Effects of temperature transfers on development, survival and reproduction of *Hermetia illucens* (Linnaeus) (Diptera: Stratiomyidae)

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Organic waste is a huge problem in many countries

3,262

1.3 billion Tonnes of food are wasted per year (FAO 2011).

34 million Tonnes of municipal solid waste per year was produced in Canada (2008) (Statistics Canada, 2012)

Food Waste

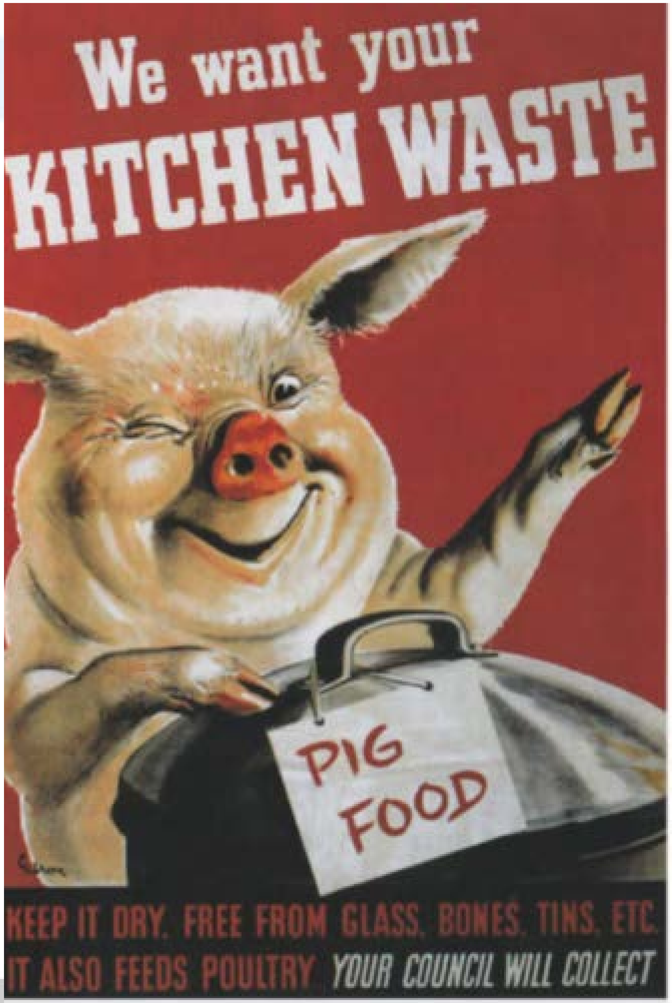
http://www.ricesolutionslimited.com/food-waste.html

