

Grow with care: body size is a signal of status in strategic growth

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Abstract

Strategic growth is an extreme form of plasticity in body growth occurring in social groups with high reproductive skew; it is typically associated with reproductive conflict. Subordinate individuals grow, stop growing or even shrink depending on size or size changes of their closer dominant, as the lack of a sufficiently large size gap fuels overt aggression. By modulating growth rate, individuals establish a size hierarchy which defines priority of access to reproductive opportunities. Initially reported in vertebrates, it has recently been documented in the annelid *Ophryotrocha puerilis* using growth curve analysis. Here, by varying the size gap between paired hatchlings of *O. puerilis*, we test whether strategic growth in annelids fulfills the criteria identified for vertebrates. Subordinates – not dominants – modulated their growth depending on the within-pair size gap (they grew faster if size gap was larger) so that initially large size gaps diminished and initially small size gaps increased. Moreover, hatchling closer in size were more likely to exhibit agonistic interactions. We discuss these results in the light of social queueing and individual decision-making: by modulating growth rate, subordinates use body size – traditionally viewed as a relatively fixed morphological signal – as a signal of status that informs dominants on their decision about the conflict.

Introduction

Competition and conflicts are inherent to animal social contexts, be them short-term interactions at mating in solitary species, or more frequent, stable relationships in social groups; the ability to resolve conflicts is fundamental for group living (West & Ghoul, 2019; Rubenstein & Rubenstein, 2024; Kappeler et al., 2019). One way to resolve conflicts is establishing social hierarchies. This happens as individuals, after initial overt agonistic interactions, acknowledge who has priority of access to key resources or social commodities which would typically result in enhanced reproductive success (Chase, 1982; Drew, 1993; Tibbetts, 2022; Strauss et al., 2022). Individuals who gain higher status – dominants – have generally higher intrinsic behavioral or physical qualities and/or stronger motivation (Parker, 1974; Tibbetts, 2022). Often, dominants are the largest individuals in the group, because competitive and fighting abilities correlates with body size (Clutton-Brock & Huchard, 2013; Holekamp & Strauss, 2016). For instance, among male gorillas in the wild, alpha males in multimale groups were the largest males in six groups out of seven (Wright et al., 2019). Similarly, the larger crayfish typically win dyadic lab-staged encounters (Ueno & Nagayama, 2012).

In the above cases, the largest individuals take advantage of physical asymmetry (their larger body size) to ascend the social hierarchy, suggesting that size affects rank. In other species, selection has promoted the opposite mechanism: in some species individuals adjust their body size to the position they have acquired in the hierarchy, so that body size reflects the exact rank in the hierarchy. Here, rank affects size. This ability, called strategic growth (Buston & Clutton-Brock, 2022), implies that body size and growth rate are plastic in relation to the *local* social context: individuals grow, stop growing, adjust their growth rate or even shrink depending on the growth and size changes of *their closest competitors* in the social group (or following changes in the group composition) (Buston, 2003; Buston & Clutton-Brock,

2022). Attaining and maintaining a size difference emerges as a fundamental mechanism to resolve reproductive conflicts in high-skew social groups, where being at the top of the size hierarchy typically gives direct access to reproduction, whereas lower ranks queue for breeding opportunities (Buston & Clutton-Brock, 2022).

Strategic growth has been documented in subordinate *Amphiprion percula* clownfish, who grow if their closer dominant is different enough in size and decrease or stop growing if the latter is close in size (Buston 2003; Buston & Cant 2006); accordingly, when clownfish shrank during a strong marine heatwave, dominants shrank more if their nearest subordinate was much smaller (Versteeg et al., 2025). Similarly, subordinate meerkats grew faster if their closer same-sex rivals accelerated their growth following experiment food supplementation (Huchard et al., 2016). Body size is strategically regulated also in relation to the sudden opening of breeding opportunities; in the wild, meerkat females accelerate growth in response to the replacement of their father by an unrelated male (i.e., a potential breeding partner) at the top position of the male hierarchy (Dubuc & Clutton-Brock, 2018). Similarly, non-breeding females of Damaraland mole rats exhibit a growth spurt at the opening of a breeding vacancy (Thorley et al., 2018).

Recently, our lab suggested that strategic growth explained the atypical growth rate observed among hatchlings of the marine annelid *Ophryotrocha puerilis*. In this sequentially hermaphroditic species, the largest individuals in the group are females (individuals initially mature as males and change sex to females later in life) (Paxton & Akesson, 2007) and body size is an important determinant of reproductive success: larger females produce larger clutches more often and larger males win fights in mate competition, although females tend to prefer to mate with small males (Berglund, 1990). When reared together, unrelated hatchlings exhibited growth spurts which consistently differed in speed and duration, so that initially size-matched hatchlings quickly established size differences and organized in a size hierarchy (Radhakrishnan et al., 2026a). Size differences were predictive of who, among the hatchlings, would become female earlier (Radhakrishnan et al., 2026b), suggesting females are dominants in the size hierarchy (females get higher reproductive success than males in male-first sequential hermaphrodites, Benvenuto et al., 2017; Pla et al., 2020). It could be claimed that the faster growth rate of females-to-be was *physiologically* triggered, i.e., associated to mobilizing resources for sexual maturation (gonadal development, traits to attract mates, etc.) rather than *socially* triggered, i.e., related to the size of direct reproductive competitors in the group (Heg et al., 2004).

