      F      v1      v2      ncp      Rsq
4454 Model:1  Min.    :15.59  Min.    :1  Min.    :18  Min.    :15.59  Min.    :0.4642
4455      1st Qu.:15.59  1st Qu.:1  1st Qu.:18  1st Qu.:15.59  1st Qu.:0.4642
4456      Median :15.59  Median :1  Median :18  Median :15.59  Median :0.4642
4457      Mean    :15.59  Mean    :1  Mean    :18  Mean    :15.59  Mean    :0.4642
4458      3rd Qu.:15.59  3rd Qu.:1  3rd Qu.:18  3rd Qu.:15.59  3rd Qu.:0.4642
4459      Max.    :15.59  Max.    :1  Max.    :18  Max.    :15.59  Max.    :0.4642
4460      upper.CL      lower.CL
4461 Min.    :0.7305  Min.    :0.1695
4462 1st Qu.:0.7305  1st Qu.:0.1695
4463 Median :0.7305  Median :0.1695
4464 Mean    :0.7305  Mean    :0.1695
4465 3rd Qu.:0.7305  3rd Qu.:0.1695
4466 Max.    :0.7305  Max.    :0.1695
4467      Effect      F      v1      v2      ncp      Rsq
4468 Model:1  Min.    :20.42  Min.    :1  Min.    :10.24  Min.    :20.42  Min.    :0.6661
4469      1st Qu.:20.42  1st Qu.:1  1st Qu.:10.24  1st Qu.:20.42  1st Qu.:0.6661
4470      Median :20.42  Median :1  Median :10.24  Median :20.42  Median :0.6661
4471      Mean    :20.42  Mean    :1  Mean    :10.24  Mean    :20.42  Mean    :0.6661
4472      3rd Qu.:20.42  3rd Qu.:1  3rd Qu.:10.24  3rd Qu.:20.42  3rd Qu.:0.6661
4473      Max.    :20.42  Max.    :1  Max.    :10.24  Max.    :20.42  Max.    :0.6661
4474      upper.CL      lower.CL
4475 Min.    :0.8831  Min.    :0.3522
4476 1st Qu.:0.8831  1st Qu.:0.3522
4477 Median :0.8831  Median :0.3522
4478 Mean    :0.8831  Mean    :0.3522
4479 3rd Qu.:0.8831  3rd Qu.:0.3522
4480 Max.    :0.8831  Max.    :0.3522
4481 =====
4482 =====
4483 Model 2a: log(ufs) ~ log(Etanl)
4484 =====
4485 =====
4486 -----
4487
4488 Redundant readout of chosen model, see above
4489
4490 -----
4491
4492
4493 Linear mixed-effects model fit by maximum likelihood
4494 Data: raw.data
4495      AIC      BIC      logLik
4496 -2.418591 1.359165 5.209295
4497
4498 Random effects:
4499 Formula: ~1 | species
4500      (Intercept) Residual
4501 StdDev: 0.02805075 0.2522209
4502
4503 Correlation Structure: corBrownian
4504 Formula: ~1 | species
4505 Parameter estimate(s):
4506 numeric(0)
4507 Fixed effects: phenotype ~ cofactor
4508      Value Std.Error DF      t-value p-value
4509 (Intercept) 4.266436 0.5865901 12      7.273284      0
4510 cofactor -0.965919 0.0878050 12     -11.000734      0
4511 Correlation:
4512      (Intr)
4513 cofactor -0.995
4514
4515 Standardized Within-Group Residuals:
4516      Min      Q1      Med      Q3      Max
4517 -1.7031611 -0.4646712 -0.1828606 0.4454772 1.7546710
4518
4519 Number of Observations: 19
4520 Number of Groups: 6
4521 -----
4522
4523 Abouheif's Cmean
4524
4525 -----
4526
4527 class: krandtest lightkrandtest
4528

```



