



Het News

Newsletter of the UK Heteroptera Recording Schemes

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Editors:

Our apologies for the belated publication of this year's issues, we hope that the record 30 pages in this combined issue are some compensation!

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SPECIES NOTES.

Ranatra linearis, *Corixa affinis*, *Notonecta glauca*, *Macrolophus* spp.,
Conostethus venustus, *Aphanus rolandri*, *Reduvius personatus*,
Elasmucha ferrugata

AROUND THE BRITISH ISLES.....

Cornwall, Wiltshire, Herts, Gloucs, Cheshire, SE Yorks, SW Yorks,
Dumfriess.

RECORDING

Regional Recorders
UK Heteroptera Recording Scheme Organisers
Guidelines for submitting records
Records received: Plant bugs & allies
Updated checklist of Heteroptera recorded in Cheshire & Lancs

LITERATURE RELATING TO BRITISH HETEROPTERA

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FERA Plant Pest Factsheet : *Halyomorpha halys*

RECENT PUBLICATIONS

Book Review: Hémiptères Pentatomoidea Euro-Méditerranéens,

Volume 3: Podopinae et Asopinae, Faune de France 93, by Jean Péricart

Fédération Française des Sociétés de Sciences Naturelles, Paris, 2010, ISBN 978-2-903052-31-7, 290pp, 24 colour plates, soft cover, ca. £70.

This is Volume 3 of three volumes covering the Pentatomidae of Europe, North Africa and the Near East - with the first already published (reviewed in *Het News* 6, Spring 2006) and Volume 2 still in preparation.

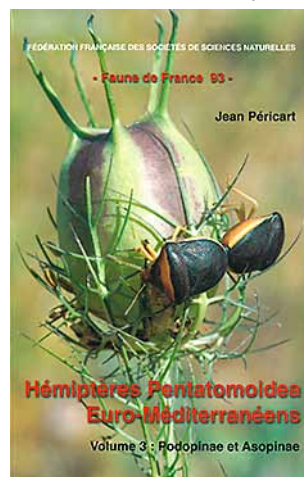
The present volume - Volume 3 - deals with two subfamilies of the Pentatomidae, the predatory Asopinae and the rather more diverse Podopinae. Unfortunately there are few representatives of these subfamilies in Britain - the Asopinae include only *Picromerus bidens*, *Rhacognathus punctatus*, *Troilus luridus*, *Zicrona caerulea* and (long extinct in Britain) *Jalla dumosa* of the 15 treated species and only *Podops inunctus* of the 70 species included in the Podopinae.

Volume 2, still in preparation, will deal with the remaining tribes of the family Pentatomidae, including the Carporini and Pentatomini. The planned series will also include

volumes on the Scutelleridae, Cydniidae and Acanthosomatidae.

The present volume is an essential introduction to some of the more 'difficult' Pentatomid species. These often cannot be identified solely from photographs, particularly those seen on Mediterranean holidays! The numerous habitus drawings throughout and the illustrations of key features and genitalia should make reliable identification of this group far more straightforward and is a major leap forward from the previous identification guide to this group, the now outdated Stichel (1961). Many of the Podopinae species are cryptically coloured although the boldly patterned species of Graphosoma are an exception.

The format follows the previous volume with details of types and synonyms followed by a description of life stages and ecology and



Life-history responses to simulated climate warming of *Nezara viridula*

Dmitry L. Musolin

Introduction

Rapid climate change implies simultaneous and complex changes of many environmental variables – primarily air temperature (IPCC 2007). There is now considerable attention directed at how the global biota are and will be responding to global warming (Bale et al. 2002; Parmesan 2006; Deutsch et al. 2008).

The southern green stink bug, *Nezara viridula* (Figs 1 & 2), is a major agricultural pest with an ever-widening range throughout tropical & subtropical regions. As readers of *Het News* already know, this species is apparently responding rapidly to climate warming in Europe & many other parts of the world (Musolin 2005, 2007, 2010; Yukawa et al. 2007; Tougou et al. 2009; Musolin et al. 2010).



Figure 1 - Adult *Nezara viridula*.

