



# The effect of social network position on female fitness in *Bolitotherus cornutus*

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## BACKGROUND

### Social networks

- Social network is a depiction of interactions between individuals of the same species [1].
- Social network metrics describe different aspects of individual's social environment [2], such as
  - Strength** – the weighted number of social partners
  - Betweenness** – centrality of an individual in the network
  - Clustering Coefficient** – cliquishness (partners of focal beetle are themselves partners with each other) of the social environment of an individual

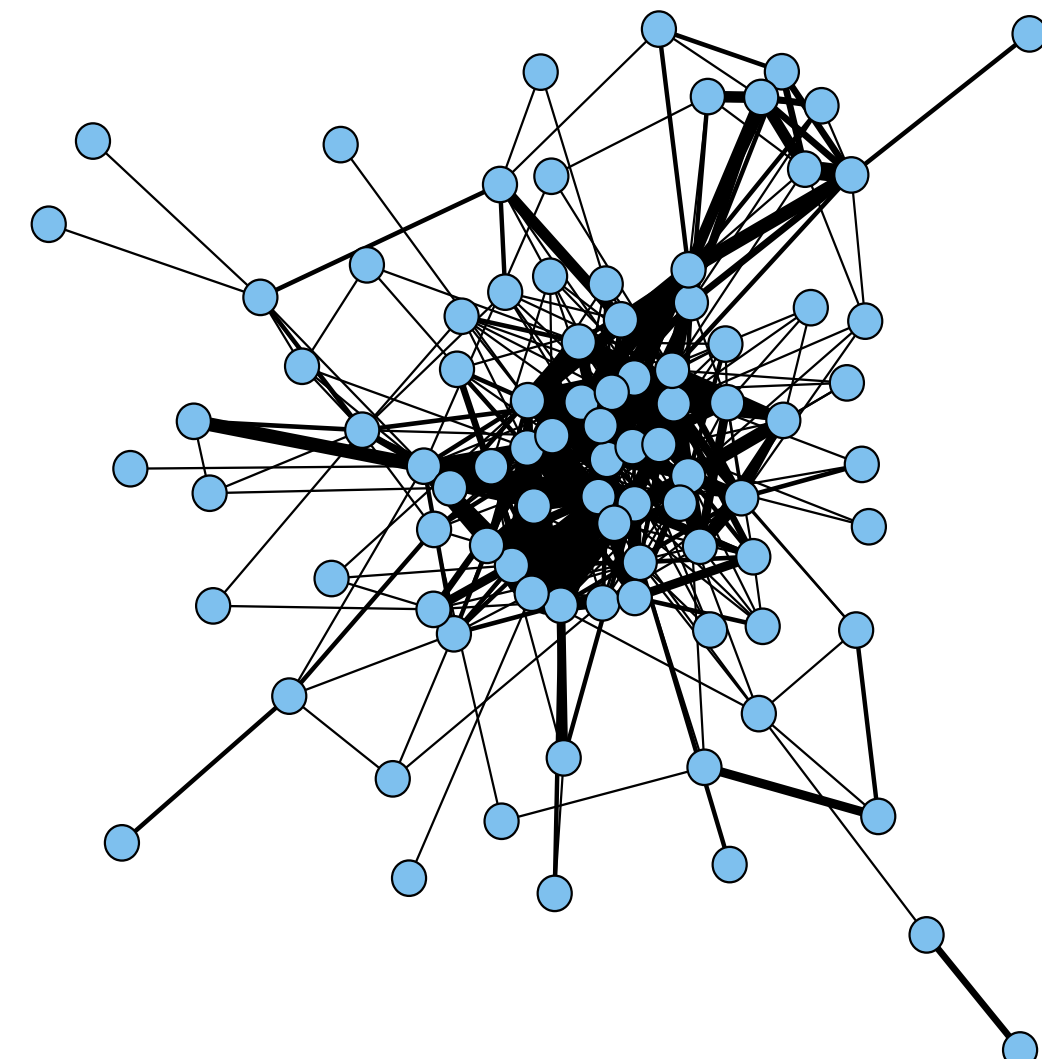


Figure 1. Social network diagram *Bolitotherus cornutus* of a large population of Pond Drain metapopulation.



Figure 2. Female *B. cornutus* lack the distinct male horns, which are typically used to fight for access to females and for territorial claims.

### *Bolitotherus cornutus*

- Social beetles that live and interact on fungi that grow on decaying wood and have easily distinguishable mating behaviors (Figure 5).
- Male social network parameters have been shown to covary with fitness, thus raising questions about effect of social interactions on females.

