FACULTY OF SCIENCE
INSTITUTE FOR BIODIVERSITY AND ECOSYSTEM DYNAMICS
UNIVERSITY OF AMSTERDAM

Martijn Egas†, Yukie Sato*, Maurice W. Sabelis & Atsushi Mochizuki*

† egas@uva.nl

*National Institute for Agro-Environmental Sciences, Japan

Male-male aggression peaks at intermediate relatedness in a social spider mite

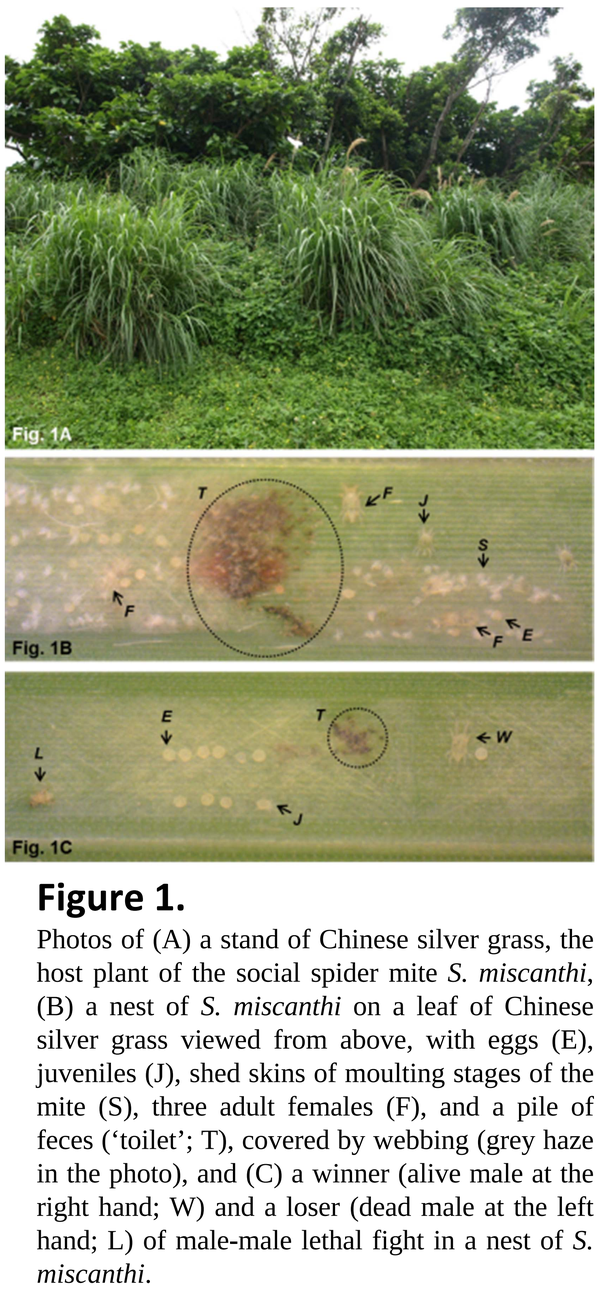

Figure 1.
Photos of (A) a stand of Chinese silver grass, the host plant of the social spider mite *S. miscanthi*, (B) a nest of *S. miscanthi* on a leaf of Chinese silver grass viewed from above, with eggs (E), juveniles (J), shed skins of moulting stages of the mite (S), three adult females (F), and a pile of feces ('toilet'; T), covered by webbing (grey haze in the photo), and (C) a winner (alive male at the right hand; W) and a loser (dead male at the left hand; L) of male-male lethal fight in a nest of *S. miscanthi*.