Gas emissions, and pollution like Methane

Food Waste Treatment

High temperature steaming of food waste for pig feed

Dr. Harvey Houng Department of Waste Management, Taiwan EPA

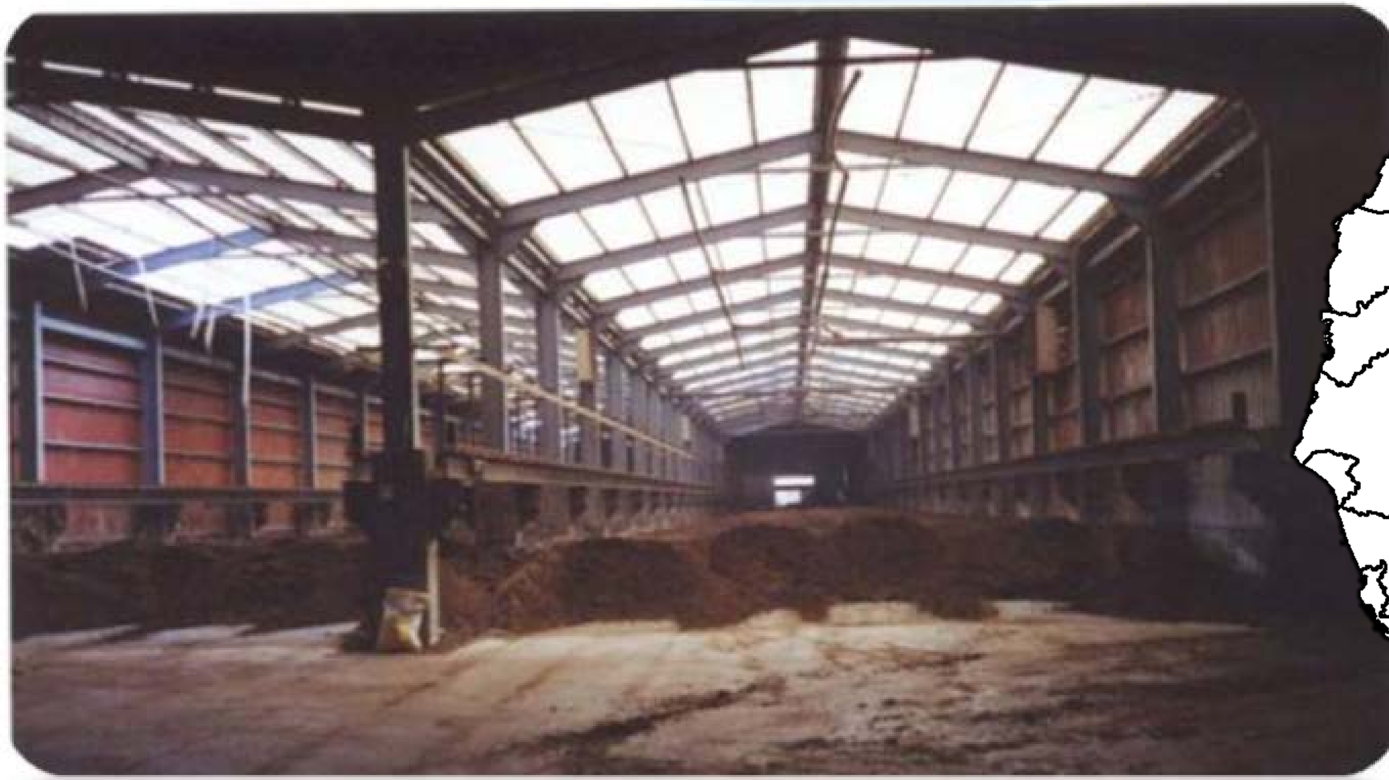


UK Second World War poster.

