1. ABOUT THE DATASET

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Title: Functional and behavioural response data of the anthocorid *Anthocoris nemoralis* to *Cacopsylla pyri*, at different temperatures, Kent, UK.

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Rights-holder(s): University of Reading

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Description: This dataset contains functional response data for the anthocorid *Anthocoris nemoralis* consuming pear sucker (*Cacopsylla pyri*) nymphs at three different temperatures (18, 21, and 23°C). The number of nymphs consumed after 24hrs was counted at 5 different prey densities (5,10,15,30 and 50 nymphs) to calculate a functional response.

The dataset also contains behavioural responses of the anthocorid *Anthocoris nemoralis* to pear sucker (*Cacopsylla pyri*) nymphs, eggs and no food as a control. The time spent demonstrating 6 different behaviours (feeding, moving, moving leaf, antennating, cleaning and stationary), was recorded over a 20-minute time period. The velocity, distance travelled, time spent in the centre and edge zones by the anthocorid were also recorded.

Finally, the dataset includes the temperature and relative humidity of the three controlled temperature cabinets, during the duration of the experiments. These were measured using an EasyLog USB datalogger at five minute intervals.

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Related publication: Reeves, L. A., Garratt, M. P. D., Fountain, M. T. and Senapathi, D. (2023) Functional and behavioral responses of the natural enemy *Anthocoris nemoralis* to *Cacopsylla pyri*, at different temperatures. Journal of Insect Behavior. 36(3) pp. 222-238. ISSN 0892-7553. <https://doi.org/10.1007/s10905-023-09836-5>

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2. TERMS OF USE

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3. PROJECT AND FUNDING INFORMATION

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Title: Pears, pests and natural enemies: modelling tri-trophic interactions in a changing climate

Dates: 21/09/2020 - 21/09/2024

Funding organisation: BBSRC

Funding type: BBSRC training grant funded PhD project.

Grant no.: BB/V509747/1

4. CONTENTS

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File listing

1. Functional\_response.csv
* 10 variables, 375 rows
* Date (date at which the experiment occurred dd/mm/yyyy), Time in (time experiment started at), Time out (time experiment finished at), Density (number of *C. pyri* nymphs in petri dish), Sex (sex of anthocorid, M, F or Control where no anthocorid was used), Temperature (temperature of CT cabinet, °C), Number eaten (number of *C. pyri* nymphs consumed after 24hrs), Still alive (whether the anthocorid was still alive after 24hrs), Batch (batch number of the anthocorids used), Notes (any other information e.g. if any nymphs became adults).
* Missing data codes: NA
* Description: Functional response data for the anthocorid *Anthocoris nemoralis* consuming pear sucker (*Cacopsylla pyri*) nymphs at three different temperatures (18, 21, and 23°C), in controlled temperature (CT) cabinets. The number of nymphs consumed by male or female *A. nemoralis* after 24hrs were counted at 5 different prey densities (5,10,15,30 and 50 nymphs) to calculate a functional response. A control treatment without anthocorids also occurred to measure the natural mortality of *C. pyri* nymphs over 24hrs.
1. Behavioural\_assay.csv
* 22 variables, 179 rows
* Trial\_no (trial number of the behavioural assay), Food (type of food in the arena: *C. pyri* eggs, *C. pyri* nymphs or no food), Sex (sex of anthocorid: male (M) or female (F)), Temp (Temperature of the room: 18, 21 or 23 °C), Scenario (temperature scenario: current summer temperature, temperature predicted by RCP4.5 scenario in 2080 or temperature predicted by RCP8.5 scenario in 2080), Eaten (number of *C. pyri* eggs or nymphs eaten), Distance (total distance travelled in 20 mins), Velocity (average velocity m/s), Centre\_zone (time spent by anthocorid in the centre), Moving (time spent moving (s)) Stationary (time spent stationary (s)), Antenating (time spent antenating (s)), Cleaning (time spent cleaning (s)), Feeding (time spent feeding (s)), Moving\_leaf (time spent moving the leaf disc (s)), Edge\_zone (time spent around the edge (s)), Middle\_zone (time spent in the middle (s)), Date, Time, Batch (batch number of anthocorids).
* Missing data codes: NA
* Description: Behavioural responses of the anthocorid *Anthocoris nemoralis* to pear sucker (*Cacopsylla pyri*) nymphs, eggs and no food as a control, at three different temperatures. The time spent demonstrating 6 different behaviours (feeding, moving, moving leaf, antennating, cleaning and stationary), was recorded over a 20-minute time period in a petri dish (55mm in diameter). The velocity, distance travelled, time spent in the centre and edge zones by the anthocorid were also recorded, using Ethovision XT tracking software (Noldus et al. 2001).
1. Data\_loggers.csv
* 6 variables, 31612 rows
* Reading (reading number for data logger), Date (dd/mm/yyyy), Time (00:00:00), Temp (temperature of CT cabinet, °C), Humidity (%rh), Cabinet (temperature regime in the cabinet, current, RCP4.5, RCP8.5).
* Missing data codes: NA
* Description: The temperature (°C) and relative humidity (%rh) of the three controlled temperature cabinets, during the duration of the experiments. These were measured using an EasyLog USB datalogger at five-minute intervals.

