

PAPER NAME

**kelly\_2024\_biol\_lett.docx**

AUTHOR

**Clint Kelly**

WORD COUNT

**3397 Words**

CHARACTER COUNT

**19548 Characters**

PAGE COUNT

**15 Pages**

FILE SIZE

**509.7KB**

SUBMISSION DATE

**Aug 7, 2024 6:33 PM GMT+1**

REPORT DATE

**Aug 7, 2024 6:35 PM GMT+1**

### ● 34% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

- 25% Internet database
- 33% Publications database
- Crossref database
- Crossref Posted Content database
- 0% Submitted Works database

### ● Excluded from Similarity Report

- Bibliographic material

# Passive plasticity and a sex difference in the predictability of mobility

Clint D. Kelly<sup>1,✉</sup>

<sup>12</sup>

Département des Sciences biologiques, Université du Québec à Montréal, Montréal, Canada

✉ Correspondence: [Clint D. Kelly](#) <[kelly.clint@uqam.ca](mailto:kelly.clint@uqam.ca)>

## Abstract

Residual within-individual variation (i.e. behavioural predictability)<sup>7</sup> represents the unexplained variance of repeated behavioural measures after controlling for individual variation in behavioural type and plasticity. Unpredictability can arise from many sources including non-adaptive passive plasticity in which an environmental factor acts directly on the individual to create non-adaptive phenotypic variation.<sup>10</sup> In this study, I use radio telemetry to field test the hypothesis that Cook Strait giant weta *Deinacrida rugosa* (Orthoptera: Anostomatidae) exhibit a sex difference in the predictability of their nightly travel distance due to passive behavioural plasticity. As predicted, I found that male mobility (i.e. nightly travel distance) was less predictable than female mobility. Females travel short and predictable distances each night for food and refuges that are close by and readily available. In contrast, male travel is less predictable because they search for female mates that are stochastically dispersed across the landscape. Therefore, their travel distance can vary considerably across nights.

## Introduction

Individuals can differ in their behavioural predictability, defined as residual intra-individual variation (i.e.  $r_{IIV}$ ), after controlling for individual variation in behavioural type (i.e. average behaviour) and behavioural plasticity (i.e. within-individual variation) (Stamps et al. 2012; Biro and Adriaenssens 2013; Cleasby et al. 2015; Westneat et al. 2015). Unpredictable individuals exhibit high variability around their behavioural type and reaction norm slope whereas predictable individuals do not (i.e. exhibit little residual variance). Within-individual residual variance can arise from a variety of non-biological sources including sampling or measurement error and incompletely or inaccurately parameterizing statistical models (i.e. terms are missing from the model that could explain or account for residual heterogeneity) (Westneat et al. 2015). Conversely, greater behavioural predictability (i.e. smaller  $r_{IIV}$ ) could be selected if it improves success in agonistic encounters (e.g. Johnstone 2001) or mating competition (Schuett et al. 2010) or if decreased behavioural predictability (i.e. larger  $r_{IIV}$ ) improves survival (Briffa et al. 2013; Chang et al. 2017; Horváth et al. 2019; see also Brand et al. 2023).

Behavioural predictability could also be weakened by non-adaptive processes such as passive plasticity whereby an environmental factor acts directly on the individual and creates non-adaptive phenotypic variation (Scheiner 2006). For example, the time to find prey could exhibit unpredictable variance if the location of prey is not known by the forager when foraging commences or if daily travel distance is dependent on the number and type of predators encountered, which can be stochastic (Westneat et al. 2015). Therefore, individual animal phenotypes might contain some stochastic variation that, if not otherwise accounted for, would be present as heterogeneous residual phenotypic variance (Westneat et al. 2015).