```

4529 Monte-Carlo tests
4530 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4531   obs = res$obs, alter = alter, names = test.names)
4532
4533 Number of tests:      1
4534
4535 Adjustment method for multiple comparisons: none
4536 Permutation number:   999
4537   Test      Obs      Std.Obs      Alter Pvalue
4538 1      dt -0.03886482 -0.2793617 greater  0.543
4539
4540 -----
4541
4542 Moran's I
4543
4544 -----
4545
4546 class: krandtest lightkrandtest
4547 Monte-Carlo tests
4548 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4549   obs = res$obs, alter = alter, names = test.names)
4550
4551 Number of tests:      1
4552
4553 Adjustment method for multiple comparisons: none
4554 Permutation number:   999
4555   Test      Obs      Std.Obs      Alter Pvalue
4556 1      dt -0.0993468 -0.3468022 greater  0.572
4557
4558 -----
4559
4560 Pagel's lambda
4561
4562 -----
4563 $lambda
4564 [1] 6.610696e-05
4565
4566 $logL
4567 [1] -26.76534
4568
4569 $logL0
4570 [1] -26.76506
4571
4572 $P
4573 [1] 1
4574
4575 -----
4576
4577
4578
4579
4580
4581 Blomberg's kappa
4582
4583 -----
4584 $K
4585 [1] 0.4345257
4586
4587 $P
4588 [1] 0.609
4589
4590 -----
4591
4592
4593
4594 R2 hypothesis testing
4595
4596 -----
4597
4598   Effect      F      v1      v2      ncp      Rsq
4599 Model:1   Min.   :334.2   Min.   :1    Min.   :18   Min.   :334.2   Min.   :0.9489
4600           1st Qu.:334.2   1st Qu.:1    1st Qu.:18   1st Qu.:334.2   1st Qu.:0.9489
4601           Median :334.2   Median :1    Median :18   Median :334.2   Median :0.9489
4602           Mean   :334.2   Mean   :1    Mean   :18   Mean   :334.2   Mean   :0.9489
4603           3rd Qu.:334.2   3rd Qu.:1    3rd Qu.:18   3rd Qu.:334.2   3rd Qu.:0.9489
4604           Max.   :334.2   Max.   :1    Max.   :18   Max.   :334.2   Max.   :0.9489
4605   upper.CL   lower.CL
4606   Min.   :0.9766   Min.   :0.9103
4607   1st Qu.:0.9766   1st Qu.:0.9103
4608   Median :0.9766   Median :0.9103
4609   Mean   :0.9766   Mean   :0.9103

```

```

4610 3rd Qu.:0.9766 3rd Qu.:0.9103
4611 Max. :0.9766 Max. :0.9103
4612 Effect F v1 v2 ncp Rsq
4613 Model:1 Min. :802 Min. :1 Min. :10.24 Min. :802 Min. :0.9874
4614 1st Qu.:802 1st Qu.:1 1st Qu.:10.24 1st Qu.:802 1st Qu.:0.9874
4615 Median :802 Median :1 Median :10.24 Median :802 Median :0.9874
4616 Mean :802 Mean :1 Mean :10.24 Mean :802 Mean :0.9874
4617 3rd Qu.:802 3rd Qu.:1 3rd Qu.:10.24 3rd Qu.:802 3rd Qu.:0.9874
4618 Max. :802 Max. :1 Max. :10.24 Max. :802 Max. :0.9874
4619 upper.CL lower.CL
4620 Min. :0.9958 Min. :0.9743
4621 1st Qu.:0.9958 1st Qu.:0.9743
4622 Median :0.9958 Median :0.9743
4623 Mean :0.9958 Mean :0.9743
4624 3rd Qu.:0.9958 3rd Qu.:0.9743
4625 Max. :0.9958 Max. :0.9743
4626 =====
4627 =====
4628 Model 2b: log(ufs) ~ log(Esec)
4629 =====
4630 =====
4631 -----
4632
4633
4634 Redundant readout of chosen model, see above
4635
4636
4637 -----
4638 Linear mixed-effects model fit by maximum likelihood
4639 Data: raw.data
4640 AIC BIC logLik
4641 9.986502 13.76426 -0.9932511
4642
4643 Random effects:
4644 Formula: ~1 | species
4645 (Intercept) Residual
4646 StdDev: 0.1548211 0.3176725
4647
4648 Correlation Structure: corBrownian
4649 Formula: ~1 | species
4650 Parameter estimate(s):
4651 numeric(0)
4652 Fixed effects: phenotype ~ cofactor
4653 Value Std.Error DF t-value p-value
4654 (Intercept) 4.747137 1.0914751 12 4.349285 9e-04
4655 cofactor -0.998803 0.1565428 12 -6.380379 0e+00
4656 Correlation:
4657 (Intr)
4658 cofactor -0.996
4659
4660 Standardized Within-Group Residuals:
4661 Min Q1 Med Q3 Max
4662 -1.62993737 -0.68552313 -0.03623807 0.34605877 1.30483948
4663
4664 Number of Observations: 19
4665 Number of Groups: 6
4666 -----
4667
4668
4669 Abouheif's Cmean
4670
4671
4672 -----
4673 class: krandtest lightkrandtest
4674 Monte-Carlo tests
4675 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4676 obs = res$obs, alter = alter, names = test.names)
4677
4678 Number of tests: 1
4679
4680 Adjustment method for multiple comparisons: none
4681 Permutation number: 999
4682 Test Obs Std.Obs Alter Pvalue
4683 1 dt -0.1767016 -1.40783 greater 0.961
4684
4685 -----
4686
4687
4688 Moran's I
4689
4690

```