Strategic growth is unequivocally identified if two criteria are met. First, subordinate – not dominant – growth should be negatively correlated with the size ratio between closest ranks (size ratio = size of the lower rank over the size of higher rank, Wong et al., 2016): subordinates, who are typically smaller, should grow faster when cohabiting with a much larger dominant than with a less large dominant (Heg et al., 2004; Buston & Cant, 2006; Hamilton & Heg, 2008; Wong et al., 2016), though they would keep being smaller than their direct dominant. Second, intensity of conflict should be positively correlated with size ratio between closest ranks: aggression should occur more frequently between size-matched competitors (Wong et al., 2016).

Here we verify whether *O. puerilis* meet the criteria for strategic growth. These segmented worms are almost microscopic (adults reach 4–7 mm, Paxton & Åkesson, 2007) and live in sediments and interstices in marine habitats, e.g., in mussel clusters (Struck et al., 2015), and behavioral observations in the wild are challenging. Analyses of mammal bones experimentally introduced in coastal areas document they easily establish new colonies where multiple size classes cohabit and haplotypes persist across generations, suggesting stable colony membership over time (Taboada et al., 2016, 2017). Their lifespan is > 5 months in laboratory conditions (Prevedelli et al., 2006). The two features – stable group membership and relatively long lifespan – are pre-requisites for the evolution of strategic growth (Buston & Clutton-Brock, 2022). *O. puerilis* worms hatch from their mucous egg-cocoon as 1–2 segment-long hatchlings and grow by adding segments. They first mature as males and change sex to female later in life (protandrous sequential hermaphrodites, Paxton & Åkesson, 2007). Size and age at sex change vary largely depending on size and sex of other group members (Radhakrishnan et al., 2026b).

To test the criteria for strategic growth, we manipulated the size difference of isolated pairs of *O. puerilis*, which allows for isolating the effects of the nearest rival's size more clearly than groups. Each pair consisted of a small focal hatchling (the “subordinate”) and a larger partner (the “dominant”); the partner was either three times larger than the focal hatchling or one-third larger. Following Wong et al. (2016), we calculated within-pair *initial* and *final* size ratio (namely, the size of the focal individual over the size of its partner), where the initial size ratio was the one we set up at the start of the experiment, and the final size ratio was that individuals reached by the end of the experiment (as any of the two pair members changed sex to female). If strategic growth explained growth rate in this annelid, we expected the *focal hatchlings* (and *not their partners*) modulated their growth rate so that within-pair size ratio decreased where it was initially larger (i.e., focal hatchlings should grow more if the size gap with their partner is larger). Second, we performed behavioral observations on pairs with different size ratios and recorded the amount of aggression, predicting that the intensity of conflict would increase with increasing size ratio (i.e., more agonistic interactions between partners with smaller size gap).

Material and methods

Model species

Ophryotrocha puerilis live in eutrophic coastal habitats of Mediterranean Sea and Atlantic Ocean (Paxton & Åkesson, 2007; Taboada et al., 2016, 2017). Our lab populations were originally collected in NW Mediterranean Sea in 2015. Hatchlings are miniature adults (direct development) and leave their egg cocoons ~ 8 days after the female lays eggs; they mature as males at a body size of 9 segments (Paxton & Åkesson, 2007) and switch to females at a size of 16–22 segments and an age of 16–42 days, depending on the size of other individuals in the group (Radhakrishnan et al., 2026b).

Mating occurs via pseudocopulation (Paxton & Åkesson, 2007), where partners, in physical contact with each other, release their gametes in a freshly produced mucous cocoon. Large females are far more

fecund than small ones (30 to up to 400 eggs, Radhakrishnan et al., 2026a) and lay eggs as often as every 5 days, for months (Berglund, 1990).

For the experiments, we produced newly hatched individuals by setting up 40 parental pairs of unrelated individuals. We isolated the hatchlings to minimize differences in developmental conditions (e.g., long-lasting effects on the expression of aggression, Holekamp & Strauss, 2016) until they entered the experiments (isolation lasted 0, 3–5 or 12–14 days, depending on whether the experimental individuals were 4-, 6 or 13 segments long, see below).

Experimental procedure

Size ratio and percent size change

We set up 40 pairs, each composed of a 4-segment-long hatchling (hereafter, focal hatchling) coupled with either a 6-segment-long partner ($n = 20$ pairs, large initial size ratio) or a 13-segment-long partner ($n = 20$ pairs, small initial size ratio). Pairs were housed in 20mL glass bowls. No individual had switched to female yet, and we distinguished pair members by size.