43 <sup>1</sup> In this study, I field test the hypothesis that Cook Strait giant weta *Deinacrida rugosa*  
44 (Orthoptera: Anostomatidae) exhibit a sex difference in the predictability of their mobility  
45 due to passive behavioural plasticity. <sup>25</sup> *Deinacrida rugosa* is a sexually size dimorphic nocturnal  
46 insect that <sup>1</sup> is endemic to New Zealand and of high conservation importance (McIntyre 2001;  
47 White et al. 2017). It inhabits old pastures, forests, and coastal scrub, and seeks refuge from  
48 predators in the daytime by hiding under vegetation or other objects on the ground (McIntyre  
49 2001). *Deinacrida rugosa* exhibits a scramble competitive mating system wherein males do not  
50 defend resources required by sexually receptive females, nor do they guard harems of females,  
51 as do other deinacridine weta (McIntyre 2001; Kelly 2006). Rather, male *D. rugosa* <sup>5</sup> seek  
52 receptive females as mates at night while females are foraging (McIntyre 2001). Mate searching  
53 results in males travelling considerably longer distances per night than females <sup>1</sup> (Kelly et al.  
54 2008; Kelly and Gwynne 2023a). In contrast, female nightly travel is generally short because  
55 suitable forage is close by <sup>1</sup> (Kelly et al. 2008; Kelly and Gwynne 2023a). <sup>1</sup> Once a male locates a  
56 receptive female, he remains in physical contact with her by using either his antennae or his legs  
57 and follows her until they pair up in a diurnal refuge (McIntyre 2001; Watts et al. 2012). The  
58 pair remains together at least until the following night and copulate repeatedly throughout the  
59 day (McIntyre 2001; Kelly et al. 2008; Kelly <sup>4</sup> et al. 2010; Kelly and Gwynne 2017; Kelly and  
60 Gwynne 2023b; Kelly and Gwynne 2023a).

61 <sup>1</sup> I use radio telemetry to track the nightly distance travelled (i.e. mobility) by <sup>1</sup> male and female *D.*  
62 *rugosa* over several days to test the prediction that females exhibit more consistent mobility than  
63 males because female travel distance is dictated largely by readily available food whereas male  
64 mobility is dictated by females being stochastically dispersed throughout the environment. I will

65 also correlate individual average mating success with behavioural (un)predictability to test if  
66 being more or less predictable confers a mating advantage.

## 67 **Methods**

68 This field study was conducted 5-18<sup>1</sup> March 2019 in an abandoned and regenerating pasture on  
69 the southern side of Te Pākeka/Maud Island, New Zealand (41°02'S, 173°54'E), a 309-ha  
70 scientific reserve free of alien predators (e.g., rodents *Mus* and *Rattus* spp. and stoats *Mustela*  
71 *erminea*) (see Kelly and Gwynne 2023b; Kelly and Gwynne 2023a for details).

72 Adult giant weta were hand-collected<sup>5</sup> by scanning the open ground and pastures at night. A<sup>1</sup> 0.35  
73 g radio transmitter (Pip Ag337; Lotek, Newmarket, Canada) was affixed to the pronotum with  
74 cyanoacrylate glue while ensuring that the antenna pointed backwards (McIntyre 2001; Kelly et  
75 al. 2008). Transmitters represent 3.83% and 1.74% of male and female body mass, respectively.  
76 Weta were released at their point of capture. I used radio<sup>4</sup> telemetry to locate radio-tagged weta  
77 each day. When<sup>1</sup> located I noted whether the radio-tagged weta was paired with an opposite-sex  
78 individual. I<sup>1</sup> then placed a field flag at the location point and measured the distance in meters  
79 between the current flag and the one from the previous day using a 50-m fibreglass tape  
80 measure. This straight-line distance is assumed to be the distance travelled by the tagged weta  
81 the previous night. The nightly travel distance was repeatedly measured  $7.44 \pm 0.56$  ( $n = 16$ )  
82 times for females and  $5.76 \pm 0.45$  ( $n = 16$ ) times for males.

83 I calculated mating success by dividing the total number of times that an individual was found  
84 paired with an opposite-sex conspecific<sup>26</sup> by the total number of times they were located.