```

4691 -----
4692 class: krandtest lightkrandtest
4693 Monte-Carlo tests
4694 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4695   obs = res$obs, alter = alter, names = test.names)
4696
4697 Number of tests: 1
4698
4699 Adjustment method for multiple comparisons: none
4700 Permutation number: 999
4701 Test Obs Std.Obs Alter Pvalue
4702 1 dt -0.2398086 -1.304939 greater 0.935
4703 -----
4704
4705
4706
4707 Page1's lambda
4708
4709 -----
4710
4711 $lambda
4712 [1] 6.610696e-05
4713
4714 $logL
4715 [1] -23.44496
4716
4717 $logL0
4718 [1] -23.44459
4719
4720 $P
4721 [1] 1
4722 -----
4723
4724
4725
4726 Blomberg's kappa
4727
4728 -----
4729
4730 $K
4731 [1] 0.3841912
4732
4733 $P
4734 [1] 0.945
4735 -----
4736
4737
4738
4739 R2 hypothesis testing
4740
4741 -----
4742
4743 Effect F v1 v2 ncp Rsq
4744 Model:1 Min. :95.93 Min. :1 Min. :18 Min. :95.93 Min. :0.842
4745 1st Qu.:95.93 1st Qu.:1 1st Qu.:18 1st Qu.:95.93 1st Qu.:0.842
4746 Median :95.93 Median :1 Median :18 Median :95.93 Median :0.842
4747 Mean :95.93 Mean :1 Mean :18 Mean :95.93 Mean :0.842
4748 3rd Qu.:95.93 3rd Qu.:1 3rd Qu.:18 3rd Qu.:95.93 3rd Qu.:0.842
4749 Max. :95.93 Max. :1 Max. :18 Max. :95.93 Max. :0.842
4750 upper.CL lower.CL
4751 Min. :0.9267 Min. :0.7239
4752 1st Qu.:0.9267 1st Qu.:0.7239
4753 Median :0.9267 Median :0.7239
4754 Mean :0.9267 Mean :0.7239
4755 3rd Qu.:0.9267 3rd Qu.:0.7239
4756 Max. :0.9267 Max. :0.7239
4757 Effect F v1 v2 ncp Rsq
4758 Model:1 Min. :125.9 Min. :1 Min. :10.24 Min. :125.9 Min. :0.9248
4759 1st Qu.:125.9 1st Qu.:1 1st Qu.:10.24 1st Qu.:125.9 1st Qu.:0.9248
4760 Median :125.9 Median :1 Median :10.24 Median :125.9 Median :0.9248
4761 Mean :125.9 Mean :1 Mean :10.24 Mean :125.9 Mean :0.9248
4762 3rd Qu.:125.9 3rd Qu.:1 3rd Qu.:10.24 3rd Qu.:125.9 3rd Qu.:0.9248
4763 Max. :125.9 Max. :1 Max. :10.24 Max. :125.9 Max. :0.9248
4764 upper.CL lower.CL
4765 Min. :0.975 Min. :0.8464
4766 1st Qu.:0.975 1st Qu.:0.8464
4767 Median :0.975 Median :0.8464
4768 Mean :0.975 Mean :0.8464
4769 3rd Qu.:0.975 3rd Qu.:0.8464
4770 Max. :0.975 Max. :0.8464
4771 =====

```