T Stuart, 2009

Composting sites located around Taiwan

Bulky compost facility



Conversion of organic material by insects

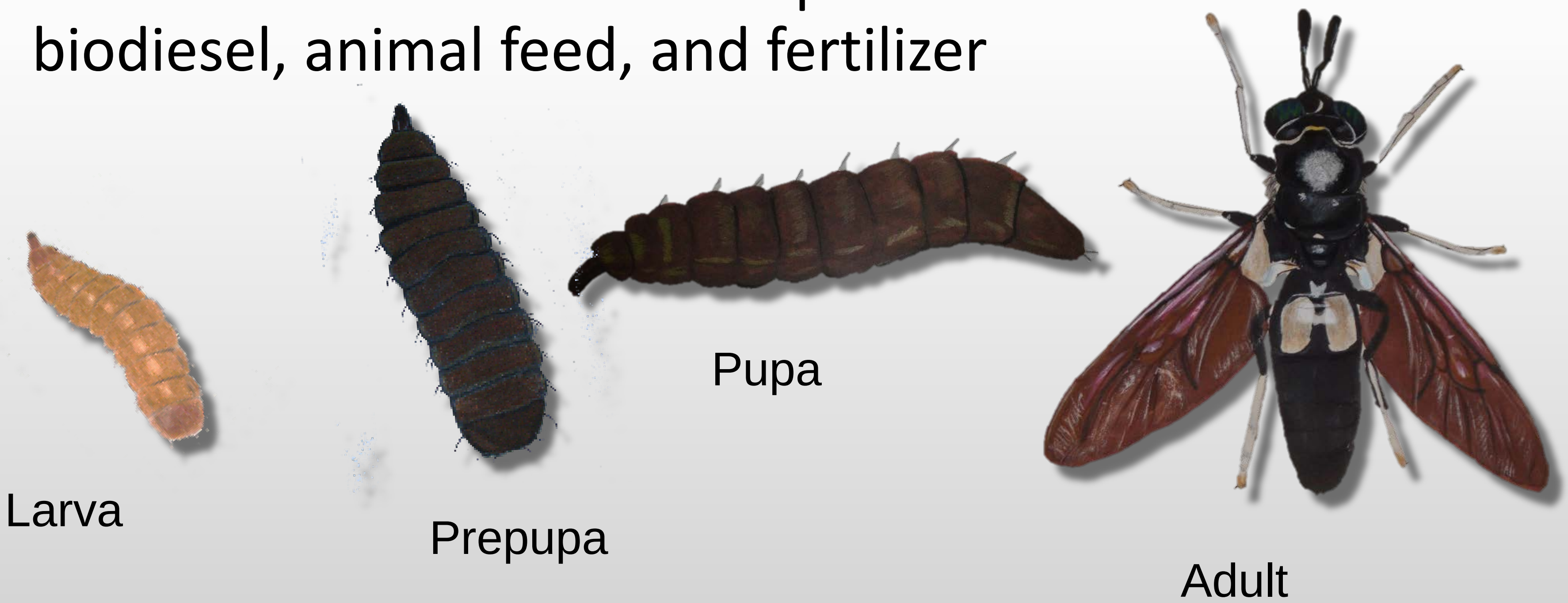
Ornidia obesa

Hermetia illucens

Musca domestica

Why *Hermetia illucens*

- Is capable of degrading large amounts of organic matter
- Has been used in the reduction of considerable quantities of solid waste
- Because its utilization in the production of biodiesel, animal feed, and fertilizer



Hermetia illucens biology

- It was believed *H. illucens* will lay only one eggs mass
- Diapause haven't been properly addressed and was unknown till 2016.

Our purpose

- Demonstrate the use of a novel technique for estimating population temperature response parameters that can be use to model the growth potential of poikilotherms
- We use *Hermetia illucens* as a case study to estimate its potential as an organic waste treatment

Why use *Hermetia illucens* and temperature transfers

- *H. illucens* requires specific light intensity and adequate space for mating and oviposition
- Using constants temperatures is not an appropriate method to study *H. illucens*

