

Introduction

Amphipods of the family Corophiidae are prey for many fishes in the San Francisco Estuary, including Delta Smelt (*Hypomesus transpacificus*). An issue encountered by ongoing Delta Smelt and Longfin Smelt (*Spirinchus thaleichthys*) diet studies is the lack of completely intact prey found in stomachs, making it difficult to quantify the contribution of amphipod prey to diet by weight and also the determination of stomach fullness in fish.

The objective of this study was to determine antenna length-body length and body length-total weight relationships for *Americorophium spinicorne* (Figure 1) and *A. stimpsoni* (Figure 2), so individual amphipod weight estimates could be generated from lengths of intact or partially digested specimens for ongoing diet studies.



Figure 1. Female and male *Americorophium spinicorne*.



Figure 2. Female and male *Americorophium stimpsoni*.

Methods

- Amphipods were obtained from mysid samples preserved in 10% formalin and from stomachs of fish preserved in 95% ethanol collected by CDFW Zooplankton and Long-Term Fish Monitoring studies, respectively.
- Samples were collected from Suisun Bay upstream through the Cache Slough and Sacramento River Deep Water Ship Channel in May and Sep-Dec, 2011 and Feb-Apr, 2012.
- Intact amphipods were processed at the CDFW laboratory (Stockton, CA) with lengths recorded using a dissecting microscope. Individuals were straightened and body length measurements were taken from the base of the telson to the tip of the rostrum (0.1mm) (Figure 3). Length measurements of the second antenna were taken from base to tip (0.1mm) (Figure 3). Individuals were blotted dry and the total wet weight (0.0001g) was recorded using an analytical balance.
- ANCOVA (SYSTAT 2013) was used to test for differences in length-weight relationships. Power functions ($y = a \cdot L^b$) were generated using Excel (2010) to determine length-length and length-weight relationships.
- Female and male data were examined individually and combined to observe sexual dimorphism. The combined category included individuals not identified as adult females or males.