16

## 85 Statistical analysis

86 Statistical analyses were performed within the R v. 4.2.1 statistical environment (R Core Team  
87 2024). I used an inverse hyperbolic sine transformation in the R package *bestNormalize*  
88 (Peterson 2021) to transform nightly travel distance (m) to approximate a Gaussian error  
89 distribution. To aid model fitting and interpretation of parameter estimates, observation number  
90 (1–8) was left-centred so that the first observation = 0, and transformed travel distance and sex  
91 were scaled (mean = 0, SD = 1; female = -0.5, male = 0.5) before analysis. Scaling sex provided  
92 variance estimates for the “average” weta irrespective of sex (Hertel et al. 2021).

8

93 I fitted a Bayesian double hierarchical generalized linear mixed-effects (DHGLM) multivariable  
94 model to investigate sex differences in mean- and residual-level nightly travel distance using the  
95 R package brms (Bürkner 2017). A DHGLM simultaneously estimates average-level  
96 behavioural types (the mean part) and the residual variance (the dispersion part) as a function of  
97 fixed effects. The dispersion part of a DHGLM estimates the residual intra-individual variation  
98 (i.e., rIIV) around a behavioural type with larger values indicating less predictability (Hertel et  
99 al. 2021). The mean model contained the fixed effects sex and observation number and their  
100 interaction to explore whether the sexes differed in how they altered their travel distance over  
101 time. Individual ID and observation number were included as random intercepts and slopes,  
102 respectively. The residual model contained the fixed effect sex to test the prediction that females  
103 and males differed in mobility predictability and individual ID and observation number as  
104 random intercepts and slopes, respectively. This model included travel distance as the dependent  
105 variable and was run on four chains using relatively uninformative, default priors for a total of  
106 10000 iterations, with a warm-up of 6000, and a thinning interval of 4. Model convergence was

2

2

2

2

4

24

2

2

2

107 verified with sufficient mixing of trace plots, with all Rhat values = 1. I report posterior means  
108 with 95% credible intervals (CrI), with inference based on CrIs not overlapping zero.

109 I extracted mobility behavioural type<sup>3</sup> as the mean and credible interval of the posterior  
110 distribution of each individual's random intercept. I then extracted<sup>11</sup> the posterior distribution of  
111 the rIIV for each level of the random intercept as an indicator of behavioural predictability. Each  
112 of these measures of behavioural variation was then correlated with individual average mating  
113 success using a Pearson product-moment correlation. Correlations were made for each sex  
114 separately.

115 Data were visualized using the R packages *ggplot2* (Wickham 2016).<sup>17</sup> Means are given  $\pm$  one  
116 standard error of the mean (SEM) unless otherwise noted.

## 117 Results

118 A previous report on this population of animals (Kelly and Gwynne 2023a) showed that males  
119 (<sup>1</sup> $18.77 \pm 4.46$  m/night,  $n = 17$ ) travel significantly farther per night on average<sup>1</sup> than females  
120 ( $7.89 \pm 1.26$  m/night,  $n = 16$ ) and that travel distance is significantly repeatable in both sexes  
121 (<sup>1</sup>males:  $R = 0.60$  [0.33–0.77],  $n = 17$ ; females:  $R = 0.30$  [0.06–0.51],  $n = 16$ ).

122 <sup>15</sup>The population level mean residual standard deviation for nightly travel distance is 7.66 m  
123 (<sup>3</sup>back-transformed intercept of the dispersion model  $\exp(y_0) = -0.47$ ; Table 1). As predicted,  
124 females were more predictable in their nightly travel distance than males ( $y_{\text{sex}} = 0.32$  [0.04,  
125 0.57]; <sup>3</sup>Figure 1). The predicted standard deviation from the mean residual standard deviation  
126 (rIIV) for nightly travel distance varied across individuals ( $\omega^2_{\text{ID}} = 0.12$  [0.01, 0.32]), which  
127 suggests that the predictability of nightly movement differs<sup>15</sup> across individuals.



128 Behavioural type was not correlated with predictability ( $r = -0.12$  [-0.87, 0.78]) nor was  
129 behavioural predictability (females:  $r = -0.122$ ,  $df = 14$ ,  $p = 0.654$ ; males:  $r = 0.064$ ,  $df = 15$ ,  
130  $p = 0.807$ ) or behavioural type (females:  $r = 0.10$ ,  $df = 14$ ,  $p = 0.714$ ; males:  $r = -0.19$ ,  $df = 15$ ,  
131  $p = 0.453$ ) correlated with mating success in either sex.