```

4772 =====
4773 Model 2a: log(U) ~ log(Etanl)
4774 =====
4775 -----
4776 -----
4777
4778 Redundant readout of chosen model, see above
4779
4780 -----
4781 -----
4782 -----
4783 Linear mixed-effects model fit by maximum likelihood
4784 Data: raw.data
4785      AIC      BIC      logLik
4786 25.04395 28.82171 -8.521976
4787
4788 Random effects:
4789 Formula: ~1 | species
4790 (Intercept) Residual
4791 StdDev: 2.617516e-05 0.5234637
4792
4793 Correlation Structure: corBrownian
4794 Formula: ~1 | species
4795 Parameter estimate(s):
4796 numeric(0)
4797 Fixed effects: phenotype ~ cofactor
4798      Value Std.Error DF   t-value p-value
4799 (Intercept)  8.777962 1.1989234 12   7.321537  0e+00
4800 cofactor    -1.044415 0.1795643 12  -5.816384  1e-04
4801 Correlation:
4802 (Intr)
4803 cofactor -0.995
4804
4805 Standardized Within-Group Residuals:
4806      Min      Q1      Med      Q3      Max
4807 -1.4767651 -0.6639426 -0.2856563  0.3301078  1.8975712
4808
4809 Number of Observations: 19
4810 Number of Groups: 6
4811 -----
4812 -----
4813
4814 Abouheif's Cmean
4815
4816 -----
4817 -----
4818 class: krandtest lightkrandtest
4819 Monte-Carlo tests
4820 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4821      obs = res$obs, alter = alter, names = test.names)
4822
4823 Number of tests: 1
4824
4825 Adjustment method for multiple comparisons: none
4826 Permutation number: 999
4827      Test      Obs      Std.Obs      Alter Pvalue
4828 1    dt -0.05868724 -0.4851516 greater 0.639
4829
4830 -----
4831 -----
4832
4833 Moran's I
4834
4835 -----
4836 -----
4837 class: krandtest lightkrandtest
4838 Monte-Carlo tests
4839 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4840      obs = res$obs, alter = alter, names = test.names)
4841
4842 Number of tests: 1
4843
4844 Adjustment method for multiple comparisons: none
4845 Permutation number: 999
4846      Test      Obs      Std.Obs      Alter Pvalue
4847 1    dt -0.1194571 -0.4284498 greater 0.613
4848
4849 -----
4850 -----
4851
4852 Pagel's lambda

```

```

4853 -----
4854 $lambda
4855 [1] 6.610696e-05
4856
4857 $logL
4858 [1] -26.54778
4859
4860 $logL0
4861 [1] -26.5475
4862
4863 $P
4864 [1] 1
4865
4866 -----
4867
4868 Blomberg's kappa
4869
4870 -----
4871 $K
4872 [1] 0.4259599
4873
4874 $P
4875 [1] 0.679
4876
4877 -----
4878
4879 R2 hypothesis testing
4880
4881 -----
4882
4883 Effect      F      v1      v2      ncp      Rsq
4884 Model:1  Min.    :95.28  Min.    :1  Min.    :18  Min.    :95.28  Min.    :0.8411
4885      1st Qu.:95.28  1st Qu.:1  1st Qu.:18  1st Qu.:95.28  1st Qu.:0.8411
4886      Median :95.28  Median :1  Median :18  Median :95.28  Median :0.8411
4887      Mean   :95.28  Mean   :1  Mean   :18  Mean   :95.28  Mean   :0.8411
4888      3rd Qu.:95.28  3rd Qu.:1  3rd Qu.:18  3rd Qu.:95.28  3rd Qu.:0.8411
4889      Max.   :95.28  Max.   :1  Max.   :18  Max.   :95.28  Max.   :0.8411
4890
4891      upper.CL      lower.CL
4892 Min.    :0.9263  Min.    :0.7224
4893 1st Qu.:0.9263  1st Qu.:0.7224
4894 Median :0.9263  Median :0.7224
4895 Mean   :0.9263  Mean   :0.7224
4896 3rd Qu.:0.9263  3rd Qu.:0.7224
4897 Max.   :0.9263  Max.   :0.7224
4898
4899 Effect      F      v1      v2      ncp
4900 Model:1  Min.    :134015  Min.    :1  Min.    :10.24  Min.    :134015
4901      1st Qu.:134015  1st Qu.:1  1st Qu.:10.24  1st Qu.:134015
4902      Median :134015  Median :1  Median :10.24  Median :134015
4903      Mean   :134015  Mean   :1  Mean   :10.24  Mean   :134015
4904      3rd Qu.:134015  3rd Qu.:1  3rd Qu.:10.24  3rd Qu.:134015
4905      Max.   :134015  Max.   :1  Max.   :10.24  Max.   :134015
4906
4907      Rsq      upper.CL      lower.CL
4908 Min.    :0.9999  Min.    :1  Min.    :0.9998
4909 1st Qu.:0.9999  1st Qu.:1  1st Qu.:0.9998
4910 Median :0.9999  Median :1  Median :0.9998
4911 Mean   :0.9999  Mean   :1  Mean   :0.9998
4912 3rd Qu.:0.9999  3rd Qu.:1  3rd Qu.:0.9998
4913 Max.   :0.9999  Max.   :1  Max.   :0.9998
4914
4915 =====
4916
4917 Model 2b: log(U) ~ log(Esec)
4918
4919 =====
4920
4921 -----
4922
4923 Redundant readout of chosen model, see above
4924
4925 -----
4926
4927 Linear mixed-effects model fit by maximum likelihood
4928 Data: raw.data
4929      AIC      BIC      logLik
4930 32.16724 35.94499 -12.08362
4931
4932 Random effects:

```