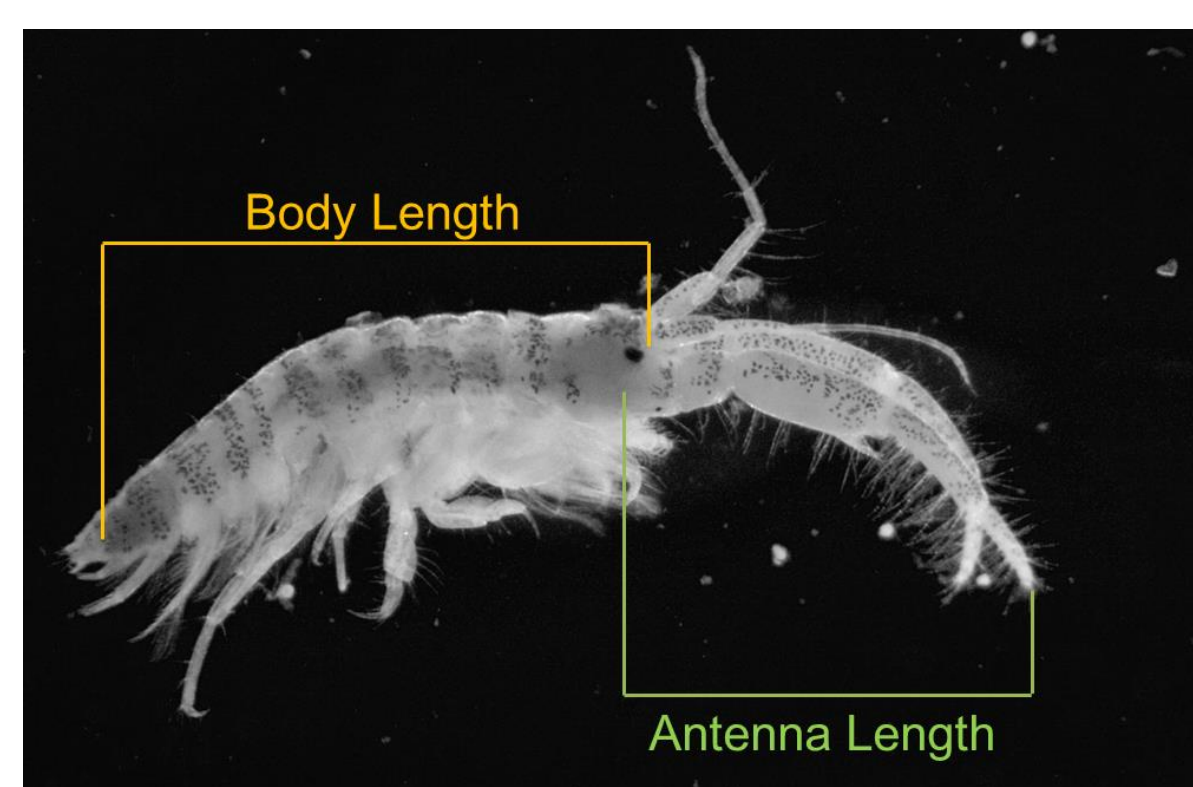


Figure 3. Method for measuring body and antenna lengths (mm) of *Americorophium* spp.

Results

- A significant difference (ANCOVA: $P < 0.01$) was found between the intercepts of the length-weight regressions of 10% formalin and 95% ethanol for both species. A significant difference was also found between the intercepts of length-weight regressions of species in 10% formalin ($P < 0.001$), but not 95% ethanol ($P = 0.156$). Our findings suggested to examine species and preservative treatments separately.
- Body length was highly correlated to antenna length for female, male, and combined *A. spinicorne* preserved in 10% formalin ($r^2 = 0.85, 0.96, \text{ and } 0.71$, respectively) (Figure 4) and also for female, male, and combined *A. spinicorne* preserved in 95% ethanol ($r^2 = 0.71, 0.82, \text{ and } 0.73$, respectively) (Figure 5).