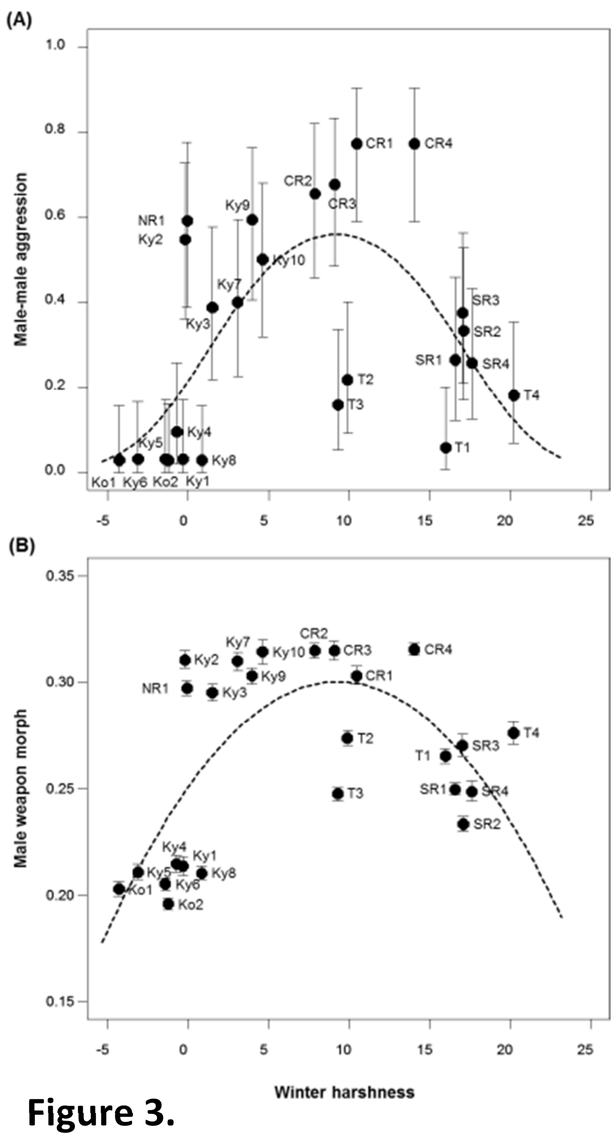

Figure 3.
Relations between (A) average male-male aggression and winter harshness and between (B) average male weapon morph and winter harshness. The dotted lines illustrate the nonlinear relation supported by the statistical analysis. Error bars indicate (A): 95% CI, (B): SEM. For population locations, see Fig. 2B.

Background

Inclusive fitness theory predicts that when individuals live in groups or colonies, male-male aggression should peak at intermediate levels of average relatedness in the colony.

Assuming that aggression is costly and directed towards nonrelatives and that competition for reproduction acts within the colony, the benefits of aggressive behaviour are maximized in colonies with a mix of related and unrelated competitors. This is because aggression hurts unrelated individuals, thereby favouring reproduction of related individuals.

This prediction has been tested with specific bacterial strains in laboratory settings, but not with organisms in the field.

Aim

Here, we study how male-male aggression varies with average relatedness in naturally occurring colonies of the social spider mite *Stigmaeopsis miscanthi*.

Social spider mite

Stigmaeopsis miscanthi lives on Chinese silver grass, constructs colonies as woven nests on the undersurface of grass leaves, and lives within these nests in kin groups (**Figure 1**). This mite species shows **parental care**: males defend the offspring they fathered by counterattacking the offspring from predatory mites when these intrude the nest.

However, males also show aggression towards conspecific males. They kill rival males inside nests, and establish their own harem. **Male-male aggression** (quantified as the probability of lethal combat) is highly variable among populations, and it is negatively correlated with a proxy for average genetic relatedness in the colony - winter harshness.

Methods

We sampled 25 populations across a wide geographic range between Taiwan and Japan (**Figure 2**), representing a gradient of high to low within-colony relatedness. For each population the **weaponry** of males was measured as the length of the first pair of legs, and **male-male aggression** was tested by placing pairs of non-sibling males together and scoring the frequency of male death over a given period.

Conclusion

In support of theory, male-male aggression and weapon size strongly peak at intermediate average relatedness (**Figure 3**).