## 132 Discussion

133 My field study found, as predicted, that adult male *D. rugosa* were less predictable in their  
134 nightly travel distance than females but there was no correlation between behavioural type  
135 (i.e. nightly travel distance) and predictability. Moreover, behavioural predictability did not  
136 correlate with mating success. The observed sex difference in behavioural predictability is likely  
137 caused by passive plasticity.

138 I hypothesize that the greater predictability of female nightly travel distance likely reflects  
139 passive plasticity rather than adaptive residual within-individual variation (Westneat et al.  
140 2015). Females travel significantly less per night, on average than males (Kelly et al. 2008;  
141 Kelly and Gwynne 2023a), likely because adequate forage and diurnal refuges happen to be  
142 nearby and do not require extensive travel. Short travel distances are likely also adaptive for  
143 females because less travel means smaller energetic costs (Kelly and Gwynne 2016). In contrast,  
144 male unpredictability also likely reflects passive plasticity as male travel distance is dictated by  
145 female proximity (Kelly and Gwynne 2016; Kelly and Gwynne 2023a) meaning that the sooner  
146 a mate is found, the less a male travels (Watts et al. 2011). Once a female is located, the male  
147 follows her until she finds a suitable place to refuge for the day. The travel distance from the  
148 point of mate location by the male to the daytime refugia is generally quite short (i.e. a few  
149 metres). Since sexually receptive females are stochastically distributed across the landscape

150 male distance-to-location should vary across nights Neither male nor female mating success  
151 correlated with behavioural predictability. Females are likely predictable for non-reproductive  
152 reasons therefore a lack of correlation with mating success is not surprising. On the other hand,  
153 it is surprising that there appears to be little reproductive advantage to males in being  
154 unpredictable further supporting the hypothesis that their plasticity is passive rather than  
155 adaptive.

156 Hertel et al. (2020) also found that male African elephants (*Loxodonta africanus*) tend to be less  
157 predictable than females in their daily travel distance, however, no biological explanation was  
158 provided for this sex difference. Another study showed considerable variation among female  
159 brown bears (*Ursus arctos*) in the predictability<sup>2</sup> of their daily movement distances (Hertel et al.  
160 2021). Unlike the current study, Hertel et al. (2021) showed that behavioural type correlates  
161 with behavioural predictability as more predictable bears moved less per day on average and  
162 were less diurnal than less predictable bears.

163 Although there is a paucity of studies examining sex differences in movement behaviour (see  
164 Spiegel et al. 2017), a handful of studies have examined<sup>2</sup> sex differences in the predictability of  
165 other fitness-related behaviours<sup>2</sup> (White and Briffa 2017; Horváth et al. 2019; McLean and  
166 Morrell 2020; Brand et al. 2023). These studies suggest, however, that one sex is not more  
167 consistently predictable than the other. For example,<sup>21</sup> Brand et al. (2023) found that male  
168 *Gambusia holbrooki* mosquitofish are more predictable than females in some behaviours but  
169 less predictable in others. They suggest that the sexes might<sup>2</sup> adjust their behavioural consistency  
170 differently in response to subtle environmental changes.

171 Previous studies have shown that male *D. rugosa* move<sup>1</sup> farther per night on average than  
172 females on Maud Island<sup>1</sup> (Kelly et al. 2008; Kelly and Gwynne 2023a) and Karori Sanctuary

173 (Watts et al. 2012) but not<sup>5</sup> on Matiu-Somes Island (Watts et al. 2011). Population differences in  
174 sex-specific travel distances might be related to the higher population density on Matiu-Somes  
175 Island, making mate location easier for males (Watts et al. 2011). Kelly and Gwynne (2023a)  
176 showed<sup>22</sup> that both males and females exhibit significant repeatability in their nightly travel  
177 distance suggesting that members of this species express behavioural types. I found, however,  
178 that type-dependent movement patterns in *D. rugosa* were not related to mating success in either  
179 sex. Perhaps behavioural types in this species confer survival advantages rather than  
180 reproductive benefits. Future work should identify how male and female *D. rugosa* benefit from  
181 adopting one behavioural type over another.