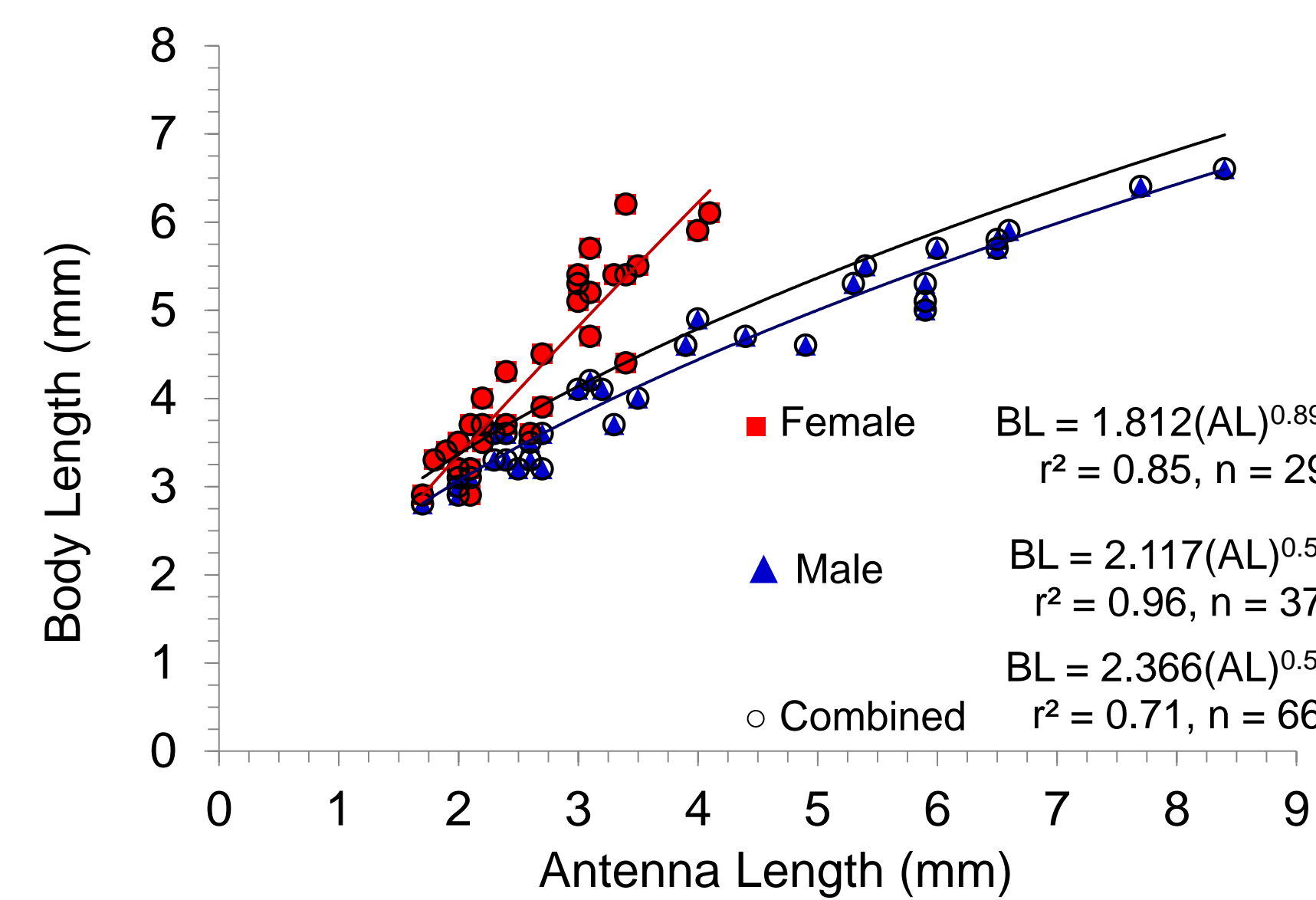


Figure 4. Relationship between body length (mm) and antenna length (mm) for female, male, and combined *Americorophium spinicorne* preserved in 10% formalin.