Each 2–3 days, we checked whether any pair members had eggs in their body cavity - a proxy for sex change to female (eggs are visible through the worms' transparent body walls); if this was the case, we measured body size in both pair members as the number of segments (annelids have a hydrostatic skeleton allowing body-length variation, Kier, 2012). The experiment ended as any of the two individuals changed sex to female (i.e., when the conflict is settled, Radhakrishnan et al., 2026a).

Behavioral interactions

We tested whether conflict intensity varied with within-pair size ratio (*O. puerilis* worms exhibit aggression, Berglund, 1986). To this aim, we set up another 77 pairs as follows:

- small size ratio ($= 0.3$): a 4-segment hatchling and a large, 13-segment partner ($n = 20$ pairs)
- intermediate size ratio ($= 0.7$): a 4-segment hatchling and a small, 6 segment partner ($n = 17$ pairs)
- large size ratio ($= 1$): size-matched individuals. Partners were either both 6-segments long ($n = 20$ pairs) or both 11–13 segments long ($n = 20$ pairs), to control for differences in behavioral performance and/or expression of aggression associated with age or body size (e.g., Vidal et al., 2019; Mauduit & Jeanson, 2023; Collard et al., 2024).

These pairs were separately housed in lids of 1.5mL Eppendorf tube (diameter: 8 mm; 0.5mL of water) perfectly fitting the microscope field of view (preliminary tests showed that worms live up to 1 week and even lay eggs in Eppendorf tube lids). We let pairs acclimate for 15 mins prior to videorecording with a Leica M80 stereo microscope equipped with Leica IC80 HD camera (1–3 hours, mean $\pm$ SD: 82 ± 24 mins). Using BORIS (Friard & Gamba, 2016), we counted the number of attacks (a proxy for conflict intensity) between pair members and measured the time they spent in spatial proximity (less than a

body-size distance) or non-aggressive physical contact (> 2 sec) because pair members might settle conflicts without direct fighting (e.g., using chemical/mechanosensory cues, Desrocher et al., 2020). There was no focal individual in these observations.

Throughout the experiments, worms were kept in artificial seawater (35‰ salinity), in thermostatic cabinets (21°C) and fed with pureed spinach. They were moved to mass cultures after data collection.

Statistical analyses

Size ratio and percent size change

Time in the experiment was shorter, on average, for pairs with initially small- rather than large-size ratio (5.9 ± 2.3 days vs 11.5 ± 3 , respectively), because larger partners changed sex earlier than shorter ones. Therefore, we controlled for time in the experiment (thereafter, time) in all models.

Using Linear Models (LMs), we tested whether final size ratio depended on initial size ratio (two levels: large or small) and included the interaction initial size ratio*time. Final size ratio values were not normally distributed; therefore, we calculated *p* values using Monte Carlo permutation tests (10000 permutations) (*pgirmess* package, Giraudoux, 2022), after testing for homogeneity of variances (non-homogenous variances inflate type-I-error rates, Faraway, 2005). We obtained homogenous variances by log-transforming final size ratio values.

We tested who, in each dyad, modulated growth rate by modeling percent size change ((final size – initial size)*100/initial size) in a LMM as a function of within-pair initial size ratio and individual role (focal hatchling/large partner) and included the interaction initial-size ratio*time*individual role). Pair ID was included as a random factor. Percent size change was not normally distributed; therefore, we calculated *p* values using permutation tests as above.

Behavioral agonistic interactions

As the distribution of the number of attacks was zero-inflated, we analysed these data as binary data (0/1) using binomial General Linear Models (GLMs) with logit link and tested for the association with size ratio (controlling for size of the smaller individual, see above). We calculated *p* values using Monte-Carlo permutation tests as above to account for sample size $n < 20$ in one treatment (this procedure also accounts for non-normal data distribution). Using LMs, we tested whether time spent in spatial proximity or physical contact varied with size ratio and the size of the smaller individual. Video duration was included in all models.

We ran the analyses in R Studio (version 2024.09.1 + 394, R version 4.4.2) using the R package *lme4* (R Core Team, 2024). In all models, non-significant interactions or terms were removed if the likelihood ratio test (LRT) was significant. Nagelkerke R^2 are reported in LMs and Cragg-Uhler Pseudo- R^2 in GLMs (package: *summ*).

Results

Size ratio variation

Final size ratio varied with initial size ratio in different ways depending on the time in the experiment (Table 1). Overall, size ratio converged towards intermediate values by the end of the experiment; pair members with small initial size ratio became less dissimilar in size and pair members with large initial size ratio became more dissimilar irrespective of time (Table 1, Fig. 1).

