1. ABOUT THE DATASET

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Title: Data on the efficacy and interactions of two natural enemy species (*Anthocoris nemoralis* and *Forficula auricularia*)for the biological control of pear psyllid (*Cacopsylla pyri*), Kent, UK

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Organisation(s): University of Reading

Rights-holder(s): University of Reading

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Description: This dataset contains behavioural response data for *Anthocoris nemoralis* and *Forficula auricularia* under two different temperature regimes (current and RCP8.5), within microcosms in controlled temperature cabinets. Behaviours (feeding, moving, moving leaf, antennating, cleaning and stationary and interacting) were assessed during the night (after 2hrs dark) and day (after 2hrs light) and position (top, middle, bottom and shelter) within the microcosm was also recorded.

The dataset also contains the amount of *Cacopsylla pyri* consumed by *A. nemoralis* and *F. auricularia* within microcosms after 24hrs and whether the predator species has also survived. This is for two different temperature regimes (current and RCP8.5) and predator treatments are *A. nemoralis* and *F. auricularia* on their own or both species together.

The dataset includes a survival analysis, the survival of anthocorids (*A. nemoralis*)(hrs), in a petri dish alongside earwigs (*F. auricularia*) and a control treatment of anthocorid survival without an earwig present. This occurred at two different temperature regimes (current and RCP8.5), with anthocorid survival being assessed after 6hrs, 12hrs and then every 12 hrs for 10 days.

Finally, the dataset contains an olfactometry analysis where *F. auricularia* chooses between two arms within an olfactometer, at two temperature regimes (current and RCP8.5). arms containing different prey species, either anthocorids (*A. nemoralis*), pear psyllid nymphs (*C. pyri*) or no food as a control treatment. Time taken to decide on an arm was recorded, alongside whether the decision was for a prey item or not.

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Related publication: Reeves, L., Fountain, M., Garratt, M. and Senapathi, D. (2024) Intraguild predation or spatial separation? The efficacy and interactions of two natural enemy speciesfor the biological control of pear psyllid (*Cacopsylla pyri*). Journal of Insect Behavior. Accepted 26/07/2024

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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.

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4. CONTENTS

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File listing

1. Behavioural\_analysis.csv
* 16 variables, 320 rows
* Temp (Temperature regime used for the CT cabinet: current or RCP8.5), Treatment (whether anthocorids and earwigs were on their own or in combination), Time (whether assessment was during the day or night), Food (whether *C. pyri* nymphs were present or not), Batch (the replicate number), Antennating (time spent demonstrating antennating behaviour in seconds), Cleaning (time spent demonstrating cleaning behaviour in seconds), Feeding (time spent demonstrating feeding behaviour in seconds), Interacting (time spent interacting with other predator in seconds), Moving (time spent moving in seconds), Stationary (time spent stationary in seconds), Activity (total time spent active in seconds), Bottom (time spent at the bottom of the microcosm in seconds), Middle (time spent in the middle of the microcosm in seconds), Top (time spent at the top of the microcosm in seconds), Shelter (time spent in the shelter in the microcosm in seconds).
* Missing data codes: NA
* Description: A behavioural and positional analysis of anthocorids (*A. nemoralis*) and earwigs (*F. auricularia*) within microcosms, under 2 different temperature regimes (Current and RCP8.5). Predators were either alone or in combination with the other predator species. Time spent demonstrating different behaviours (Antennating, Cleaning, Feeding, Interacting, Moving and Stationary) was recorded for 2 minutes after 2hrs light or 2hrs dark.
1. Olfactometry\_analysis.csv
* 8 variables, 120 rows
* Trial no. (trial number of olfactometry assay), Scenario (temperature regime used: current or RCP8.5), Temp (temperature for each regime °C), Choice (whether earwig chose arm containing anthocorids (1) or no prey (0)), Outcome (whether left or right arm was chosen), Time\_taken (time taken to make choice in seconds), Position of antho (whether prey was located in left or right arm), Treatment (what prey species the olfactometer arms contained).
* Missing data codes: NA
* Description: Responses of earwigs (*F. auricularia*) to olfactometry assays between arms containing different prey species, either anthocorids (*A. nemoralis*), pear psyllid nymphs (*C. pyri*) or no food as a control treatment, for two temperature regimes (current and RCP8.5). Time taken to decide on an arm was recorded, alongside whether the decision was for a prey item or not.
1. Prey\_consumption.csv
* 13 variables, 89 rows
* Temp (temperature regime: current or RCP8.5), Min (minimum temperature of regime, °C), Max (maximum temperature of regime, °C), Food (whether food is present or absent), Anthocorid (whether an anthocorid is present or absent), Earwig (whether an earwig is present or absent), Antho\_alive (whether the anthocorid is alive or not), Earwig\_alive (whether the earwig is alive or not), Number eaten (number of pear psyllid nymphs eaten), Batch (replicate number), Notes (any other additional information), Treatment (the predators in the treatment), Mort (adjustment of prey consumption with respect to natural mortality).
* Missing data codes: NA
* Description: The number of *Cacopsylla pyri* nymphs consumed by *A. nemoralis* and *F. auricularia* within microcosms after 24hrs and whether the predator species has also survived. This is for two different temperature regimes (current and RCP8.5) and predator treatments are *A. nemoralis* and *F. auricularia* on their own or both species together.
1. Survival\_analysis.csv
* 28 variables, 100 rows
* ID no (trial number), Stage (stage of earwig e.g. stage 3 or 4 nymph or adult female or male), Temp (temperature regime: current or RCP8.5), Anthocorid (anthocorid present), Earwig (earwig present in petri dish), Sur\_6 (survival of anthocorid after 6hrs, yes or no), Sur\_12 (survival after 12 hrs), Sur\_24 (survival after 24hrs), Sur\_36 (survival after 36hrs), Sur\_48 (survival after 48hrs), Sur\_60 (survival after 60hrs), Sur\_72 (survival after 72hrs), Sur\_84 (survival after 84hrs), Sur\_96 (survival after 96hrs), Sur\_108 (survival after 108hrs), Sur\_120 (survival after 120hrs), Sur\_132 (survival after 132hrs), Sur\_144 (survival after 144hrs), Sur\_156 (survival after 156hrs), Sur\_168 (survival after 168hrs), Sur\_180 (survival after 180hrs), Sur\_192 (survival after 192hrs), Sur\_204 (survival after 204hrs), Hours (total survival time in hrs), Mins (total survival time in minutes), Eaten (was the anthocorid completely consumed by the earwig), Notes (other additional information), Status (dead (1) or alive (0)).
* Missing data codes: NA
* Description: The survival of anthocorids (*A. nemoralis*)(hrs), in a petri dish alongside earwigs (*F. auricularia*, stage 3 and 4 nymphs and adults) and a control treatment of anthocorid survival without an earwig present. This occurred at two different temperature regimes (current and RCP8.5), with anthocorid survival being assessed after 6hrs, 12hrs and then every 12 hrs for 10 days.