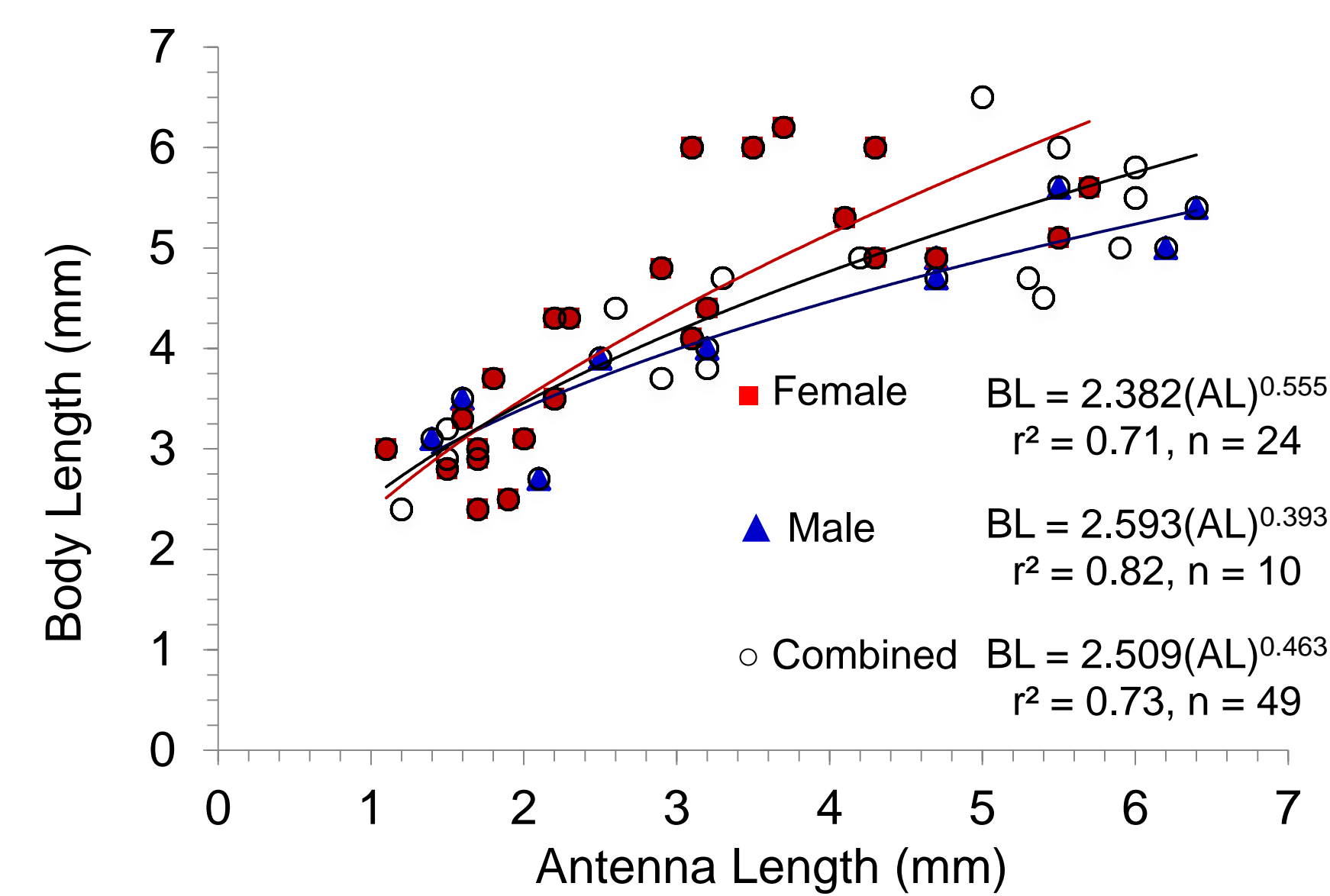


Figure 5. Relationship between body length (mm) and antenna length (mm) for female, male, and combined *Americorophium spinicorne* preserved in 95% ethanol.

- Body length was highly correlated to antenna length for female and male *A. stimpsoni* preserved in 10% formalin ($r^2 = 0.85 \text{ and } 0.84$, respectively), but was not highly correlated for combined *A. stimpsoni* ($r^2 = 0.29$) (Figure 6). A similar pattern occurred for female, male, and combined *A. stimpsoni* preserved in 95% ethanol ($r^2 = 0.86, 0.82, \text{ and } 0.53$, respectively) (Figure 7).