```

4934 Formula: ~1 | species
4935 (Intercept) Residual
4936 StdDev: 0.2284927 0.5868126
4937
4938 Correlation Structure: corBrownian
4939 Formula: ~1 | species
4940 Parameter estimate(s):
4941 numeric(0)
4942 Fixed effects: phenotype ~ cofactor
4943 Value Std.Error DF t-value p-value
4944 (Intercept) 8.651421 1.9158831 12 4.515631 0.0007
4945 cofactor -0.986726 0.2751413 12 -3.586251 0.0037
4946 Correlation:
4947 (Intr)
4948 cofactor -0.996
4949
4950 Standardized Within-Group Residuals:
4951 Min Q1 Med Q3 Max
4952 -1.5349111 -0.6038602 -0.1151023 0.3642676 1.4312340
4953
4954 Number of Observations: 19
4955 Number of Groups: 6
4956 -----
4957
4958 Abouheif's Cmean
4959
4960 -----
4961
4962 class: krandtest lightkrandtest
4963 Monte-Carlo tests
4964 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4965 obs = res$obs, alter = alter, names = test.names)
4966
4967 Number of tests: 1
4968
4969 Adjustment method for multiple comparisons: none
4970 Permutation number: 999
4971 Test Obs Std.Obs Alter Pvalue
4972 1 dt -0.1582943 -1.249247 greater 0.912
4973
4974 -----
4975
4976 Moran's I
4977
4978 -----
4979
4980 class: krandtest lightkrandtest
4981 Monte-Carlo tests
4982 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
4983 obs = res$obs, alter = alter, names = test.names)
4984
4985 Number of tests: 1
4986
4987 Adjustment method for multiple comparisons: none
4988 Permutation number: 999
4989 Test Obs Std.Obs Alter Pvalue
4990 1 dt -0.2213866 -1.204019 greater 0.925
4991
4992 -----
4993
4994 Pagel's lambda
4995
4996 -----
5000
5001 $lambda
5002 [1] 6.610696e-05
5003
5004 $logL
5005 [1] -24.19247
5006
5007 $logL0
5008 [1] -24.19212
5009
5010 $P
5011 [1] 1
5012
5013 -----
5014

```