In the early 1960s, a wide-scale field survey was conducted in central Japan at the northern margin of *N. viridula*'s Asian range and the northern limit of the range was mapped (Kiritani et al. 1963; see also Tougou et al. 2009 & Musolin 2010). The survey showed that the northern limit of the species' distribution in central Japan occurred in Wakayama Prefecture (approximately 34.1°N). The range limit was shown to lie on the +5 °C isotherm for mean temperature of the coldest month (usually January), therefore January temperature was proposed as the principal factor determining the northern limit of its distribution (Kiritani et al. 1963).

A recent repeat survey demonstrated that the northern limit had shifted northwards by 85 km from the early 1960s to 2006–2007, 19 km/decade (Tougou et al. 2009; Musolin 2010). Analysis of climatic data showed that the mean Jan–Feb temperature was 1.0–1.9 °C higher in 1998–2007 than in 1960–1969. The number of days with mean temperature <5 °C also significantly decreased, while the annual minimum significantly increased. It was concluded that the mean January temperature and number of cold days are the most important factors controlling the northern limit of distribution of *N. viridula*. Over the last 45 years, at many locations in central Japan conditions have become more favourable for

Figure 2 - Experimental setup.

- Quasi-natural conditions: open metal shelves.
- Simulated warming: incubator with transparent walls.
- 1st Aug. series: difficulties moulting to adult, simulated warming.
- Adults, quasi-natural conditions (lt), simulated warming (rt).
- 1st Sept. series: numbered dark-coloured adults in diapause at start of overwintering, in group container. (Musolin et al. 2010)

overwintering of *N. viridula* and this has probably promoted the northward spread of the species (Tougou et al. 2009; Musolin et al. 2010).

Warming of approximately 0.2 °C per decade is projected for the next two decades (IPCC 2007) so it is important to understand how insects will respond to this. We therefore studied the effect of simulated global warming on the life-history & phenology of *N. viridula*, by exposing two groups to different conditions: one group at outdoor conditions for 15 months; the other group at warmer conditions simulating a moderate temperature rise (2.5 °C), within the range predicted for the end of the XXI century, 1.1–6.4 °C (IPCC 2007). The most important results are presented & discussed here (full results in Musolin et al. 2010),

Material & Methods

Adult *N. viridula* were collected in Kochi (33.6°N, 133.6°E) & transferred to Kyoto (35.0°N, 135.8°E) where the experiment was conducted. On ten dates in 2006–2007 (1st June, 1st July, etc.), egg masses were transferred to plastic containers and placed under two experimental conditions: quasi-natural (i.e. outdoor) & simulated warming.

Under quasi-natural conditions, insects were reared in plastic containers on metal shelves open from all sides (Fig. 2a). Under simulated warming, insects were reared in a modified incubator next to the open shelves (Fig. 2b). The transparent walls ensured that the insects experienced the same photoperiods as their outside siblings. A sensor measured outdoor temperature on the shelves of the quasi-natural conditions,