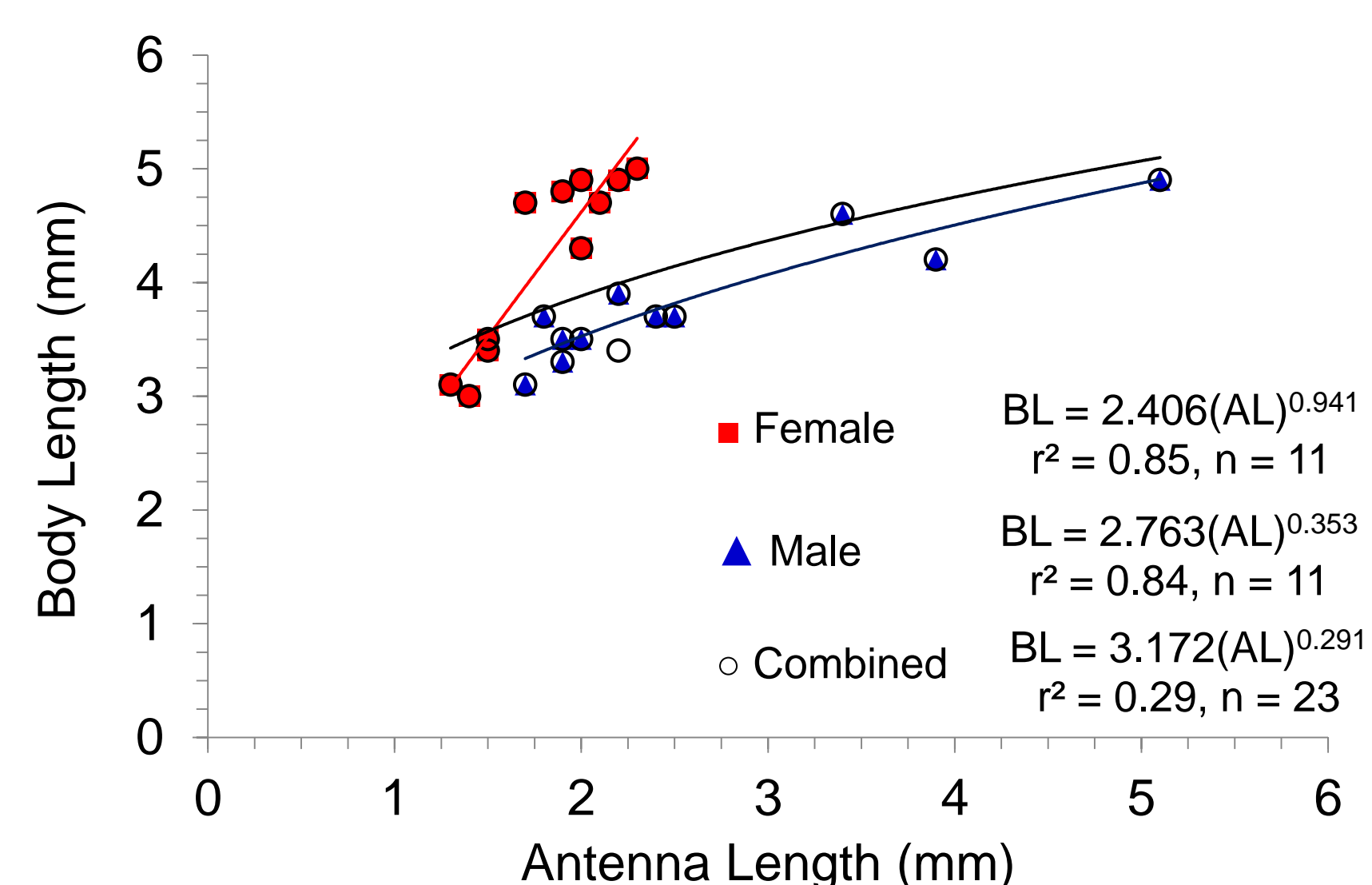


Figure 6. Relationship between body length (mm) and antenna length (mm) for female, male, and combined *Americorophium stimpsoni* preserved in 10% formalin.