182 In conclusion, the sex difference in behavioural predictability exhibited by *D. rugosa* in the  
183 current study appears to be driven by male responses to female dispersion across the landscape.  
184 Confirmation of this hypothesis will require controlled laboratory tests wherein food, for  
185 example, is not provided and travel distance is measured. I would expect no sex difference in  
186 travel distance under this scenario because females will continue to walk in search of food and  
187 males will walk as far in search of females. We need to redress the paucity of published studies  
188 on sex differences in behavioural predictability, particularly regarding mobility (Spiegel et al.  
189 2017), to elucidate if differences between males and females is the general pattern, and if so,  
190 identify why.

## 191 **Declarations**

192 **Funding**<sup>13</sup> Natural Sciences and Engineering Research Council of Canada (NSERC).

193 **Availability of data and materials**<sup>19</sup> Data are available on Open Science Framework:  
194 DOI 10.17605/OSF.IO/T9CEH.

## References

- Biro P, Adriaenssens B. 2013. Predictability as a personality trait: Consistent differences in intraindividual behavioral variation. *Am Nat.* 182(5):621–629.
- Brand J, Henry J, Melo G, Wlodkowic D, Wong B, Martin J. 2023. Sex differences in the predictability of risk-taking behavior. *Behav Ecol.* 34(1):108–116.
- Briffa M, Bridger D, Biro PA. 2013. How does temperature affect behaviour? Multilevel analysis of plasticity, personality and predictability in hermit crabs. *Anim Behav.* 86(1):47–54.
- Bürkner P-C. 2017. brms: An R package for Bayesian multilevel models using Stan. *Journal of Statistical Software.* 80(1):4308.
- Chang C, Teo H, Norma-Rashid Y, Li D. 2017. Predator personality and prey behavioural predictability jointly determine foraging performance. *Sci Rep.* 7:40734.
- Cleasby IR, Nakagawa S, Schielzeth H. 2015. Quantifying the predictability of behaviour: Statistical approaches for the study of between-individual variation in the within-individual variance. Hadfield J, editor. *Methods Ecol Evol.* 6(1):27–37.
- Hertel A, Niemelä P, Dingemanse N, Mueller T. 2020. A guide for studying among-individual behavioral variation from movement data in the wild. *Mov Ecol.* 8:30.
- Hertel A, Royauté R, Zedrosser A, Mueller T. 2021. Biologging reveals individual variation in behavioural predictability in the wild. *J Anim Ecol.* 90(3):723–737.
- Horváth G, Garamszegi L, Bereczki J, Urszán T, Balázs G, Herczeg G. 2019. Roll with the fear: Environment and state dependence of pill bug (*armadillidium vulgare*) personalities. *Naturwissenschaften.* 106(3-4):7.
- Johnstone R. 2001. Eavesdropping and animal conflict. *Proc Natl Acad Sci U S A.* 98(16):9177–9180.
- Kelly CD. 2006. The relationship between resource control, association with females and male weapon size in a male dominance insect. *Ethology.* 112(4):362–369.
- Kelly CD, Bussiere LF, Gwynne DT. 2010. Pairing and insemination patterns in a giant weta (*Deinacrida rugosa*: Orthoptera; Anostostomatidae). *J Ethol.* 28(3):483–489.
- Kelly CD, Bussière LF, Gwynne DT. 2008. Sexual selection for male mobility in a giant insect with female-biased size dimorphism. *Am Nat.* 172(3):417–423.
- Kelly CD, Gwynne DT. 2016. The effect of condition on mate searching speed and copulation frequency in the Cook Strait giant weta. *Behav Ecol Sociobiol.* 70(8):1403–1409.
- Kelly CD, Gwynne DT. 2017. Do male Cook Strait giant weta prudently allocate sperm. *J Insect Behav.* 30(3):308–317.

