Coarse Vison, Small Legs: Active Space of Visual Signaling in the Carolina Grasshopper

Nicholas Brandley and Claire Campbell - The College of Wooster

Introduction

- Visual signals can typically be detected over moderate distances; however, the active space is determined by numerous factors including the visual capabilities of the receivers and the initial size of the signal [1,2].
- The Carolina grasshopper (*Dissosteira carolina*) uses their banded femurs in a suite of visual signals to communicate with conspecifics (Figure 1; [3]).

When considering their coarse visual acuity (~2°) and small legs (width of femur = ~2 mm), how far can these visual signals be used in conspecific interactions?

Figure 1: A Carolina grasshopper showing the banded patterns of their femur(gold arrow).

Visual Modelling of Spatial Characteristics

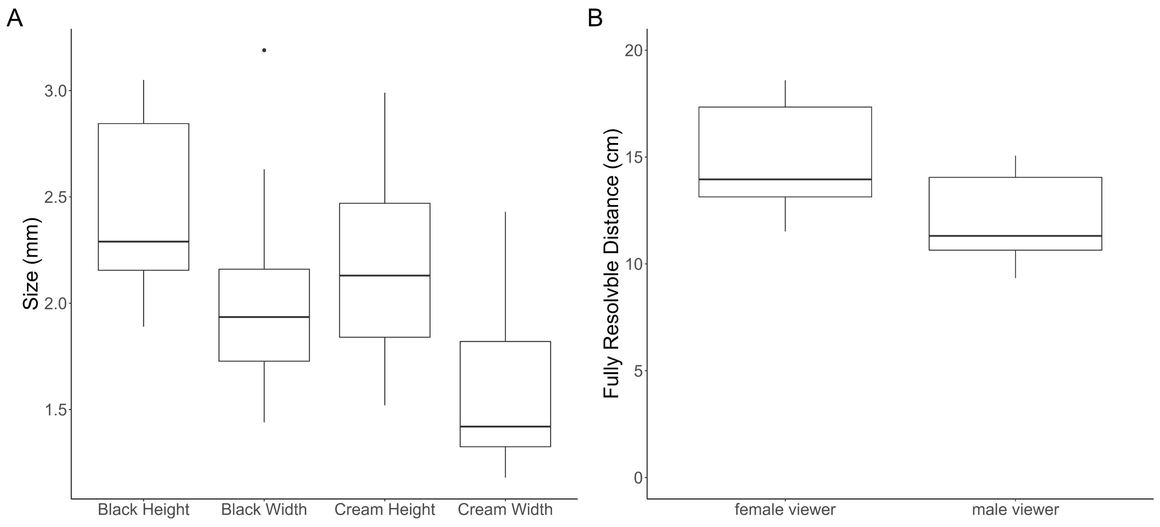

Figure 2: A) Measurements of femur regions (n = 19) suggest that the patterning is very small, and B) can only be fully resolved at short distances (<15 cm). Legs were photographed and measure in ImageJ, and then modelled with interommatidial angle data from Duncan et al. 2021 [4]. The fully resolvable distance was defined at the point where the height of the cream region fully fell upon one photoreceptor.

Behavioral Analysis of Femur Signals

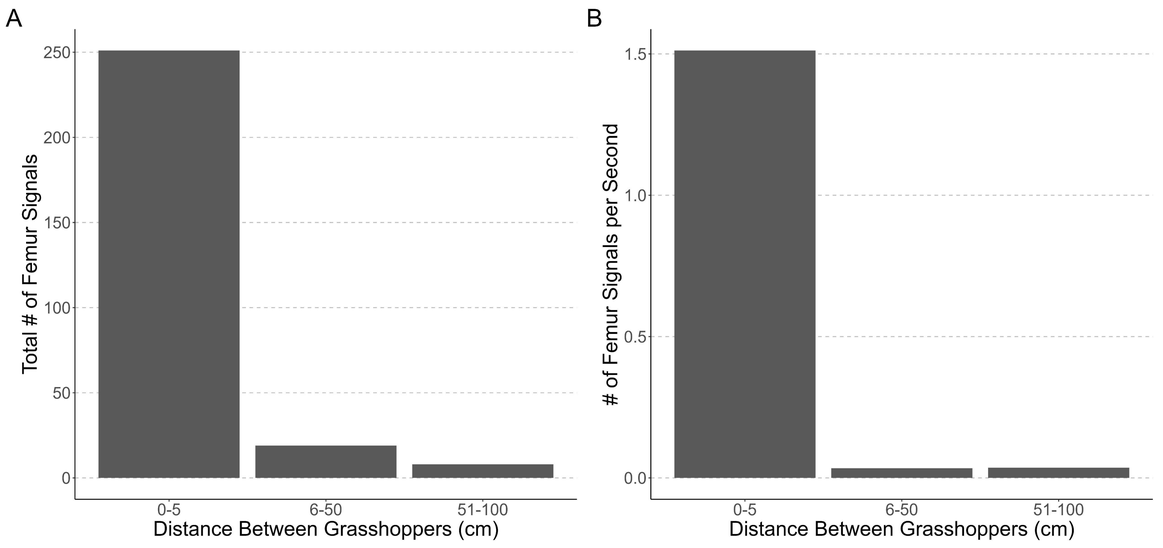

Figure 3: A) Carolina grasshoppers predominantly use femur signals when within 5 cm of other grasshoppers, and B) this relationship holds when controlling for time spent at each distance. Signals included double (n=160) and single (n=54) femur tips, stridulation (n=39), kicks (n=19) and femur raises (n=4). After the interactions (n=9 videos) had concluded, landmarks were used to measure the distance between the grasshoppers.

Discussion

- **Both visual modelling and behavioral analysis suggest that the active space of femur signaling is limited to very short distances (~5-15 cm).**
- As humans with relatively great spatial vision [5], we may overestimate the active space of many visual signals, especially in those organisms with small eyes.
- The limited signal range suggests that this signal may be under intense selection to not be obvious to potential predators.

Literature Cited **1:** Melin AD, Kline DW, Hiramatsu C, Caro T (2016) Zebra Stripes through the Eyes of Their Predators, Zebras, and Humans. PLOS ONE 11(1): e0145679., **2:** Marshall NJ (2000) Communication and Camouflage with the Same 'Bright' Colours in Reef Fish. Philos Trans R Soc Lond B Biol Sci 355(1401): 1243-1248. **3:** Otte, D (1970) A comparative study of communicative behavior in grasshoppers. Miscellaneous Publications: Museum of Zoology, University of Michigan. **4:** Duncan AB, Salazar BA, Garcia SR, Brandley NC (2021) A Sexual Dimorphism in the Spatial Vision of North American Band-Winged Grasshoppers, *Integrative Organismal Biology*, 3(1): obab008. **5:** Caves EM, Brandley NC, Johnsen S (2018) Visual Acuity and the Evolution of Signals 33(5): 358-372.

Acknowledgements Thanks to Alona Abdufarha, Henry Steinmetz, and Nina Sahita Reddy S. Yeduguri Sandinti for help in the field and scoring femur photos. This work was supported by the College of Wooster Sophomore Research Fund. Claire Campbell was supported by a Whitmore-Williams fellowship.