Table 1. The outcomes of the LMs testing for the source of variation in final-size ratio (p values from permutation test; significant values in bold).					
	Source of variation	Coefficient	Estimate ± SE		P
				F _{1,36}	
Overall model	Initial size ratio	β[large initial size ratio]	1.152 ± 0.275	17.578	0.095
	Time		0.129 ± 0.025	27.061	< 0.0001
	Initial size ratio* Time	β[large initial size ratio *Time]	-0.119 ± 0.031	14.630	0.004
	Number of observations = 40 R ² = 0.660				
				F _{1,18}	
Post hoc tests	Small initial size ratio	Time	0.129 ± 0.020	40.169	< 0.0001
		Number of observations = 20 R ² = 0.691			
	Large initial size ratio	Time	0.010 ± 0.022	0.216	0.640
		Number of observations = 20 R ² = 0.012			

Percent size change

Focal hatchlings and their partner differed significantly in the way their percent size changed depending on initial within-pair size ratio and how it varied over time (Table 2, overall model). Focal hatchlings underwent percent size changes which varied over time in different ways depending on within-pair initial size ratio: focal hatchlings paired with larger partners grew significantly faster than those paired with

less large partners (Fig. 2a, Table 2). In contrast, partners grew at a similar pace irrespective of within-pair initial size ratio (Fig. 2b, Table 2).

Table 2

The outcomes of the tests for the source of variation in percent size change (overall model: LMM, p values from permutation test; post-hoc tests: LMs; significant values in bold).

Test	Source of variation	Coefficient	Estimate ± SE	χ^2	P
Overall model	Initial size ratio	β [focal hatchling]	-134.969 ± 46.001	8.609	0.001
	Individual role	β [partner]	55.471 ± 50.843	1.190	0.606
	Time		6.946 ± 3.137	4.904	0.0001
	Initial size ratio*Time		17.628 ± 5.197	11.504	0.036
Overall model	Individual role*time	β [focal hatchling]*Time	-2.889 ± 4.214	0.470	0.007
	Individual role*Initial size ratio	β [partner]*Initial size ratio	43.224 ± 61.793	0.489	0.001
	Individual role*Initial size ratio*time	β [partner]*Initial size ratio*Time	-19.103 ± 6.982	7.486	0.010
Number of observations = 80 (n = 40 pairs)					
$R^2 = 0.672$					
$F_{1,36}$					
Post hoc test: focal hatchlings	Initial size ratio	β [focal hatchling]	-134.969 ± 62.092	4.725	0.036
	Time		6.946 ± 4.234	2.691	0.109
	Initial size ratio*Time	β [focal hatchling]	17.628 ± 7.015	6.314	0.017
Number of observations = 40 (n = 20 pairs)					
$R^2 = 0.52$					
Post hoc test: partners	Initial size ratio	β [partner]	-91.745 ± 19.407	22.349	< 0.00011
	Time		4.057 ± 1.323	9.399	0.004
	Initial size ratio*Time	β [partner]	-1.474 ± 2.193	0.452	0.506

Test	Source of variation	Coefficient	Estimate $\pm$ SE	P
χ^2				
Number of observations = 40 (n = 20 pairs)				
$R^2 = 0.92$				

Behavioral agonistic interactions

There was not any attack between worms with small or intermediate size ratios (except for two attacks in a pair of a 4- and a 6-segment worms). In contrast, we recorded up to 25 attacks (16 attacks per hour) in pairs with large size ratio, so that within-pair initial size ratio was a highly significant predictor of intensity of conflict (Table 3, Fig. 3). Intensity of conflict did not depend on absolute body size: pairs of size-matched individuals (size ratio = 1; 6 vs 11–13 segments) experienced similar intensity of conflict irrespective of their body size (body size: $\beta = -0.093 \pm 0.088$, $\chi^2 = 1.178$, $p = 0.278$; video duration: $\beta = 0.006 \pm 0.013$, $\chi^2 = 0.20$, $p = 0.655$).

Neither time in proximity nor time in physical contact was associated to size ratio, suggesting that these behavioral traits were not directly involved in settling interindividual conflict. Pairs whose focal was larger spent less time in physical proximity irrespective of size ratio (size of focal: $\beta = -109.964 \pm 45.110$, $F_{1,73} = 5.942$, $p = 0.016$; size ratio: $\beta = 216.874 \pm 599.308$, $F_{1,73} = 0.131$, $p = 0.718$; video duration: 17.097 ± 6.152 , $F_{1,73} = 7.724$, $p = 0.007$). Time spent in physical contact varied irrespective of both focal absolute size and pair size-ratio (size of focal: $\beta = 90.677 \pm 65.063$, $F_{1,73} = 1.942$, $p = 0.168$; size ratio: $\beta = -622.794 \pm 864.407$, $F_{1,73} = 0.519$, $p = 0.473$; video duration: 33.681 ± 8.873 , $F_{1,73} = 14.409$, $p = 0.001$).

Table 3

The outcomes of the binomial GLM testing for the source of variation in intensity of conflict (p values from a permutation test; significant values in bold).

