**ReadMe for “Temperature response parameters.R”**

The following ReadMe gives a brief overview of how to use “Temperature response parameters.R”. ***Please note that running this script is not strictly necessary for the populations in the manuscript as all temperature response parameters already exist in “Temperature response parameters.csv” in the “Model Parameters” folder.*** Also, please note that the nonlinear least squares regression function *nls* in R must be given a ‘start’ list of rough parameter estimates. To do this efficiently, this script uses the parameter estimates in “Temperature response parameters.csv” in the ‘start’ list of *nls*, which is a circular method for parameter estimation. All parameters, however, were initially estimated by providing rough estimates in the ‘start’ list of *nls*, and can thus be estimated *a priori* by ‘seeding’ each parameter column in “Temperature response parameters.csv” with a rough estimate of each parameter.

**Input:** User-defined species name and location for an insect population or *all* = TRUE

**Output:** Updated “Temperature response parameters.csv” file (if *save* = TRUE) and print out of the temperature response parameters for either a specified population (if *all* = FALSE) or all populations (if *all* = FALSE)

**To run:**

1. Update variable *species* (line 13) and *location* (line 14) with a species name and location from “Temperature response parameters.csv”. If a new population is added to “Temperature response parameters.csv”, then parameters must be ‘seeded’ by adding a rough estimate to each parameter column (this is used in the ‘start’ list of *nls* to estimate parameters via nonlinear regression). Set *all* = TRUE (line 15) if the script is to be run for all populations in “Temperature response parameters.csv” or set *all* = FALSE if the script is to be run just for the specified population.
2. To save parameter fits (over existing values in “Temperature response parameters.csv”), change *save* from FALSE to TRUE in line 18
3. Run the script

**Potential issues:**

* The script only works if the working directory (see line 10) is in the main folder of the downloaded GitHub repo
* The variable *species* (line 13) and *location* (line 14) must exist within “Temperature response parameters.csv” and match the “Population” and “Location” columns exactly
* Some modifications to the “start” list of the various *nls* functions throughout the script may be needed for new populations not in “Temperature response parameters.csv”
* If script yields Error: “singular gradient matrix at initial parameter estimates”, it may be that a parameter value is 0 in “Temperature response parameters.csv”. In this case, ‘seed’ the parameter with a small non-zero number and try to run the script again.

**Script details:**

Lines 5-10 Load required packages and set working directory

Lines 12-18 Have user enter required information

Lines 20-41 Read in, and then find selected population in, “Temperature response parameters.csv”

Lines 43-45 Obtain data for selected population (note: *Apolygus lucorum* is automatically set from its field census location to the location reported in “Temperature response data.csv”)

Lines 47-62 Remove columns that do not contain temperature data and set minimum and maximum values for x-axes of plots as well as the reference temperature used in the *nls* functions

Lines 65-95 Fit parameters for intrinsic growth rate, *rm*, via *nls* (note: for *Clavigralla tomentosicollis* in Burkina Faso, *rMax* (“rMax”) and *Topt,r* (“Toptr”) are first set to data and then *nls* is used to estimate *Tmax,r* (“Tmaxr”) and *σr* (“sr”))

Lines 98-111 Fit parameters of the net reproductive rate, *R0*, via *nls*

Lines 114-127 Fit parameters of the per capita birth rate, *b*, via *nls*

Lines 130-155 Fit parameters of the juvenile per capita mortality rate, *δJ*, via *nls* (note: for *Myzus persicae* in Canada Chatham and *Aulacorthum solani* in US Ithaca, (“dJTR”) is first set to data and then *nls* is used to estimate *AJ* (“AdJ”))

Lines 158-180 Fit parameters for the adult per capita mortality rate, *δA*, via *nls* (note: for *Aulacorthum solani* in Brazil, (“dATR”) is set to data and *nls* is used to estimate *AA* (“AdA”))

Lines 183-203 For the development rate, *g*, quantify *Topt,g* (“Toptg”) and *Tmax,g* (“Tmaxg”) directly from the data (note: for the Brazil populations and *Apolygus lucorum*, the index *i* specifying the temperature treatment of the temperature optima is also updated)

Lines 205-246 Fit parameters of the development rate, *g*, by first fitting *gTR* (“gTR”) and *Ag* (“Ag”) to data below the temperature optima (≤ *Topt,g*) and then *AL* (“AL”), *TL* (“TL”) and *gmax* (“gMax”) to data at all laboratory temperatures (Note: for *Myzus persicae* in Canada Chatham, it is possible to fit all remaining parameters via one *nls*; see lines 206-217)

Lines 247-266 If *nls* fails (error = TRUE), then fit *TL* (“TL”) and *AL* (“AL”) separately to data below the temperature optima (≤ *Topt,g*) and then fit *gmax* (“gMax”) to data at all temperatures

Lines 268-289 Plot development rate thermal response and fit minimum developmental temperature (*Tmin*) via *nls* (note: for *Apolygus lucorum* and *Acyrthosiphon pisum*, *Tmin* is set based on the literature or field observations, respectively)

Lines 291-302 Break the for loop if the analyses are run for a specified species (all = FALSE) and then save (if save = TRUE) and print the model parameters (if the population was found in “Temperature response parameters.csv”; i.e., if found = TRUE)