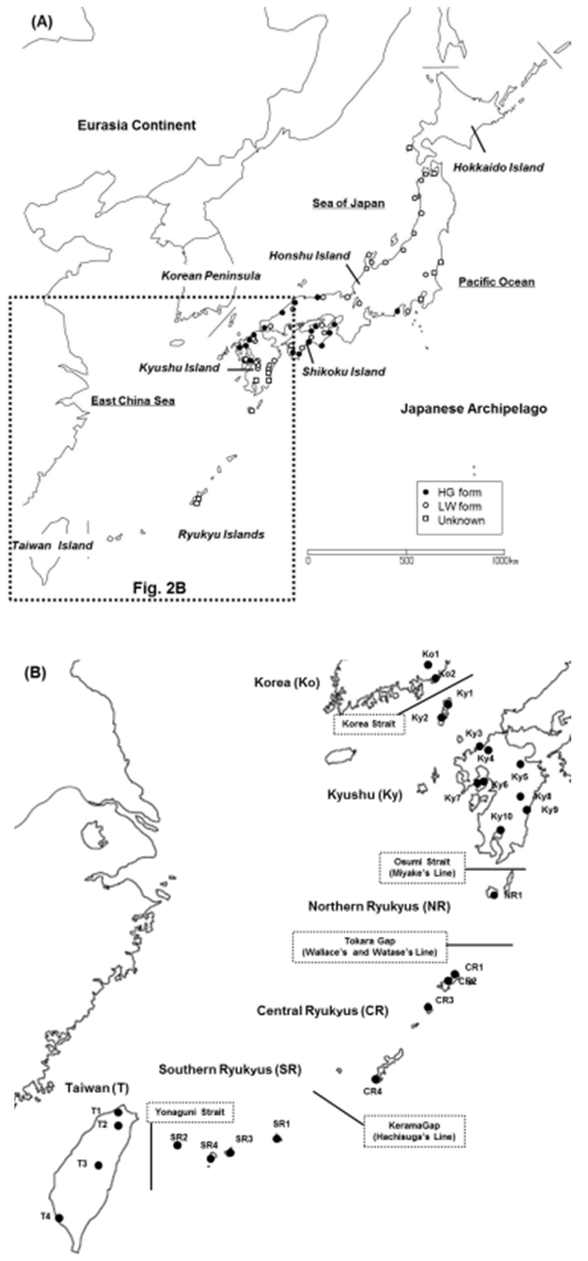

Figure 2.
Locations of *S. miscanthi* populations in a study prior to ours (A) and the research area in the study described here (B).
(B): Filled circles indicate the locations of *S. miscanthi* sampled for this study. These populations are grouped into six regions based on current faunal characteristics and geographic features and are numbered in order of north latitude in each region.

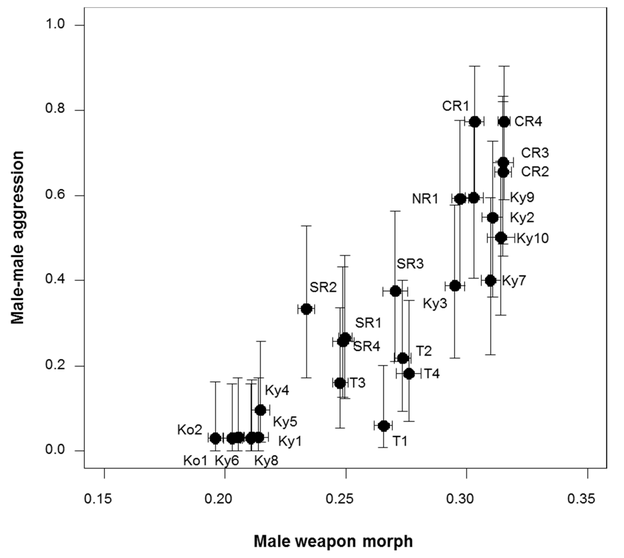

Figure 4.
Relation between average male-male aggression per population and average relative length of male leg I, as a measure of male investment in weaponry. Vertical and horizontal error bars indicate 95% CI and SEM, respectively. For population locations, see Fig. 2B.

OPEN ACCESS article:

***Ecology and Evolution* 3(8): 2661-2669 (2013)**