Response variable	Source of variation	Estimate $\pm$ SE	χ^2	P
Intensity of conflict	Size ratio	11.242 $\pm$ 3.670	18.077	< 0.001
	Size of smaller individual	-0.192 $\pm$ 0.111	3.184	0.086
	Video duration	0.016 $\pm$ 0.015	1.066	0.320
Number of observations = 77				
Pseudo $R^2 = 0.52$				

Discussion

The current work give evidence that variation of size ratio over time and the pattern of aggression in *O. puerilis* annelid dyads match the criteria for the identification of strategic growth in vertebrates, highlighting that vertebrates and invertebrates evolved convergent mechanisms to resolve the reproductive conflict. Size ratios in the annelids converged towards intermediate values as, on average, initially large size ratios diminished over time, and initially small size ratios increased, due to growth rate adjustments. Such adjustments were performed by the smaller “subordinate” individuals, who regulated their growth rates to those of their partners (the smaller the size gap between the two, the lower the growth speed) as the lack of size asymmetry was more likely to trigger aggression (intensity of conflict increased with increasing size ratios). Therefore, these results confirm the interpretation given by Radhakrishnan et al. (2026a) to the atypical and socially-responsive growth rates observed in these annelids: growth is strategically regulated so that subordinates place themselves at a position in the size hierarchy which reflects their social rank. Similar mechanisms of plastic adjustments of the body size to the social position has been documented in vertebrates as diverse meerkats and clownfish (Huchard et al., 2016; Wong et al., 2016), whereas the species under investigation in the current work is the first invertebrate known to modulate growth and size depending on social interactions with closest group members (Radhakrishnan et al. 2026a).

Aggression by dominants has been addressed as one of the behavioral mechanisms that allows dominants to control subordinates and inhibit their growth and/or reproduction (social control hypothesis, Maldonado-Chaparro et al., 2024). Aggression – and the social stress imposed by repeated aggression – is associated with increased abortion rate in subordinate meerkats, as well as subordinate infertility in Callitrichid primates, rodents and other mammals (Young et al., 2006; Mustoe, 2023; review in Freeman, 2021). These reports have been considered as evidence for the hypothesis of reproductive suppression by dominants, which was initially formulated to explain low fecundity in subordinate female primates (Abbott, 1987) and suppression of growth and sex change in hermaphroditic fish (Ross, 1990). However, stress hormone measures (e.g., glucocorticoids) have often failed to find support for this hypothesis (Creel, 2001; Solomon-Lake et al., 2015).

Alternatively, at the ultimate (evolutionary) level, social queuing can explain why subordinates do not reproduce and do not quit the group in highly skewed societies with low interindividual relatedness. In such models, subordinates self-restrain from reproduction (and avoid eviction) as they “queue” for the dominant status: they will likely inherit breeding resources and/or opportunities as dominants die or leave the group (Kokko & Johnstone, 1999; Sawada et al., 2017). Social queueing is supported by numerous studies in different taxa. In the social wasps *Polistes dominulus*, subordinate females unrelated to the dominants inherit the nest, its work force and occupy the dominant vacancy as the dominants weaken or die (Leadbeater et al., 2011). In clownfish *Amphiprion percula*, the removal of the dominant fish in the reproductive pair triggers ascent to the vacant breeding role by the largest fish in the queue (Buston, 2003). Likewise, changes in the social hierarchy, such as body size variations in one individual, trigger size changes among the individuals queuing (in freshwater African cichlid, *Neolamprologus pulcher*, Heg et al., 2004, and in meerkats, Huchard et al., 2016). Expectedly, while queuing, *N. pulcher* subordinate males prepare for access to the dominant rank by storing energy

reserves they use as they become more aggressive towards partners after the opening of a breeding vacancy (Culbert et al., 2019).

Typically, the concept of queuing refers to a group of individuals but applies to pairs as well. Under the social queueing hypothesis, pairs of *O. puerilis* hatchlings compete for being the first to change sex to female (the most fitness-rewarding sex in male-first sequential hermaphrodites, Benvenuto et al., 2017; Pla et al., 2020). While dominants grow and change sex as first, subordinates constrain their growth rate and keep a size gap with their partners. By doing so, they abide by their rank, stop challenging the dominants and start queuing for the opportunity to become female.

The phenomenon where individuals converge to intermediate size ratios strongly suggest that, in social relationships resulting in strategic growth, body size (traditionally considered as a relatively fixed morphological signal, Bradbury & Vehrencamp, 2011) functions as a signal of status: individuals adjust their size to that of the adjacent competitors as size conveys information on the individual fighting ability and allows opponents in agonistic encounters to regulate their behavior appropriately without the need to remember the outcome of past interactions – i.e., avoid overt fights and their cost if they are relatively weaker (Chaine et al., 2018). By adjusting their size, individuals inform their opponents they concede the competition; by maintaining a size difference, they signal the resolution of the conflict. The reproductive conflict is thus settled via reciprocal signaling rather than social control (Benvenuto & Lorenzi, 2023); dominants grow freely and exhibit their large body size as a signal of high status whereas subordinates limit their growth, maintain a size gap with their close dominants, and signal their submission via their relatively smaller body size. Adjusting body growth rates to the dominant's – as subordinates do – appears as the submissive signal (*sensu* Reddon et al., 2022).