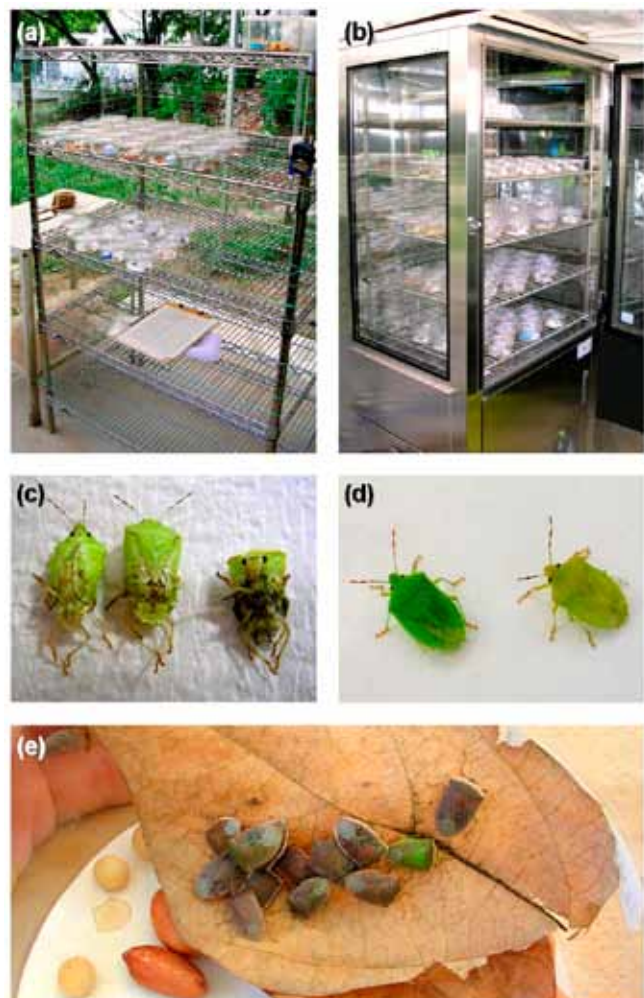


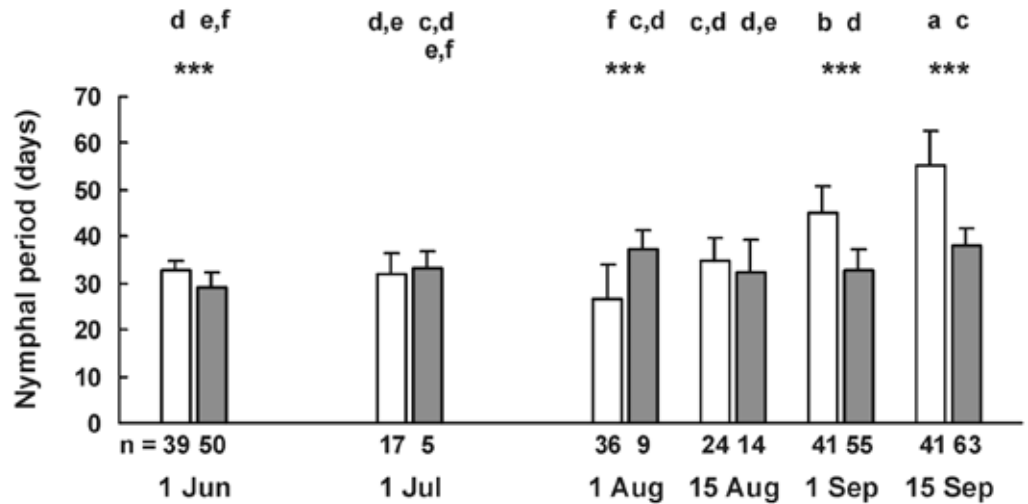
Figure 3 - Mean duration (+SD) of nymphal period in *Nezara viridula* ♀.

Bar:

white = quasi-natural conditions;
grey = simulated warming.

★: pair-wise comparison between treatments in same series, t-test; ***, $P < 0.001$.

a...f: multiple comparisons (all series & treatments), Tukey–Kramer HSD test; same letter not significantly different ($P > 0.05$) (Musolin et al. 2010).



while the incubator simulated warming conditions inside by adding 2.5 °C to the outside temperature. In each series and treatment, important events such as hatching, moulting, copulation, oviposition, adult colour change & death were recorded daily. Life-history & phenology were compared between the two conditions, & all series, to examine whether & how warming affected performance & fitness.

Results

Nymphal development. The duration of the nymphal period showed a predictable seasonal trend under the quasi-natural conditions: higher outdoor temperatures in August resulted in a shorter nymphal period in the 1st August series compared to the 1st June & 1st July series and as the season progressed the nymphal period became significantly longer (Fig. 3). The effect of the artificial warming was unexpected. While warming significantly accelerated nymphal development in the 1st June, 1st & 15th September series, it retarded development to varying levels in the 1st July & 1st August series. Thus, while under the quasi-natural conditions the nymphal development tended to be faster in the 1st August series than in the June and July series, under warming conditions it tended to be slower.