230 Kelly CD, Gwynne DT. 2023a. Effect of body condition on mobility and mating success in a  
 231 wild population of the scramble polygynous Cook Strait giant weta. *Behav Ecol Sociobiol.*  
 232 77:5.

233 Kelly CD, Gwynne DT. 2023b. Mating assortment and the strength of sexual selection in a  
 234 polyandrous population of cook strait giant weta. *Behav Ecol.* 34:506–513.

235 McIntyre M. 2001. The ecology of some large weta species in New Zealand. In: Field LH,  
 236 editor. *The biology of wetas, king crickets and their allies.* Wallingford, UK: CABI  
 237 Publishing. p. 225–242.

238 McLean S, Morrell L. 2020. Consistency in the strength of laterality in male, but not female,  
 239 guppies across different behavioural contexts. *Biol Lett.* 16(5):20190870.

240 Peterson RA. 2021. Finding optimal normalizing transformations via best normalize. *R*  
 241 *Journal.* 13(1):2312–2327.

242 R Core Team. 2024. *R: A language and environment for statistical computing.*

243 Scheiner SM. 2006. Genotype-environment interactions and evolution. In: Fox C, Wolf J,  
 244 editors. *Evolutionary genetics: Concepts and case studies.* Oxford, UK: Oxford ÉUniversity  
 245 Press. p. 326–338.

246 Schuett W, Tregenza T, Dall S. 2010. Sexual selection and animal personality. *Biol Rev*  
 247 *Camb Philos Soc.* 85(2):217–246.

248 Spiegel O, Leu S, Bull C, Sih A. 2017. What’s your move? Movement as a link between  
 249 personality and spatial dynamics in animal populations. *Ecol Lett.* 20(1):3–18.

250 Stamps JA, Briffa M, Biro PA. 2012. Unpredictable animals: Individual differences in  
 251 intraindividual variability (IIV). *Anim Behav.* 83(6):1325–1334.

252 Watts C, Empson R, Thornburrow D, Rohan M. 2012. Movements, behaviour and survival  
 253 of adult Cook Strait giant weta (*Deinacrida rugosa*; Anostostomatidae: Orthoptera)  
 254 immediately after translocation as revealed by radiotracking. *J Insect Conserv.* 16(5):763–  
 255 776.

256 Watts C, Stringer I, Thornburrow D, MacKenzie D. 2011. Are footprint tracking tunnels  
 257 suitable for monitoring giant weta (Orthoptera: Anostostomatidae)? Abundance,  
 258 distribution and movement in relation to tracking rates. *J Insect Conserv.* 15(3):433–443.

259 Westneat D, Wright J, Dingemanse N. 2015. The biology hidden inside residual within-  
 260 individual phenotypic variation. *Biological Reviews.* 90(3):729–743.

261 White DJ, Watts C, Allwood J, Prada D, Stringer I, Thornburrow D, Buckley TR. 2017.  
 262 Population history and genetic bottlenecks in translocated Cook Strait giant weta,  
 263 *Deinacrida rugosa*: Recommendations for future conservation management. *Conservation*  
 264 *Genetics.* 18(2):411–422.

265 White S, Briffa M. 2017. How do anthropogenic contaminants (ACs) affect behaviour?  
266 Multi-level analysis of the effects of copper on boldness in hermit crabs. *Oecologia*.  
267 183(2):391–400.

268 Wickham H. 2016. *ggplot2: Elegant graphics for data analysis*. Springer.

269

Table 1: Estimates [95% credible intervals, CrI] of fixed and random effects on nightly travel distance (mean model) and residual standard deviation of nightly travel distance (dispersion model) in Cook Strait giant weta (*D. rugosa*). Variation in mean behaviour and residual standard deviation of behaviour ( $r_{IIV}$ ) was estimated among individual weta of both sexes. Estimates are based on double hierarchical mixed models.

