

Climate Change & Butterfly Flight Design

Melanie Gibbs, Christer Wiklund & Hans Van Dyck

Aim: To determine how local climate conditions during larval development influence adult phenotype in different seasonal cohorts of the speckled wood butterfly, *Pararge aegeria*.

Methods

Collected male specimens from a Swedish woodland population in Ransvik. Census performed several times each year (1990-1999) from May to September, to collect adult males from the 3 developmental pathways corresponding to different seasonal cohorts:

- 1) Development with a pupal winter diapause resulting in early spring adults (May)
- 2) Development with a larval winter diapause resulting in late spring adults (June)
- 3) Direct development resulting in either early summer (July) & late summer (August/ early September) adults.

Traits measured: total adult body mass, wing loading, forewing surface area & forewing length.

Temperature & rainfall data for the months of larval development provided by the Swedish Meteorological & Hydrological Institute.

Results

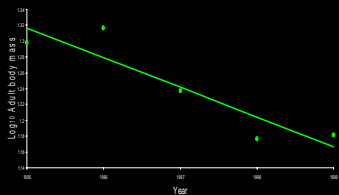


Figure 1

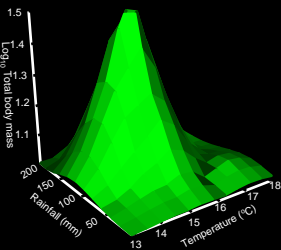


Figure 2

Fig.1. For the pupal diapausing seasonal cohort weather conditions became warmer and drier over time. In response, adult body mass ($F_{4,77} = 15.55$, $P = <0.001$) and wing loading ($F_{4,76} = 16.84$, $P = <0.001$) declined over time.

There was a significant effect of temperature & rainfall, & a significant temperature x rainfall interaction on adult body mass & wing loading in the pupal diapausing seasonal cohort. Fig. 2. shows the significant interaction effect on adult body mass ($R^2 = 0.63$, $P = <0.001$). Heaviest masses were achieved at temperature & rainfall levels around the mean. There was no effect of weather conditions on forewing surface area and forewing length.

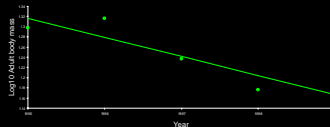


Figure 3

Fig.3. For the larval diapausing seasonal cohort weather conditions became colder and wetter over time. In response, adult body mass ($F_{4,72} = 5.97$, $P = <0.001$) & wing loading ($F_{4,71} = 4.37$, $P = <0.001$) declined over time.

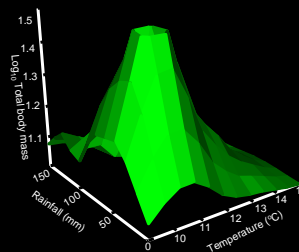


Figure 4.

There was a significant effect of temperature & rainfall, & a significant temperature x rainfall interaction on adult body mass & wing loading in the larval diapausing seasonal cohort. Fig 4. shows the significant interaction effect on adult body mass ($R^2 = 0.48$, $P = 0.007$). Heaviest masses were achieved at mean temperature and rainfall levels. There was no effect of weather conditions on forewing surface area and forewing length.

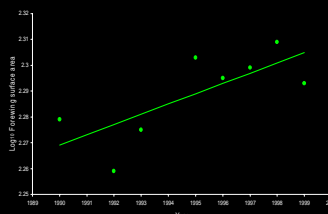


Figure 5

For early summer direct developing adults, weather conditions during larval development became colder over time. In response, forewing surface area ($F_{8,142} = 9.08$, $P = <0.001$) & forewing length ($F_{8,142} = 10.15$, $P = <0.001$) significantly increased over time (e.g. Fig. 5.). There was no effect of weather conditions on adult body mass or wing loading.

For the late summer direct developing adults there was no effect of changes in temperature & rainfall on adult phenotype development.

Discussion

- Local climate conditions during larval development influence adult phenotype development.
- The response of flight morphological traits differed in both magnitude & direction depending on the developmental pathway, and hence seasonal cohort, examined.
- Through its flexibility & ability to follow different developmental pathways, *P. aegeria* may be able to adjust to changes in weather conditions over time.
- **IMPORTANT:** studies are needed that focus on threatened species, particularly those with less flexible trait and only one specific period of development during the year, as these species may be less fortunately buffered.