```

5015
5016 Blomberg's kappa
5017
5018 -----
5019
5020 $K
5021 [1] 0.390273
5022
5023 $P
5024 [1] 0.931
5025
5026 -----
5027
5028
5029 R2 hypothesis testing
5030
5031 -----
5032
5033      Effect      F      v1      v2      ncp      Rsq
5034 Model:1  Min.    :33.37  Min.    :1   Min.    :18  Min.    :33.37  Min.    :0.6496
5035      1st Qu.:33.37  1st Qu.:1   1st Qu.:18  1st Qu.:33.37  1st Qu.:0.6496
5036      Median :33.37  Median :1   Median :18  Median :33.37  Median :0.6496
5037      Mean   :33.37  Mean    :1   Mean   :18  Mean   :33.37  Mean   :0.6496
5038      3rd Qu.:33.37  3rd Qu.:1   3rd Qu.:18  3rd Qu.:33.37  3rd Qu.:0.6496
5039      Max.   :33.37  Max.    :1   Max.   :18  Max.   :33.37  Max.   :0.6496
5040      upper.CL      lower.CL
5041 Min.    :0.8323  Min.    :0.4107
5042 1st Qu.:0.8323  1st Qu.:0.4107
5043 Median :0.8323  Median :0.4107
5044 Mean   :0.8323  Mean   :0.4107
5045 3rd Qu.:0.8323  3rd Qu.:0.4107
5046 Max.   :0.8323  Max.   :0.4107
5047      Effect      F      v1      v2      ncp      Rsq
5048 Model:1  Min.    :43.4  Min.    :1   Min.    :10.24  Min.    :43.4  Min.    :0.8092
5049      1st Qu.:43.4  1st Qu.:1   1st Qu.:10.24  1st Qu.:43.4  1st Qu.:0.8092
5050      Median :43.4  Median :1   Median :10.24  Median :43.4  Median :0.8092
5051      Mean   :43.4  Mean    :1   Mean   :10.24  Mean   :43.4  Mean   :0.8092
5052      3rd Qu.:43.4  3rd Qu.:1   3rd Qu.:10.24  3rd Qu.:43.4  3rd Qu.:0.8092
5053      Max.   :43.4  Max.    :1   Max.   :10.24  Max.   :43.4  Max.   :0.8092
5054      upper.CL      lower.CL
5055 Min.    :0.9353  Min.    :0.6137
5056 1st Qu.:0.9353  1st Qu.:0.6137
5057 Median :0.9353  Median :0.6137
5058 Mean   :0.9353  Mean   :0.6137
5059 3rd Qu.:0.9353  3rd Qu.:0.6137
5060 Max.   :0.9353  Max.   :0.6137
5061 =====
5062
5063 Model 3a: log(Etanl) ~ log(length)
5064 =====
5065 -----
5066
5067
5068
5069 Redundant readout of chosen model, see above
5070
5071 -----
5072
5073 Linear mixed-effects model fit by maximum likelihood
5074 Data: raw.data
5075      AIC      BIC      logLik
5076 29.05284 32.8306 -10.52642
5077
5078 Random effects:
5079 Formula: ~1 | species
5080      (Intercept) Residual
5081 StdDev: 0.4208043 0.4641961
5082
5083 Correlation Structure: corBrownian
5084 Formula: ~1 | species
5085 Parameter estimate(s):
5086 numeric(0)
5087 Fixed effects: phenotype ~ cofactor
5088      Value Std.Error DF t-value p-value
5089 (Intercept) 5.21384 0.9346700 12 5.578268 0.0001
5090 cofactor 0.84298 0.5160489 12 1.633527 0.1283
5091 Correlation:
5092      (Intr)
5093 cofactor -0.975
5094
5095 Standardized Within-Group Residuals:

```

```

5096      Min      Q1      Med      Q3      Max
5097 -1.56461685 -0.50594577 -0.08848169  0.14488667  2.26842990
5098
5099 Number of Observations: 19
5100 Number of Groups: 6
5101 -----
5102
5103
5104 Abouheif's Cmean
5105
5106 -----
5107
5108 class: krandtest lightkrandtest
5109 Monte-Carlo tests
5110 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
5111      obs = res$obs, alter = alter, names = test.names)
5112
5113 Number of tests: 1
5114
5115 Adjustment method for multiple comparisons: none
5116 Permutation number: 999
5117      Test      Obs      Std.Obs      Alter Pvalue
5118 1      dt -0.1366435 -1.359744 greater  0.941
5119 -----
5120
5121
5122
5123 Moran's I
5124
5125 -----
5126
5127 class: krandtest lightkrandtest
5128 Monte-Carlo tests
5129 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
5130      obs = res$obs, alter = alter, names = test.names)
5131
5132 Number of tests: 1
5133
5134 Adjustment method for multiple comparisons: none
5135 Permutation number: 999
5136      Test      Obs      Std.Obs      Alter Pvalue
5137 1      dt -0.2013167 -1.449279 greater  0.954
5138 -----
5139
5140
5141
5142 Pagel's lambda
5143
5144 -----
5145
5146 $lambda
5147 [1] 6.610696e-05
5148
5149 $logL
5150 [1] -30.19343
5151
5152 $logL0
5153 [1] -30.19304
5154
5155 $P
5156 [1] 1
5157 -----
5158
5159
5160
5161 Blomberg's kappa
5162
5163 -----
5164
5165 $K
5166 [1] 0.3732806
5167
5168 $P
5169 [1] 0.992
5170 -----
5171
5172
5173
5174 R2 hypothesis testing
5175
5176

```