In this perspective, the aggression annelids exhibited in the dyadic interactions we staged reflects the typical outcome of dyadic competitive encounters between rivals with limited asymmetry in competitive traits (similar Resource Holding Potential, RHP, Pinto et al., 2019). If two individuals express matching competitive phenotypes, contests are more likely to result in overt physical aggression rather than agonistic displays, either because assessing fighting ability in a rival is more difficult (Enquist et al., 1990) or because such subordinates are more likely to challenge dominants (dominance testing: Cant & Johnstone, 2000). While self-assessment mechanisms are currently thought to be the prevailing mechanisms in regulating conflict escalation (Pinto et al., 2019), conflicts solved by strategic growth imply subordinates track dominants' size variations over time and either use mutual assessment or other mechanisms (see also Reddon et al., 2011). In this respect, species where individuals are organized in size hierarchies and subordinates exhibit strategic growth might be interesting cases where testing the mechanisms that govern giving up a conflict and, more generally, enhance our comprehensions of the mechanisms underlying reproductive skew in group-living species.

Declarations

Data accessibility:

Data are available as Supplementary Material.

Declaration of AI use:

The authors occasionally used AI-assisted language editing (Perplexity, free version, spring 2026) to improve English grammar and clarity and get help in producing the figures. All content was reviewed and revised by the authors, who take full responsibility for the final manuscript.

Ethics statement:

The species used in the experiments (*Ophryotrocha puerilis*) is not endangered or protected. Individuals were returned to the lab masses upon data collection.

Author contributions:

ML: data curation, formal analysis, investigation, methodology, writing—review and editing;

MCL: conceptualization, data curation, formal analysis, investigation, methodology, supervision, writing—original draft, writing—review and editing.

All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

Competing interests sections:

The authors declare no competing interests

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Figures

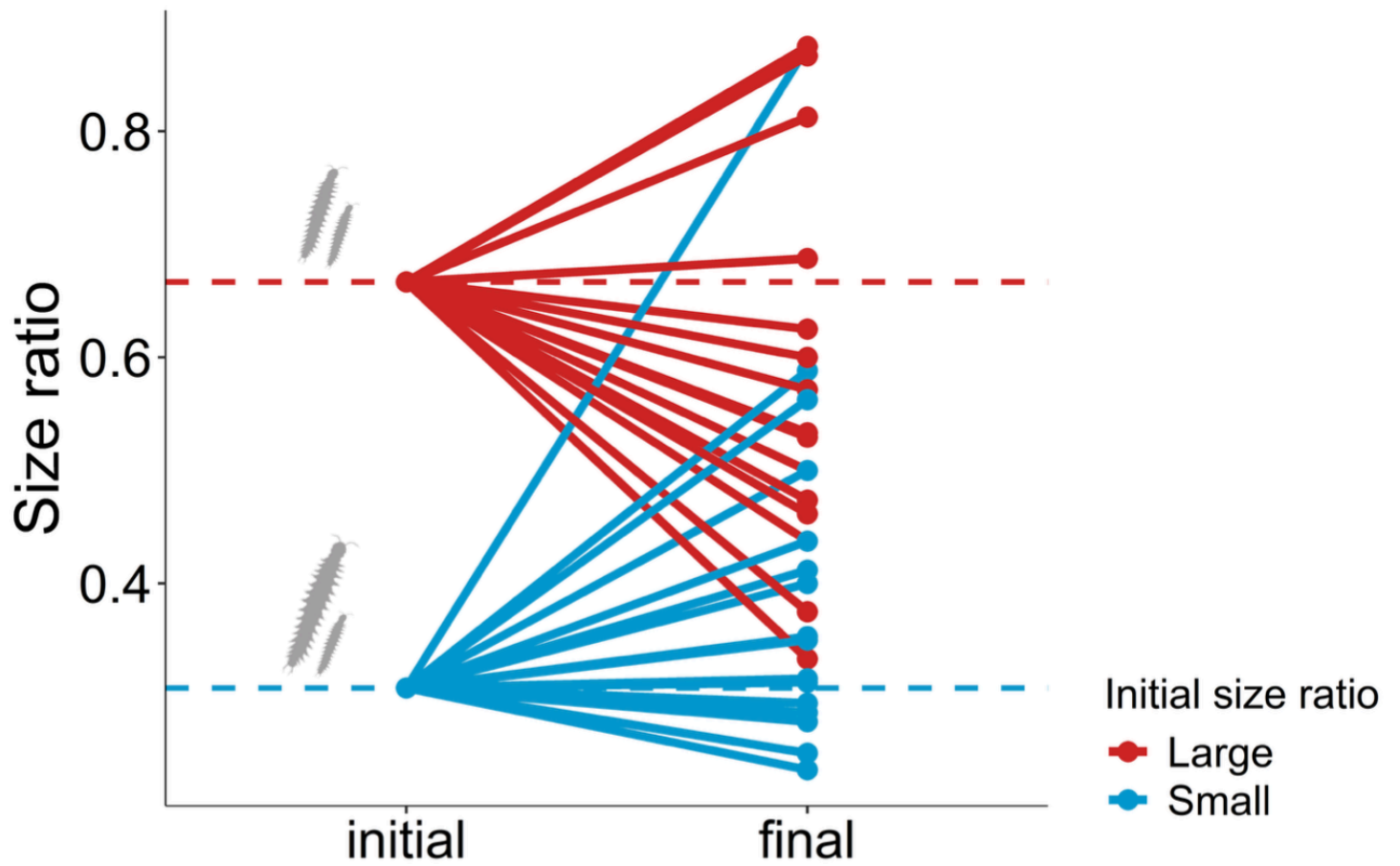


Figure 1

The variation in size ratio in experimental pairs. Dotted lines mark initial size ratios and highlight that, on average, size ratios converged towards intermediate values.

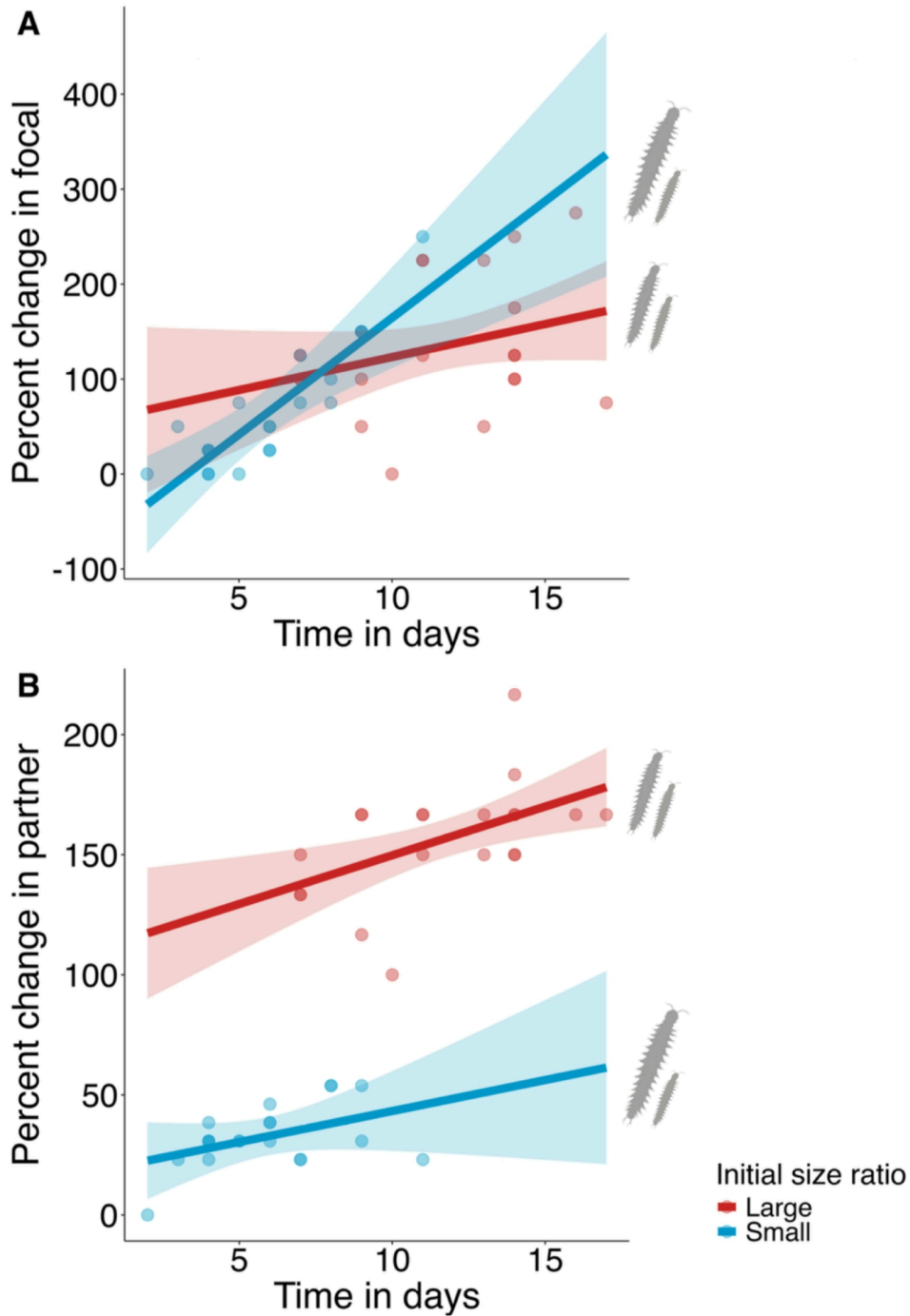


Figure 2

Predicted values for percent size change over time: a) focal hatchlings with a larger initial size gap with their partner (small initial size ratio) exhibited a steeper size increase than those with a smaller size gap (large initial size ratio); b) size increase occurred at the same pace in partners, irrespective of within-pair initial size ratio.