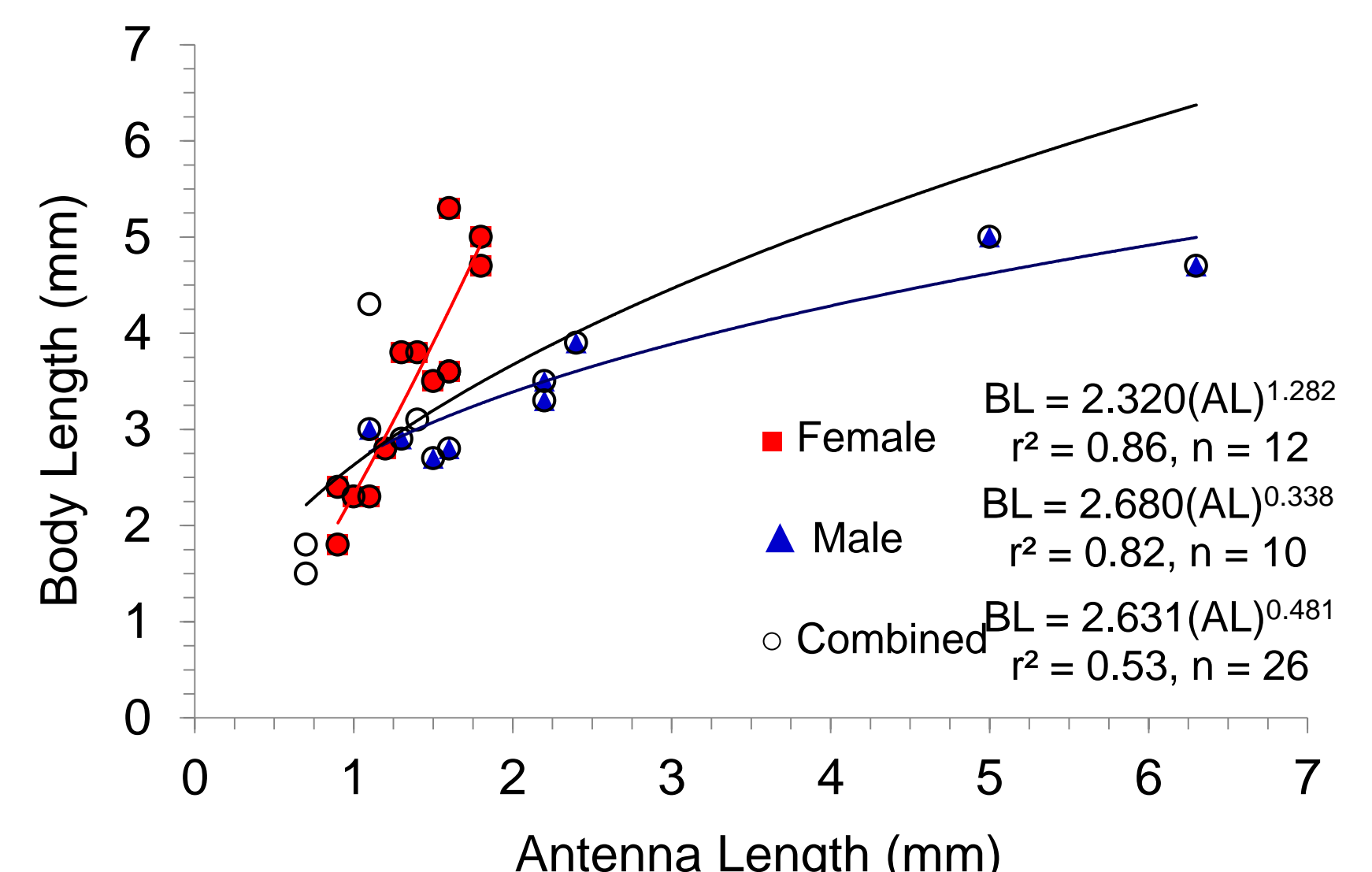


Figure 7. Relationship between body length (mm) and antenna length (mm) for female, male, and combined *Americorophium stimpsoni* preserved in 95% ethanol.

- Total weight was highly correlated to body length for *A. spinicorne* individuals preserved in 10% formalin and 95% ethanol ($r^2 = 0.82, \text{ and } 0.66$, respectively) (Figure 8).
- Total weight was moderately correlated to body length for *A. stimpsoni* individuals preserved in 10% formalin and 95% ethanol ($r^2 = 0.45, \text{ and } 0.65$, respectively) (Figure 9).