```

5177 -----
5178      Effect      F      v1      v2      ncp      Rsq
5179      Model:1      Min.      :8.686      Min.      :1      Min.      :18      Min.      :8.686      Min.      :0.3255
5180              1st Qu.:8.686      1st Qu.:1      1st Qu.:18      1st Qu.:8.686      1st Qu.:0.3255
5181              Median :8.686      Median :1      Median :18      Median :8.686      Median :0.3255
5182              Mean   :8.686      Mean   :1      Mean   :18      Mean   :8.686      Mean   :0.3255
5183              3rd Qu.:8.686      3rd Qu.:1      3rd Qu.:18      3rd Qu.:8.686      3rd Qu.:0.3255
5184              Max.   :8.686      Max.   :1      Max.   :18      Max.   :8.686      Max.   :0.3255
5185      upper.CL      lower.CL
5186      Min.      :0.6417      Min.      :0.05026
5187      1st Qu.:0.6417      1st Qu.:0.05026
5188      Median :0.6417      Median :0.05026
5189      Mean   :0.6417      Mean   :0.05026
5190      3rd Qu.:0.6417      3rd Qu.:0.05026
5191      Max.   :0.6417      Max.   :0.05026
5192      Effect      F      v1      v2      ncp      Rsq
5193      Model:1      Min.      :12.28      Min.      :1      Min.      :10.24      Min.      :12.28      Min.      :0.5453
5194              1st Qu.:12.28      1st Qu.:1      1st Qu.:10.24      1st Qu.:12.28      1st Qu.:0.5453
5195              Median :12.28      Median :1      Median :10.24      Median :12.28      Median :0.5453
5196              Mean   :12.28      Mean   :1      Mean   :10.24      Mean   :12.28      Mean   :0.5453
5197              3rd Qu.:12.28      3rd Qu.:1      3rd Qu.:10.24      3rd Qu.:12.28      3rd Qu.:0.5453
5198              Max.   :12.28      Max.   :1      Max.   :10.24      Max.   :12.28      Max.   :0.5453
5199      upper.CL      lower.CL
5200      Min.      :0.8349      Min.      :0.1757
5201      1st Qu.:0.8349      1st Qu.:0.1757
5202      Median :0.8349      Median :0.1757
5203      Mean   :0.8349      Mean   :0.1757
5204      3rd Qu.:0.8349      3rd Qu.:0.1757
5205      Max.   :0.8349      Max.   :0.1757
5206      =====
5207      =====
5208      Model 3b: log(Esec) ~ log(length)
5209      =====
5210      =====
5211      -----
5212
5213      Redundant readout of chosen model, see above
5214
5215      -----
5216
5217      Linear mixed-effects model fit by maximum likelihood
5218      Data: raw.data
5219            AIC      BIC      logLik
5220            21.82962 25.60737 -6.914808
5221
5222      Random effects:
5223      Formula: ~1 | species
5224              (Intercept) Residual
5225      StdDev: 0.2997113 0.4010905
5226
5227      Correlation Structure: corBrownian
5228      Formula: ~1 | species
5229      Parameter estimate(s):
5230      numeric(0)
5231      Fixed effects: phenotype ~ cofactor
5232              Value Std.Error DF t-value p-value
5233      (Intercept) 5.636584 0.7250005 12 7.774593 0.0000
5234      cofactor 0.749311 0.4014293 12 1.866607 0.0866
5235
5236      Correlation:
5237      (Intr)
5238      cofactor -0.976
5239
5240      Standardized Within-Group Residuals:
5241              Min      Q1      Med      Q3      Max
5242      -1.18046327 -0.36667996 -0.15086541 -0.05279163 2.36567818
5243
5244      Number of Observations: 19
5245      Number of Groups: 6
5246      -----
5247
5248      Abouheif's Cmean
5249
5250      -----
5251
5252      class: krandtest lightkrandtest
5253      Monte-Carlo tests
5254      Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
5255              obs = res$obs, alter = alter, names = test.names)
5256
5257

```