Simulated warming also affected survival of nymphs. In summer it led to increased nymphal mortality, some adults in these series had apparent difficulties while moulting to the adult stage and many of them died during moult (Fig. 2c).

Size & physical condition of adults. The body length of females tended to be smaller in the 1st and 15th August series than in most of other series (Fig. 4). The simulated warming strongly enhanced this tendency. When compared pairwise with the quasi-natural conditions on the same dates, warming significantly reduced the size of adults in August, but increased it in September. In addition to having a smaller size in the warmest season, some adults were apparently in a weaker physical condition under the warming treatment: they had a softer cuticle and a lighter yellowish body colour instead of intensive green (Fig. 2d).

Adult size & winter survival. Under both conditions, the series with larger mean body length tended to have higher winter survival than those with smaller means (Fig. 5a), although not significant, probably because of the very low survival rate in some series under quasi-natural conditions. However, when analysed on an individual basis, both the ♀♀ size & simulated warming strongly affected overwintering success. Larger ♀♀ had significantly higher winter survival rates under each of the two experimental conditions

(Fig. 5b). Moreover, ♀♀ from each size group had higher winter survival rates under the simulated warming conditions than under the quasi-natural conditions (Fig. 5b). Finally, simulated warming allowed smaller ♀♀ to reach the same winter survival rate as larger ♀♀ had under quasi-natural conditions.

Adult body colour & winter survival. Induction of winter diapause is associated with adult body colour change from green (Fig. 1) to russet (brown; Fig. 2e). The experiment showed that winter survival of ♀♀ was strongly correlated with body colour.

When winter survival was analysed separately for each colour grade in the non-reproductive ♀♀, it differed significantly between green & russet ♀♀, but not between these & intermediates (Fig. 6a).

Warming strongly influenced the relationship between body colour and winter survival. Under quasi-natural conditions dark ♀♀ had a significantly higher survival rate than the green, whereas under warming survival rates were higher in both colour groups and did not differ significantly (Fig. 6b). Comparison of winter survival within colour grade, showed that green ♀♀ had a significantly higher survival rate under warming. Survival of dark-coloured ♀♀ was also slightly higher under warming, but the difference was not significant (Fig. 6b).

Timing of reproduction. Before overwintering, ♀♀ tended to start both copulation & oviposition earlier under simulated warming than quasi-natural conditions, although this was not significant likely due to the small number of reproducing ♀♀ under warming conditions. In the hottest mid-summer season, the start of reproduction tended to be delayed. After overwintering, the trend to advance reproduction was more pronounced: in all series, copulation & oviposition started earlier under simulated warming than under quasi-natural conditions, in most cases the difference was significant.

Fecundity. In early summer, simulated warming significantly increased egg production, whereas later in the season fecundity tended to be lower under simulated warming than under quasi-natural conditions, although not significantly. After overwintering, no common patterns were detected & only in the 15th September series did warming significantly increase post-diapause egg production.

Longevity. Simulated warming significantly reduced ♀♀ longevity in the summer series. In the autumn series, most ♀♀ survived until the next spring & early summer & the simulated warming increased longevity, probably by optimizing thermal overwintering conditions.