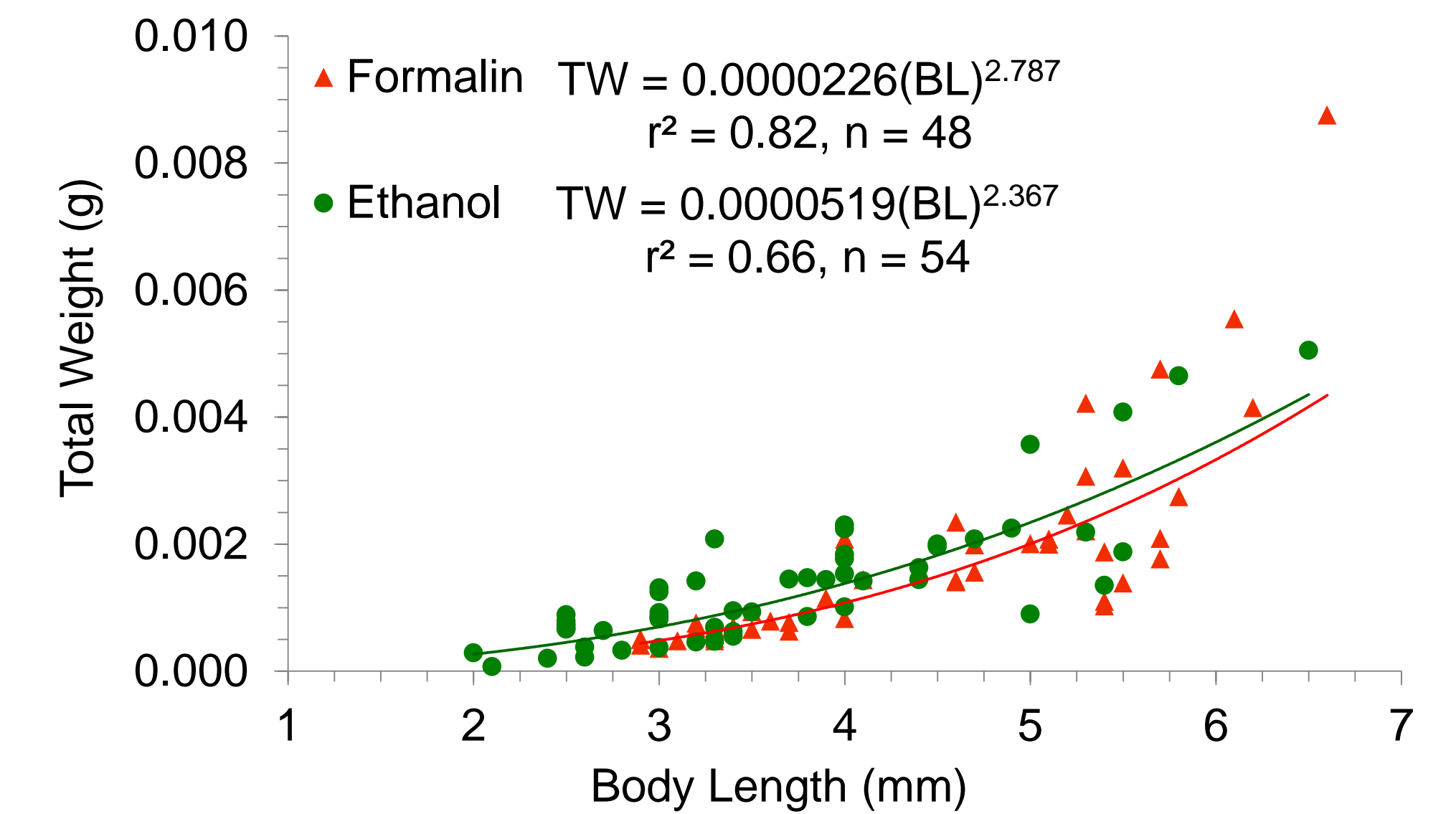


Figure 8. Relationship between total weight (g) and body length (mm) for *Americorophium spinicorne* preserved in 10% formalin and 95% ethanol.