5. METHODS

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*Functional response experiments*

For functional response experiments, adult *A. nemoralis* were starved for approximately 24 hrs at either 18 °C, 21 °C or 23°C in controlled temperature (CT) cabinets. A batch of 500 *A. nemoralis* adults was ordered from the biocontrol company Koppert each week of the study. Then, a male or female individual was added to a triple-vented Petri dish (55 mm in diameter). The floor of the dish was covered with 1% set agar to provide moisture and support for leaf disks. The Petri dish contained a leaf disk of *P. communis* ‘Conference’ (20 mm in diameter) and *C. pyri* nymphs (4th - 5th instar), at one of five densities (5, 10, 15, 30 and 50 nymphs). Pear sucker hardshell nymphs (L4-L5, the fourth or fifth nymph stage in a pear sucker’s life history) were collected from cv. Conference pear trees (*Pyrus communis*) at NIAB East Malling (51.2885° N, 0.4383° E). Nymphs were removed from trees daily, using a soft, fine tipped paintbrush, to minimize damage to insects.

After the anthocorid was added, the Petri dish was sealed with plastic paraffin film to prevent *C. pyri* nymphs escaping and returned to the same temperature treatment for 24 hrs. Nymphs were not replaced during the experiment. After 24 hrs the anthocorid and numbers of *C. pyri* nymphs were recorded as alive or dead. There were 10 replicates for *A. nemoralis* male and female tests at each temperature treatment, for the 5 prey densities, giving a total of 300 observations. Five control treatment replicates of *C. pyri* nymphs were set up for each temperature, to quantify natural mortality.

*Behavioral assays*

For behavioural assays adult *A. nemoralis* were starved for 24 hrs, in one of the three temperature treatments (18 °C, 21 °C and 23 °C) in CT cabinets. After this the anthocorid was moved to a CT room with Ethovision insect behavior tracking software (Noldus et al. 2001, 2002). The anthocorid was then added to a triple-vented Petri dish (55 mm in diameter). The Petri dish contained a 5 mm piece of leaf with either of 2 *C. pyri* nymphs (4-5th instar), 15 semi-mature *C. pyri* eggs, or no prey (as a control). The numbers of eggs and nymphs were chosen as they were approximately equivalent to each other in size. The leaf containing the food was placed in the center of the Petri dish (marked with a cross), the anthocorid was then placed in the 20 mm center circle (not on the leaf) and given 10 minutes to acclimatize. After this period the Ethovision camera was set to record for 20 minutes, then the anthocorid was removed and the number of nymphs/eggs consumed was counted.

Movement and behaviours of anthocorids were recorded using Ethovision XT tracking software (Noldus et al. 2001, 2002); the velocity, distance travelled, time spent in the center (20 mm diameter center circle) and edge (up to 10 mm from the edge) zones and time spent displaying certain behaviours were recorded. These measurements were tracked from the centre-point of the anthocorid’s body. The 6 recorded behaviours were: feeding (when the anthocorid was stationary and had its stylet in an egg or nymph), moving (when the anthocorid was walking or flying), moving leaf (when the anthocorid was moving the leaf around the arena), antennating (when the anthocorid was stationary and repeatedly touching a surface with its antennae), cleaning (when an anthocorid was grooming its legs or antennae) and stationary (when an anthocorid was completely still and not feeding). All behaviors were independent of each other. There were ten replicates each of the three food treatments, three temperature treatments and if the anthocorid was male or female, giving a total of 180 observations.

*Temperature regimes and controlled temperature cabinets*

The three temperature treatments (18, 21 or 23 °C) were determined based on the current mean July-August temperature (1990-2020) and mean July-August temperatures predicted in 2080, based on the RCP4.5 (medium emissions) and RCP8.5 (high emissions) scenarios. RCPs are future Representative Concentration Pathways, which are concentrations of released greenhouse gases that will result in radioactive forcing (the change in energy going in and out of the upper atmosphere) increasing by a specific amount by 2100 (Lowe et al., 2018; Van Vuuren et al., 2011). The current temperature was calculated using mean July-August temperatures (1990-2020) from East Malling weather station (51.288° N, 0.448° E) in Kent. To calculate future temperatures for 2080, data was extracted using the UK Climate Projections User Interface, based on UKCP18 projections (UKCP 2021). The predicted increase in mean air temperature at 1.5 m for 2080 was calculated for July to August (baseline scenario 1981-2000) for a 25 km x 25 km region in Kent, surrounding East Malling (562500.00, 162500.00). These temperatures were calculated for each of the RCP4.5 and RCP8.5 scenarios and added to the average 1981-2000 July-August temperature (17.41 °C).

The three controlled temperature (CT) cabinets (set at 18, 21 and 23 °C) had two containers half-filled with water to keep humidity constant. Temperature and humidity were monitored using EasyLog USB dataloggers. The daylight cycle within the cabinets was 16 hrs light, 8 hrs dark, based on average summer day length in the UK.

References:

Lowe JA, Bernie D, Bett P, Bricheno L, Brown S, Calvert D, . . . Fosser G (2018) UKCP18 science overview report. Met Office Hadley Centre: Exeter, UK.

Noldus LP, Spink AJ, Tegelenbosch RA (2001) EthoVision: a versatile video tracking system for automation of behavioral experiments. Behav res meth instrum comput 33(3):398-414. https://doi.org/10.3758/BF03195394

Noldus LP, Spink AJ, Tegelenbosch RA (2002) Computerised video tracking, movement analysis and behaviour recognition in insects. Comput Electron Agric 35(2-3):201-227. https://doi.org/10.1016/S0168-1699(02)00019-4

UKCP (2021) UK Climate Projections User Interface Data: Anomalies for probabilistic projections (25km) over UK, 1961-2100. https://ukclimateprojections-ui.metoffice.gov.uk/products/form/LS1\_Sample\_01. Accessed 11 September 2022

Van Vuuren DP, Edmonds J, Kainuma M, Riahi K, Thomson A, Hibbard K, . . . Lamarque JF (2011) The representative concentration pathways: an overview. Clim change 109(1): 5-31. https://doi.org/10.1007/s10584-011-0148-z