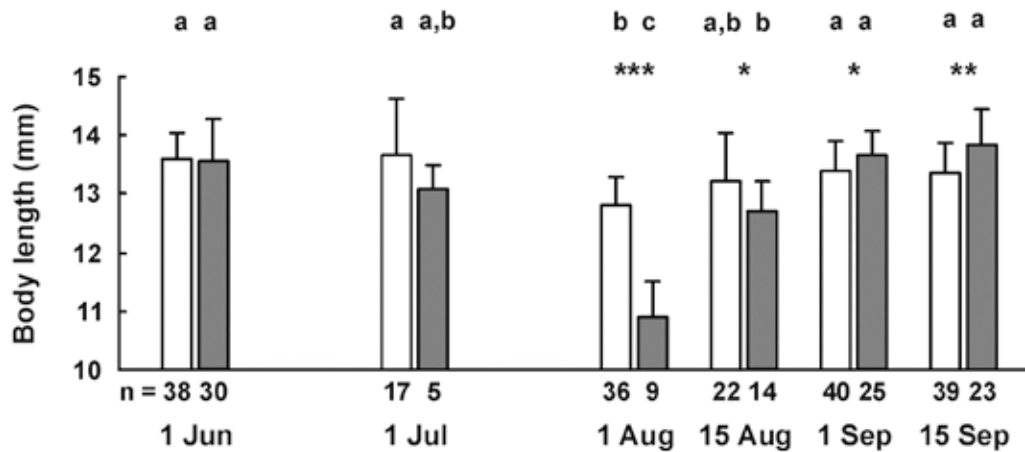


Figure 4 - Body length of *Nezara viridula* ♀, mean (+SD)

Bar: white, quasi-natural conditions; grey, simulated warming conditions.

*: pair-wise comparison between treatments in same series, t-test; *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$.

a...c: multiple comparison, Tukey-Kramer HSD test; same letter not significantly different ($P > 0.05$) (Musolin et al. 2010).

Discussion

As in many species (e.g., Bale et al. 2002; Parmesan 2006), temperature elevation is expected to affect numerous phenological events in *N. viridula*. For example, in this experiment, simulated warming advanced the start of spring colour change & reproduction. A further temperature increase is likely to stimulate earlier start of reproduction in *N. viridula* and perhaps other insects, if they can find enough food.

Simulated warming strongly affected timing of nymphal development. Growth was significantly accelerated by warming in early summer & autumn series, but retarded in late summer series (Fig. 3). Late summer is the warmest period in central Japan: in August 2006, daily maximum temperature reached +40 °C under quasi-natural conditions &, thus, +42.5 °C under simulated warming. As a result, nymphs developed slower, suffered higher mortality, & had difficulties during the final moulting (Fig. 2c).

Simulated warming also affected many life-history traits. In general, under quasi-natural conditions, *N. viridula* ♀♀ had smaller body size in the 1st August series than earlier in summer or later in autumn (Fig. 4), a seasonal tendency reported in some other insect species. Simulated warming strongly enhanced this tendency: ♀♀ emerging in the 1st & 15th August series were not only the smallest in the entire experiment, but on each of these dates were significantly smaller under warming conditions than under quasi-natural conditions. These findings show that the response to further warming is not the same throughout the year and differs by season. In turn, difference in size is likely to affect other life-history traits such as survival or reproductive performance.

Winter is a critical season for insects in the temperate zone. This proved true for *N. viridula* too (Kiritani et al. 1963; Tougou et al. 2009; Kiritani 2011). Under both experimental conditions, larger ♀♀ had significantly higher winter survival rates (Fig. 5). More importantly, an additional 2.5 °C of simulated warming in winter strongly increased the likelihood of winter survival in both size classes & allowed smaller ♀♀ to reach the same winter survival rate as larger ♀♀ had under the quasi-natural conditions. Thus, if warming continues in the future, not only larger but also smaller ♀♀ of *N. viridula* will survive winters more successfully than they do now and this will likely provide a basis for faster population growth.

Simulated warming strongly affected the functional relationship between colour change in autumn and overwintering success. Under warming, green ♀♀ survived winter even better than dark-coloured ♀♀ did under quasi-natural condi-

tions (Fig. 6). This implies that further climate warming will increase chances of successful winter survival even in individuals that fail to change body colour and, thus, properly prepare for diapause before winter.

Whereas it is believed that many species of insects in the temperate zone will benefit from the temperature rise in one or another way (e.g., Deutsch et al. 2008), the present experiment shows that the situation is more complicated. The strong retardation of nymphal development, smaller size, softer cuticle and lighter yellowish body colour of *N. viridula* adults as well as their dramatically reduced life span in the 1st August series suggest that the elevated temperature experienced by nymphs and young adults exceeded their thermal optima. The mechanism underlying the abnormality of the cuticle colour and structure is so far unknown, although it might be related not only to thermal stress experienced by the bugs but also to the malfunction of their gut symbiotic bacterial fauna caused by the daily high temperature extremes (T. Fukatsu et al., unpubl. data). The design and the results of our experiment suggest that the warming-mediated suppression of performance might be a direct effect of temperature rather than an indirect one (via altered precipitation or condition of host plants). On the other hand, in contrast to plants, active life stages of insects can possibly minimize the deleterious effect of elevated temperature, for example, by active selection of microhabitats. This might be especially useful in coping with daily temperature extremes. Some insect species will probably be able to mitigate the negative hot season effects of warming by evolving a summer diapause.