	Estimate [95% CrI]
<b>Mean model</b>	
<b>Fixed effects</b>	
Intercept	0.28 [-0.07, 0.63]
Sex	0.85 [0.13, 1.57]
Observation.n	-0.07 [-0.15, 0.01]
Sex x observation.n	-0.08 [-0.24, 0.08]
<b>Random effects</b>	
$sd_{\text{intercept}}$	0.72 [0.43, 1.09]
$sd_{\text{slope.observation.n}}$	0.09 [0.01, 0.17]
$r_{\text{intercept-slope}}$	-0.51 [-0.88, 0.50]
<b>Dispersion model</b>	
<b>Fixed effects</b>	
Intercept	-0.47 [-0.65, -0.27]
Sex	0.32 [0.04, 0.57]
<b>Random effects</b>	
$\omega^2$	0.12 [0.01, 0.32]
$r_{\text{intercept-}\omega}$	-0.12 [-0.87, 0.78]
$r_{\text{observation.n-}\omega}$	-0.11 [-0.88, 0.83]

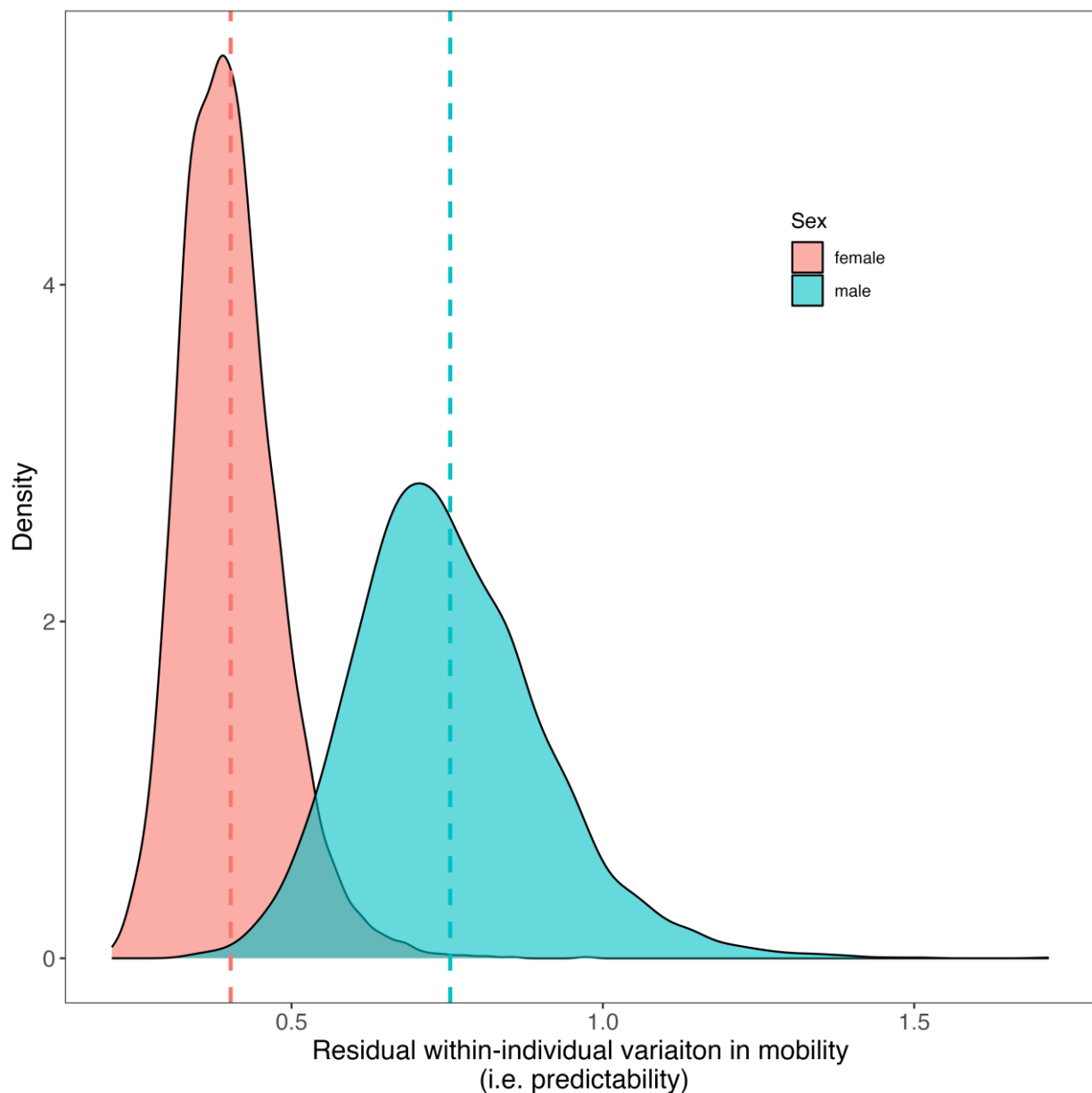


Figure 1: Sex difference in behavioural predictability in the Cook Strait giant weta (*D. rugosa*). Plots represent the posterior probability distributions for residual within-individual variance (i.e., predictability) in nightly distance travelled extracted from a Bayesian double hierarchical linear mixed-effects model. Distributions are shown for females (red) and males (blue) with vertical dotted lines representing posterior means for each sex, respectively.



## ● 34% Overall Similarity

Top sources found in the following databases:

- 25% Internet database
- 33% Publications database
- Crossref database
- Crossref Posted Content database
- 0% Submitted Works database

### TOP SOURCES

The sources with the highest number of matches within the submission. Overlapping sources will not be displayed.

1	<b>Clint D. Kelly, Darryl T. Gwynne. "Effect of body condition on mobility a...</b>	14%
	Crossref	
2	<b>ncbi.nlm.nih.gov</b>	7%
	Internet	
3	<b>publikationen.ub.uni-frankfurt.de</b>	2%
	Internet	
4	<b>academic.oup.com</b>	1%
	Internet	