```

5258 Number of tests:      1
5259
5260 Adjustment method for multiple comparisons:  none
5261 Permutation number:    999
5262 Test      Obs      Std.Obs  Alter Pvalue
5263 1      dt -0.1302653 -1.340364 greater  0.952
5264
5265 -----
5266
5267 Moran's I
5268
5269 -----
5270
5271 class: krandtest lightkrandtest
5272 Monte-Carlo tests
5273 Call: as.krandtest(sim = matrix(res$result, ncol = nvar, byrow = TRUE),
5274      obs = res$obs, alter = alter, names = test.names)
5275
5276 Number of tests:      1
5277
5278 Adjustment method for multiple comparisons:  none
5279 Permutation number:    999
5280 Test      Obs      Std.Obs  Alter Pvalue
5281 1      dt -0.1950242 -1.31925 greater  0.951
5282
5283 -----
5284
5285 Pagel's lambda
5286
5287 -----
5288 $lambda
5289 [1] 6.610696e-05
5290
5291 $logL
5292 [1] -30.70119
5293
5294 $logL0
5295 [1] -30.70082
5296
5297 $P
5298 [1] 1
5299
5300 -----
5301
5302 Blomberg's kappa
5303
5304 -----
5305
5306 $K
5307 [1] 0.3765127
5308
5309 $P
5310 [1] 0.994
5311
5312 -----
5313
5314 R2 hypothesis testing
5315
5316 -----
5317
5318 Effect      F      v1      v2      ncp      Rsq
5319 Model:1  Min.    :12.2  Min.    :1  Min.    :18  Min.    :12.2  Min.    :0.4041
5320      1st Qu.:12.2  1st Qu.:1  1st Qu.:18  1st Qu.:12.2  1st Qu.:0.4041
5321      Median :12.2  Median :1  Median :18  Median :12.2  Median :0.4041
5322      Mean    :12.2  Mean    :1  Mean    :18  Mean    :12.2  Mean    :0.4041
5323      3rd Qu.:12.2  3rd Qu.:1  3rd Qu.:18  3rd Qu.:12.2  3rd Qu.:0.4041
5324      Max.    :12.2  Max.    :1  Max.    :18  Max.    :12.2  Max.    :0.4041
5325
5326      upper.CL      lower.CL
5327      Min.    :0.6938  Min.    :0.1103
5328      1st Qu.:0.6938  1st Qu.:0.1103
5329      Median :0.6938  Median :0.1103
5330      Mean    :0.6938  Mean    :0.1103
5331      3rd Qu.:0.6938  3rd Qu.:0.1103
5332      Max.    :0.6938  Max.    :0.1103
5333
5334 Effect      F      v1      v2      ncp      Rsq
5335 Model:1  Min.    :81.51  Min.    :1  Min.    :10.24  Min.    :81.51  Min.    :0.8884

```

```

5339      1st Qu.:81.51  1st Qu.:1  1st Qu.:10.24  1st Qu.:81.51  1st Qu.:0.8884
5340      Median :81.51  Median :1  Median :10.24  Median :81.51  Median :0.8884
5341      Mean   :81.51  Mean   :1  Mean   :10.24  Mean   :81.51  Mean   :0.8884
5342      3rd Qu.:81.51  3rd Qu.:1  3rd Qu.:10.24  3rd Qu.:81.51  3rd Qu.:0.8884
5343      Max.    :81.51  Max.    :1  Max.    :10.24  Max.    :81.51  Max.    :0.8884
5344      upper.CL      lower.CL
5345      Min.    :0.9627  Min.    :0.7723
5346      1st Qu.:0.9627  1st Qu.:0.7723
5347      Median :0.9627  Median :0.7723
5348      Mean   :0.9627  Mean   :0.7723
5349      3rd Qu.:0.9627  3rd Qu.:0.7723
5350      Max.    :0.9627  Max.    :0.7723

```

R code 1.1: Output