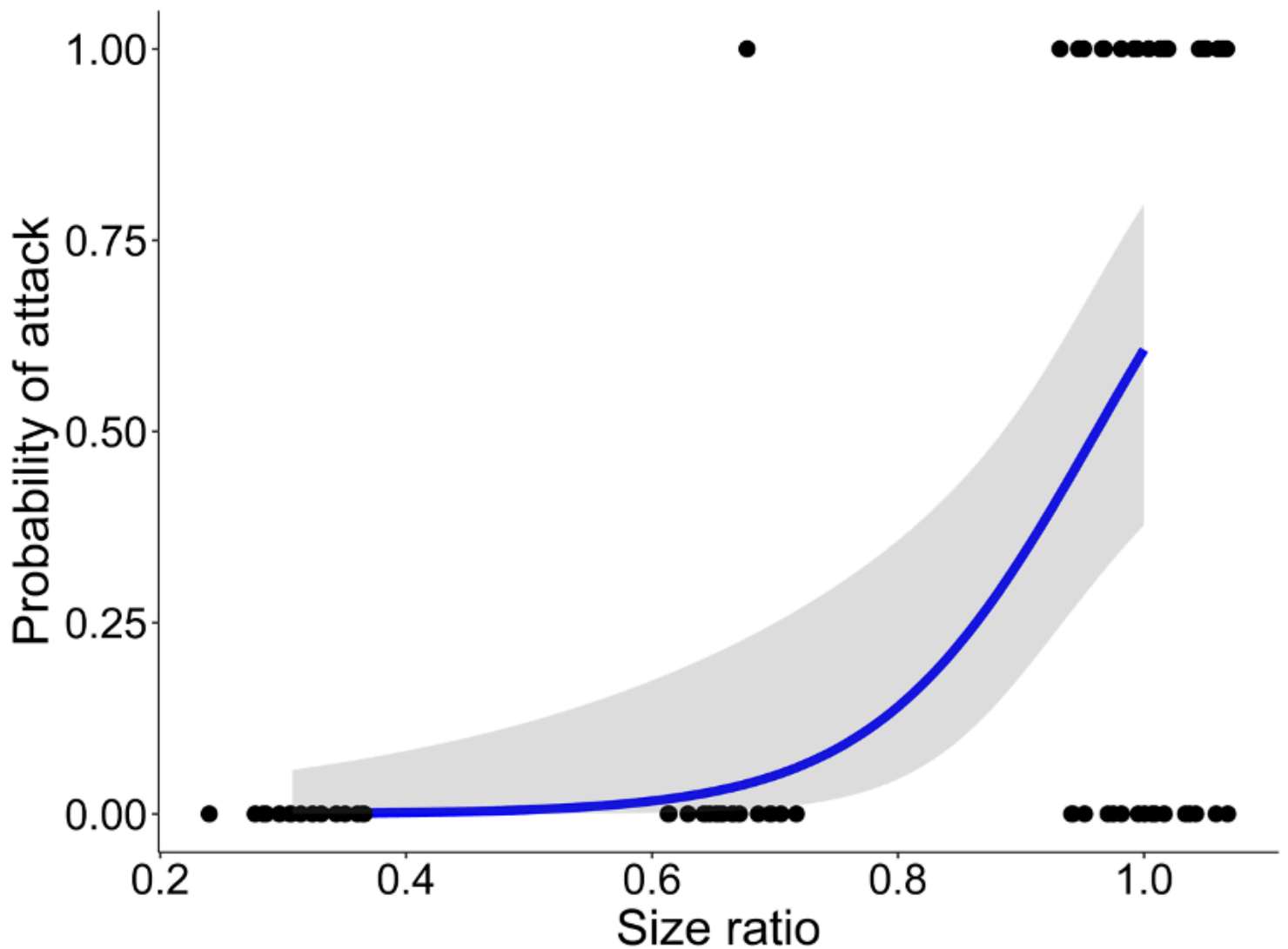


Figure 3

Predicted values from the GLM testing the association between intensity of conflict (probability of attack) and size ratio (size-ratio values are jittered horizontally, which makes them to seemingly appear < 0.4 and > 1).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [behavdataLoubiereLorenzi.csv](#)
- [morphdataLoubiereLorenzi.csv](#)