## METHODOLOGY

### Field data collection

- Two large study populations were located in Pond Drain metapopulations in the Appalachian Mountains in southwest Virginia.
- Scan sampling was performed daily two times a day for two months.



Figure 3. Researcher scan sampling one of the populations in Pond Drain

### Data Analysis

All statistical analyses were performed in R.

### Generalized Linear Model (GLM) – Question 1

- GLM, a generalized multiple linear regression process, used beetle activity level, body size and social network position to predict female fitness [3].
- Standardized strength, betweenness and clustering coefficient were used to estimate social network position and were standardized per population.

### Piecewise structural equation modeling – Question 2

- PiecewiseSEM is a path modeling R-package that incorporates a series of linked multivariate regression models [4].

## OBJECTIVES AND GOALS

- Evaluate the effect of social network position of females on their fitness, thus providing information on effects of social environment on females
- Examine whether the social network directly affects female fitness or acts indirectly through reproductive behavior

## QUESTION 1: DOES SOCIAL NETWORK POSITION AFFECT FEMALE FITNESS?

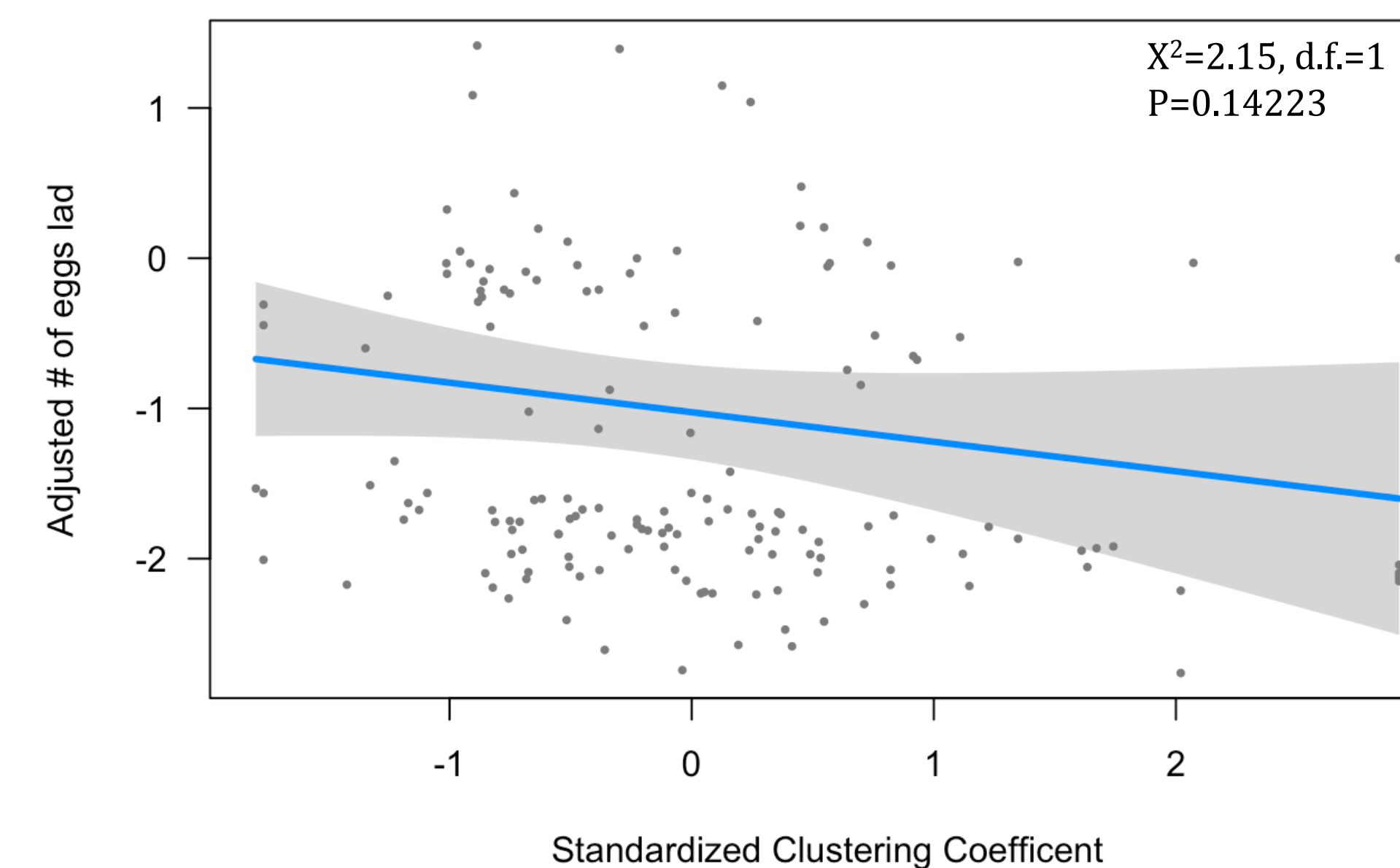
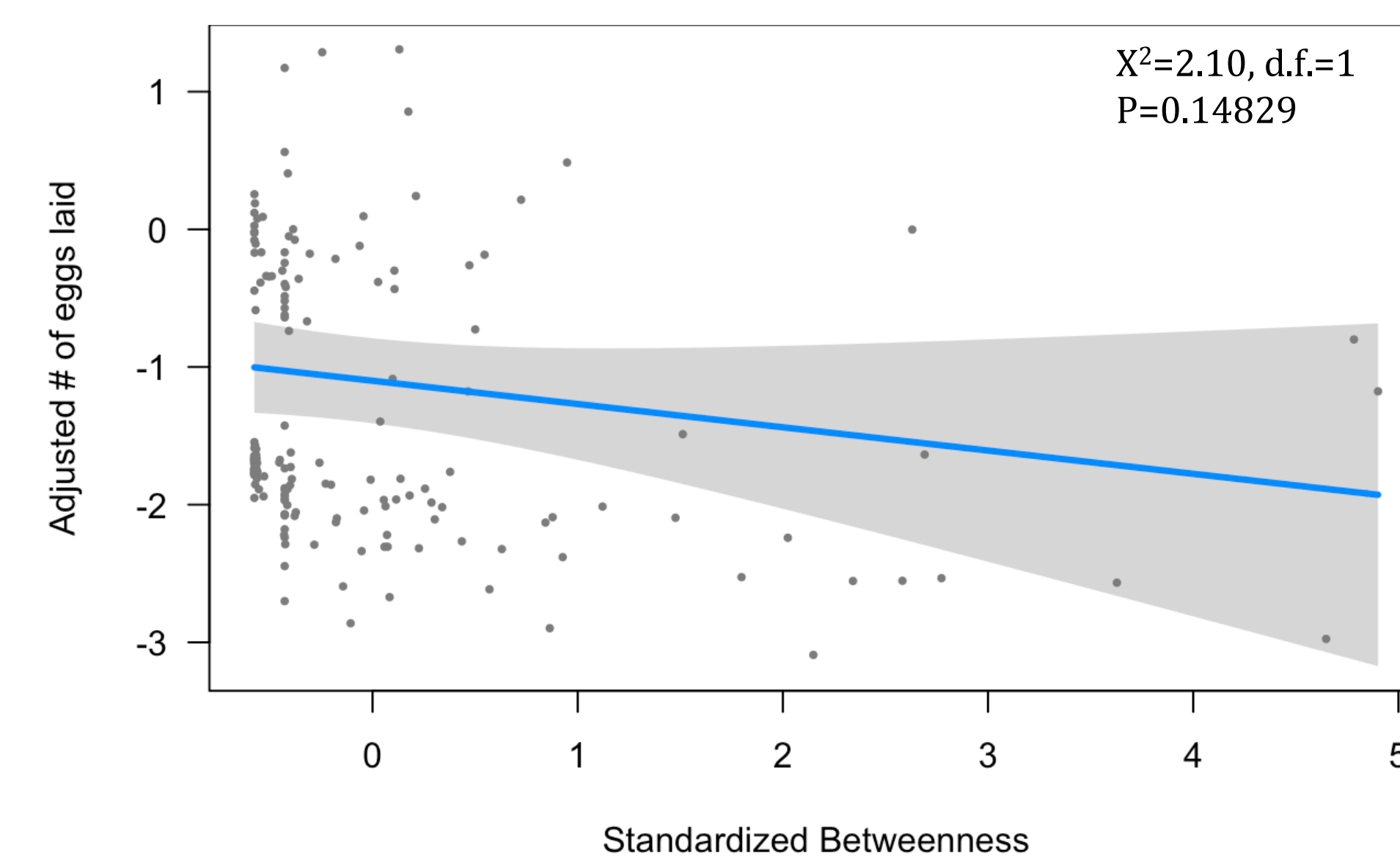
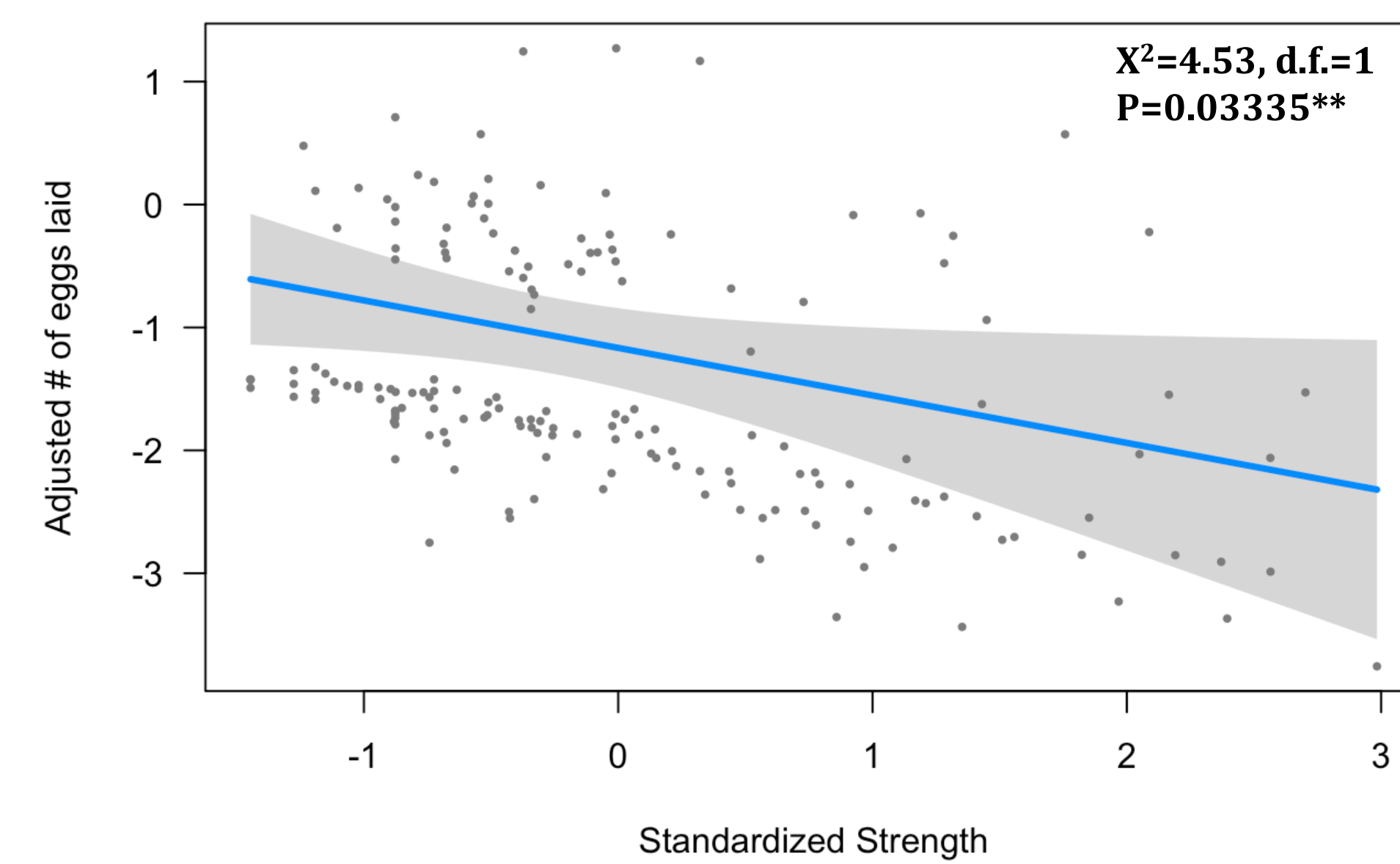