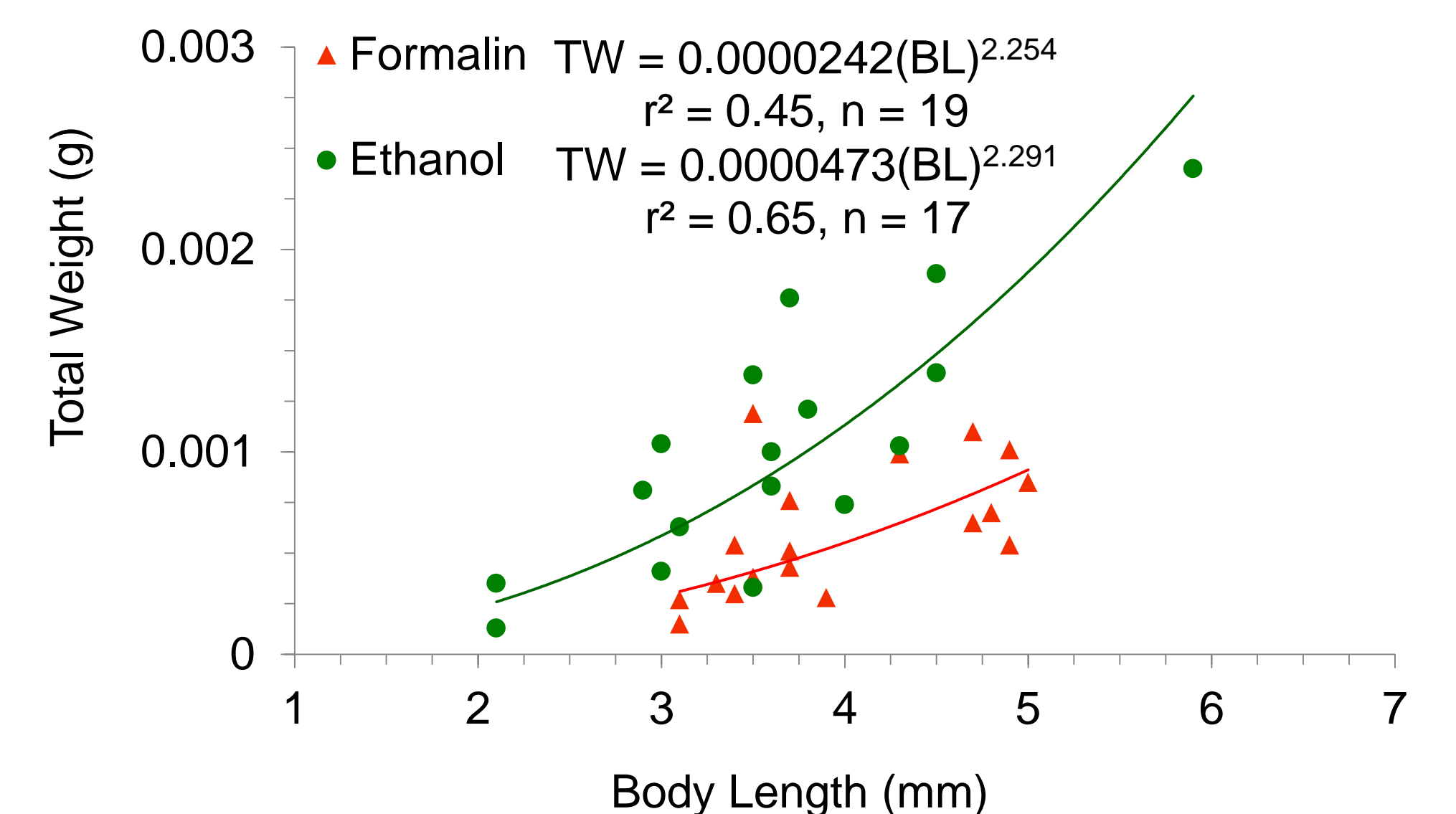


Figure 9. Relationship between total weight (g) and body length (mm) for *Americorophium stimpsoni* preserved in 10% formalin and 95% ethanol.

Conclusions

- Antenna lengths were highly predictive of body lengths.
- Second antenna were larger in males, notably with *A. stimpsoni*.
- Body lengths were predictive of total body weights, with *A. spinicorne* being heavier at length than *A. stimpsoni* preserved in formalin.
- High variability in weights at length among *A. stimpsoni* could be due to sexual dimorphism.
- Preservatives and the degree of digestion can significantly influence weight measurements. These factors must be considered in length-weight data analysis.
- This study contributes to our understanding of lower trophic organisms that are an important food resource to fish of management concern in the San Francisco Estuary.
- This work is ongoing and future efforts will include examination of other Corophid species.

Acknowledgements

This study was conducted under the auspices of the Interagency Ecological Program for the San Francisco Estuary as part of CDFW Diet and Condition Studies and the EMP Zooplankton Study. Photos are courtesy of Tricia Bippus. Many thanks to April Hennessy, Tricia Lee, Phillip Poirier, and other CDFW field and lab crews who participated in collection and processing of samples during this study.