The data accumulated so far suggest that the effect of the rapid climate change is likely to be complex and differ among species and regions. The current study demonstrates that, even within the same species or population, responses will be different for different life-history traits and seasons. Thus, for instance, warming might negatively affect nymphal development during the hot season, stimulate development in autumn and/or strongly enhance survival of adults in winter. All this together, in a complex way, will affect species' population dynamics, voltinism, relationships with other members of the community & likely pest status (Musolin et al. 2010).

Acknowledgements

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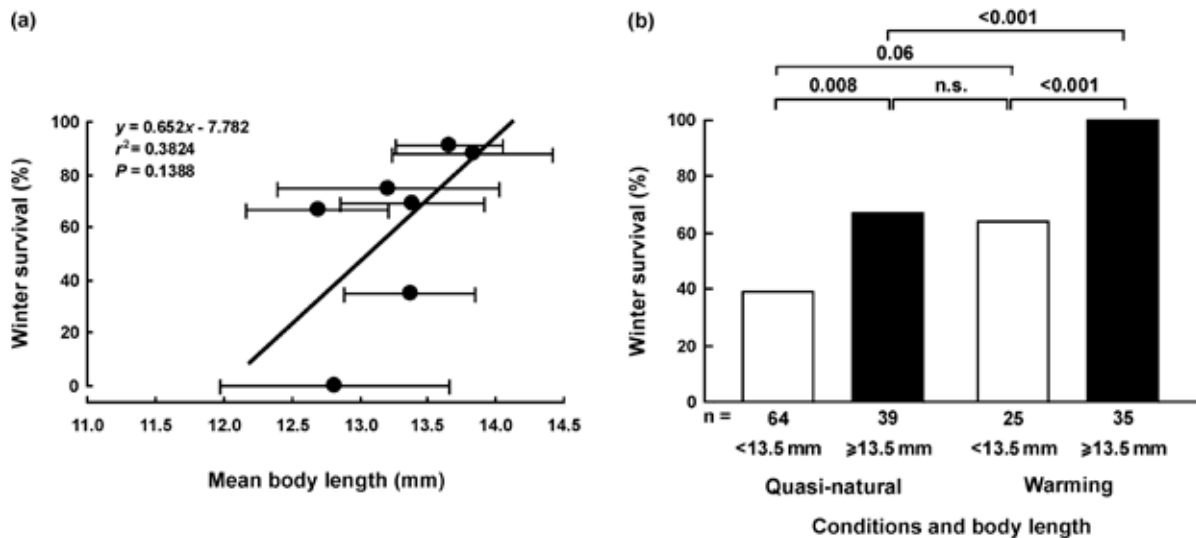


Figure 5 - Winter survival -v- body length of *Nezara viridula* ♀♀.

(a) Bugs surviving to at least 1st December, linear regression line & mean (\pm SD) after arcsine transformation.
 (b) Winter survival of body length groups, for different treatments of non-reproductive bugs (all series combined; P of Fisher exact test after Bonferroni adjustment is shown (from Musolin et al. 2010).