Figure 4. Linear regression results demonstrating the correlation between standardized social network metric and female fitness, estimated by the adjusted number of eggs laid.

**Standardized strength was negatively correlated with the adjusted number of eggs laid by females ( $P=0.033$ ), such that females with a greater number of social partners laid fewer eggs.**

## QUESTION 2: DOES STRENGTH DIRECTLY AFFECT THE FEMALE FITNESS?



Courtship – attempted mating    Guarding – successful insemination    Laying – production of offspring  
Figure 5. Sequence of mating behaviors of *Bolitotherus cornutus*. Each of the previous events are necessary for the next to occur.

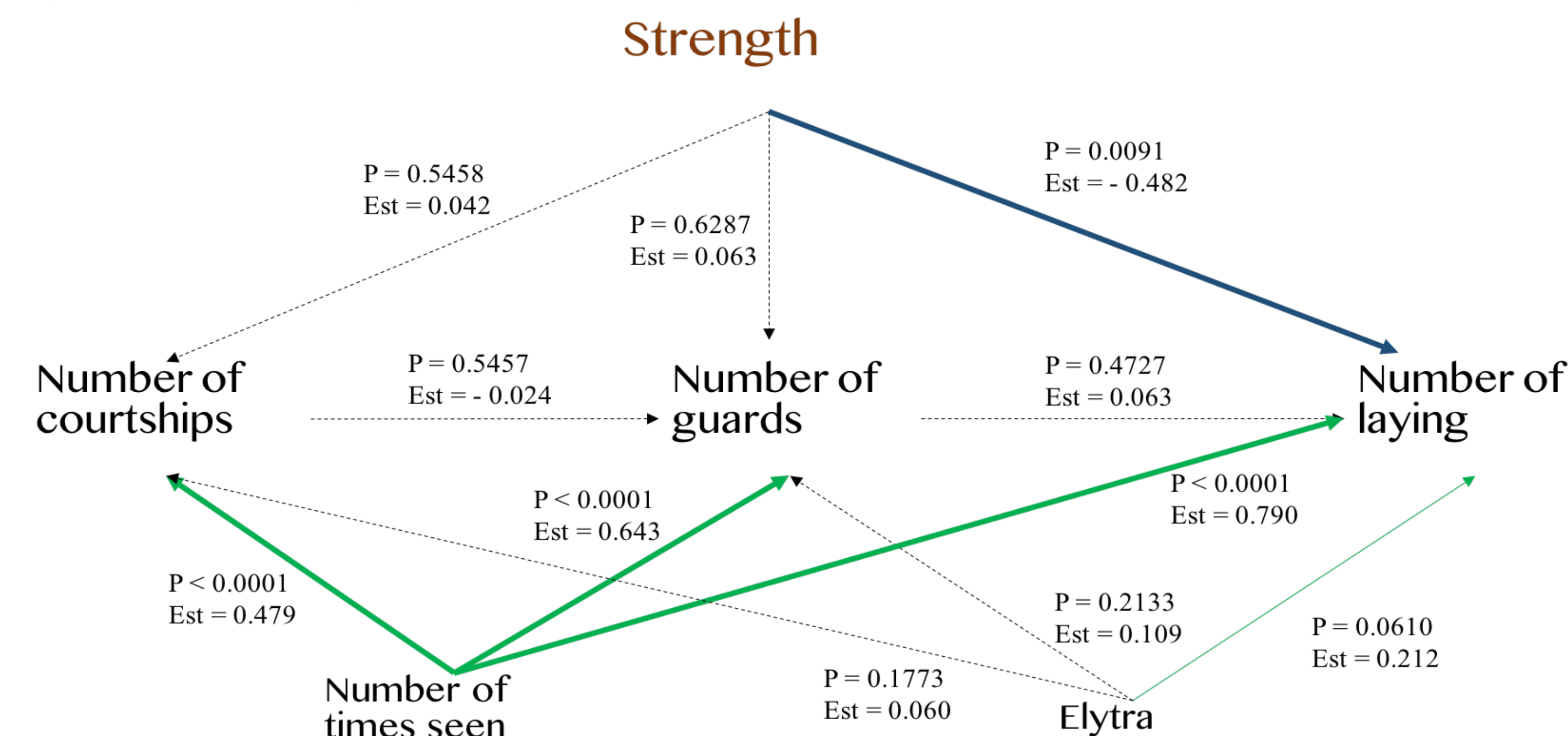


Figure 6. PiecewiseSEM demonstrates the relationship between strength (social network metric), reproductive behaviors and female fitness, accounting for the number of times beetle is seen and elytra (body size).

## DISCUSSION & CONCLUSIONS

- Clustering coefficient and betweenness of female beetles did not seem to affect female fitness.



Figure 7. A male observed courting a female while she laid an egg.

- The number of social partners of a beetle significantly negatively correlated with female fitness, but was not predictive of the reproductive behaviors (courtship and guard).
- The results suggest the effect of strength influences fitness through other mechanisms. The effect was not due to the decrease in mating.

## FUTURE DIRECTION



Figure 8. Four egg masses on top of a fungus bracket

- How does the connectivity of females affect the relationship between reproductive behaviors?
- Evaluate other effects of the social environment on the laying and mating behavior of female beetles

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## REFERENCES

- Formica *et al.* 2012, 2. Formica *et al.* 2011, 3. Nelder and Baker 2006, 4. Lefcheck 2016.