5	<b>link.springer.com</b>	1%
	Internet	
6	<b>Westneat, David F., Jonathan Wright, and Niels J. Dingemanse. "The bi...</b>	1%
	Crossref	
7	<b>movementecologyjournal.biomedcentral.com</b>	<1%
	Internet	
8	<b>Jack A. Brand, Winston K. W. Yee, Ian J. Aitkenhead, Jake M. Martin et ...</b>	<1%
	Crossref	

9	<b>researcharchive.vuw.ac.nz</b> Internet	<1%
10	<b>researchgate.net</b> Internet	<1%
11	<b>Gergely Horváth, Tibor Sos, Gábor Bóné, Csanád Endre Lőrincz, Péter L...</b> Crossref	<1%
12	<b>Clint D. Kelly. " Sexually dimorphic effect of mating on the melanotic e...</b> Crossref	<1%
13	<b>microbiomejournal.biomedcentral.com</b> Internet	<1%
14	<b>Peter A. Biro, Theodore Garland, Christa Beckmann, Beata Ujvari, Frede...</b> Crossref	<1%
15	<b>Anne G. Hertel, Raphaël Royauté, Andreas Zedrosser, Thomas Mueller....</b> Crossref	<1%
16	<b>assets.researchsquare.com</b> Internet	<1%
17	<b>Clint D. Kelly. "Alternative mating strategies in the Wellington tree weta...</b> Crossref	<1%
18	<b>dx.doi.org</b> Internet	<1%
19	<b>journals.plos.org</b> Internet	<1%
20	<b>Johannes Strauß, Daniel R. Howard. "Chapter 3 Vibrational Behaviour a...</b> Crossref	<1%

- 
- 21** Kasper, Julia C.. "Mate Choice and Sexual Conflict in a Livebearing Fis... **<1%**  
Publication
- 
- 22** Clint D Kelly, Darryl T Gwynne. "Mating assortment and the strength of ... **<1%**  
Crossref
- 
- 23** Kasja Malkoc, Lucia Montesana, Stefania Casagrande, Michaela Hau. "... **<1%**  
Crossref
- 
- 24** eprints.nottingham.ac.uk **<1%**  
Internet
- 
- 25** Clint D. Kelly. " Effect of nutritional stress and sex on melanotic encaps... **<1%**  
Crossref
- 
- 26** Iago Sanmartín-Villar, Raphaël Jeanson. "Early social context does not ... **<1%**  
Crossref