5. METHODS

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*Behavioural analysis and prey consumption experiments*

Microcosms consisted of a ventilated Tupperware pot (diameter 105 mm, height 75 mm), containing a pear shoot with four leaves collected from cv. Conference pear trees (*Pyrus communis*), kept moist in a plant holder (20 mm diameter, 57 mm height), with a small stick attached so that natural enemies could crawl to the top of the holder, a wignest for earwigs to shelter in (59 mm, length 48 mm width, 14 mm height) and a small dish of distilled water (20 mm diameter, 10 mm height). For the purposes of recording whether there was spatial overlap between earwigs and anthocorids, the microcosm was divided into four different zones: top (T), middle (M), bottom (B) and wignest shelter (S).

Adult anthocorid females and earwigs were starved for 24 h at one of the two temperature regimes, current (12.1°C during dark and 22.0°C during light conditions) or RCP8.5 (15.9°C during dark and 26.4°C during light conditions) in a microcosm, within a controlled temperature cabinet. There were seven treatments: 1. earwig, anthocorid and *C. pyri* nymphs, 2. earwig and *C. pyri* nymphs, 3. anthocorid and *C. pyri* nymphs, 4. earwig, anthocorid no prey, 5. earwig no prey, 6. anthocorid no prey and 7. control with no predators. After 24 h, 100 L4-5 stage *C. pyri* nymphs and anthocorids were added to the required treatments. The prey density was above the combined natural enemies’ saturation points for maximal prey intake, so prey consumption could be compared between treatments. Microcosms were monitored after 2 h dark and 2 h light for two minutes to check the position of the earwig or anthocorid (top, middle, bottom or shelter) and the behavior demonstrated (Antennating, Cleaning, Feeding, Interacting, Moving and Stationary). A red-light torch was used during behavioral observations to minimize disturbance. After 24 h natural enemies were removed and whether they were alive was recorded. The number of live *C. pyri* nymphs was also recorded. Each treatment was replicated ten times.

*Survival analyses*

For survival analyses, *F. auricularia* and adult *A. nemoralis* were starved for approximately 24 h at either Current (12.1°C during dark and 22.0°C during light conditions) or RCP8.5 (15.9°C during dark and 26.4°C during light conditions) temperature regimes in controlled temperature (CT) cabinets, in separate triple vented Petri dishes (55 mm in diameter) containing a leaf disk of *P. communis* ‘Conference’ (20 mm in diameter) and moist kitchen towel. The Petri dish was sealed with plastic paraffin film to prevent insects escaping and returned to the CT cabinet. After 24h the earwig was added to the Petri dish containing the anthocorid and resealed. There were five different treatments (stage 3 nymph, stage 4 nymph, adult female, adult male *F. auricularia* and a control where no earwig was added). The Petri dish was checked after 6 h, 12 h and then at 12 h intervals, to see if anthocorid and earwig were still alive or had been consumed, over a period of 10 days. The petri dish was sprayed with distilled water every 24 h, to keep the leaf disc moist. There was a total of 10 replicates for each treatment and temperature, giving a total of 100 observations.

*Olfactometer assays*

For olfactometer assays, female earwigs were starved for 24h in CT cabinets at Current and RCP 8.5 temperature treatments. Glass chambers at the end of each arm contained either *C. pyri* nymphs and adult *A. nemoralis*, *C. pyri* nymphs and nothing and adult *A. nemoralis* and nothing, as control treatments. Experimental set-up of the glass Y-tube olfactometer (main arm, 15 cm long; side arms: 10 cm long; 0.9 cm internal diameter). Air was pumped through for 10 mins prior to releasing the earwig, using a Dymax 8 vacuum pump, average air flow was 1.6 L/min. Each arm had an activated carbon filter to remove other odours and VOCs from the air. The earwig was then added to the base of the olfactometer, whilst air was still being circulated. This was videoed in darkness with a red-light torch over the equipment, in the CT cabinet to minimize disturbance. After 10 minutes video footage was viewed and the time taken for the earwig to reach the end of one of the arms was recorded, as well as the choice made (Left or Right arm). Any individuals that did not make a choice after 10 minutes were disregarded; 2 individuals were disregarded during the experiment. After each replicate, the equipment was washed using 70% ethanol and distilled water, then dried. The position of prey on the left or right arm was randomised. There were 20 replicates for each treatment and temperature giving a total of 120 observations.