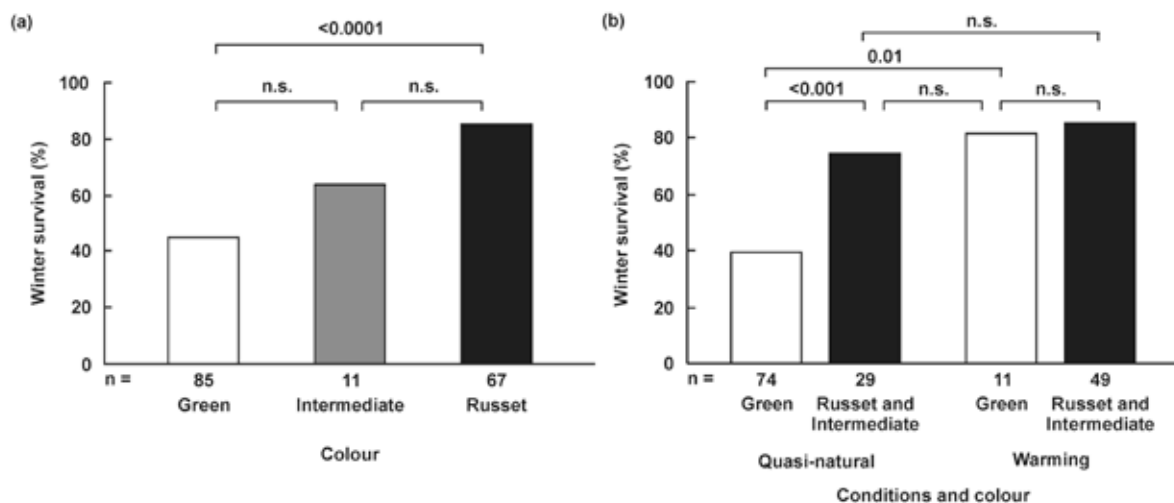


Figure 6 - Winter survival -v- colour: non-reproductive *Nezara viridula* ♀♀.

(a) Response of colour groups (all series & treatments combined; P of χ^2 test shown).
 (b) Effects of colour & warming (all series combined; P of Fisher exact test shown) (Musolin et al. 2010).

References

- Bale, J.S., Masters, G.J., Hodkinson, I.D. et al.** 2002. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. *Global Change Biology*, **8**, 1–16.
- Deutsch, C.A., et al.** 2008. Impacts of climate warming on terrestrial ectotherms across latitude. *Proceedings of the National Academy of Sciences of the United States of America*, **105**, 6668–6672.
- IPCC.** 2007. *Climate Change 2007: The Physical Science Basis*. Contribution of Wkg Gp I to 4th Assessment. Report of Intergovernmental Panel on Climate Change (ed. S. Solomon, et al.). CUP, Cambridge, U.K.
- Kiritani, K., Hokyo, N., & Yukawa, J.** 1963. Co-existence of the two related stink bugs *Nezara viridula* and *N. antennata* under natural conditions. *Res. on Population Ecology*, **5**, 11–22.
- Musolin, D.L.** 2005. The southern green shield bug *Nezara viridula* (L.) expands its distribution range, not only in the U.K. *Het News*, **5** (Ser. 2), 2–3.
- Musolin, D.L.** 2007. Insects in a warmer world: ecological, physiological and life-history responses of true bugs (Heteroptera) to climate change. *Global Change Biology*, **13**, 1565–1585.
- Musolin, D.L.** 2010. Range expansion of the southern green stink bug

Nezara viridula (Heteroptera: Pentatomidae) in response to the rapid climate change in Japan. *Het News*, **15** (Ser. 2): 4–6.

- Musolin, D.L., Tougo, D., Fujisaki, K.** 2010. Too hot to handle? Phenological and life-history responses to simulated climate change of the southern green stink bug *Nezara viridula* (Heteroptera: Pentatomidae). *Global Change Biology*, **16**, 73–87.
- Parmesan, C.** 2006. Ecological and evolutionary responses to recent climate change. *Ann. Rev. of Ecol., Evol. & Syst.*, **37**, 637–669.
- Tougo, D., Musolin, D.L., Fujisaki, K.** 2009. Some like it hot! Rapid climate change promotes changes in distribution ranges of *Nezara viridula* and *Nezara antennata* in Japan. *Entomologia Experimentalis et Applicata*, **130**, 249–258.
- Yukawa, J., et al.** 2007. Distribution range shift of two allied species, *Nezara viridula* and *N. antennata* (Hemiptera: Pentatomidae), in Japan, possibly due to global warming. *Appl. Entomol. & Zool.*, **42**, 205–215.

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