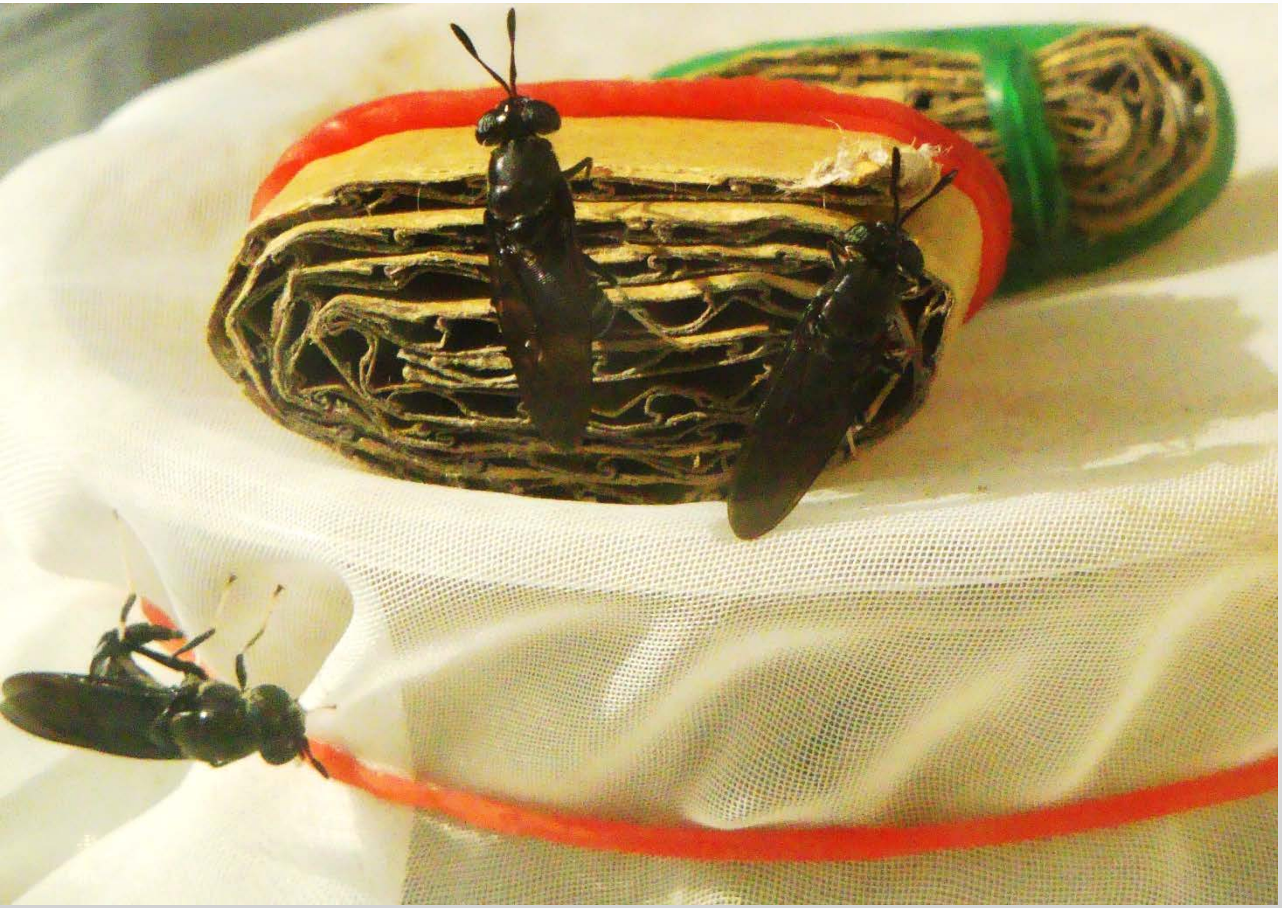
Materials and methods

3:1 combination of wheat bran, chicken feed and water

1.5 g of Sobic Acid
1.75 of Methyl-p-hydroxbenzoate
Diluted in 40 ml of 70% of alcohol
5ml of the solution was added to 100g of artificial diet + 250 ml of water

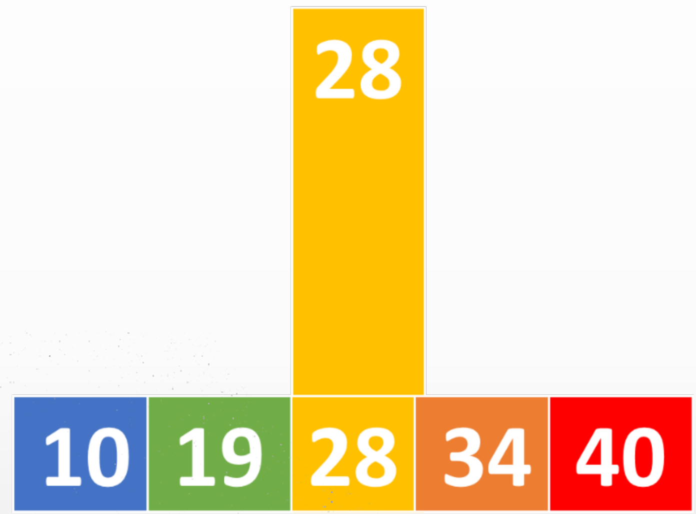
Newly-laid egg masses of *H. illucens* was exposed at 28 ° C

28

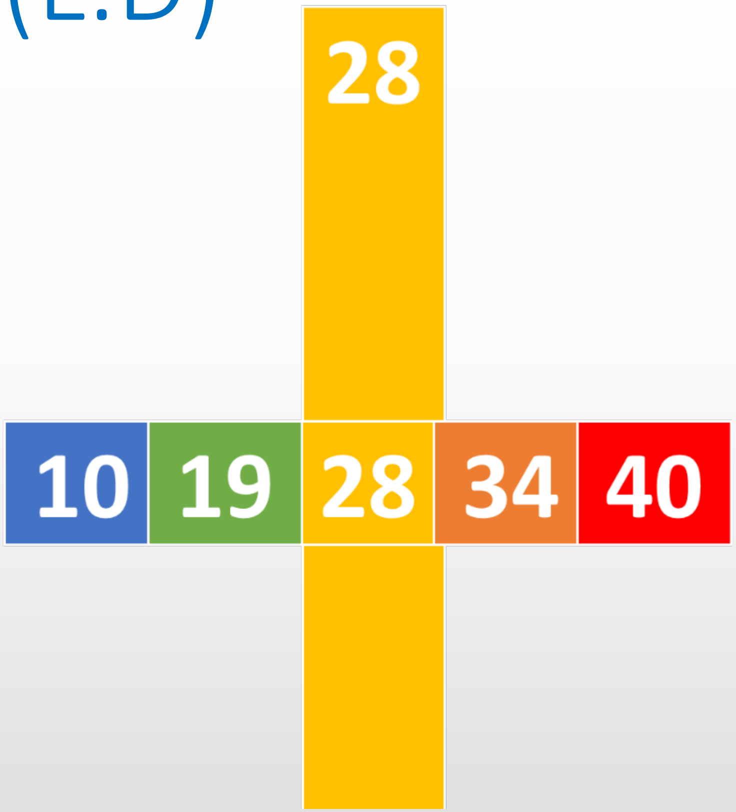


were then transferred into treatment temperatures (10, 19, 28, 34, and 40 °C) for five days

100 Eight day old larvae (from eggs)

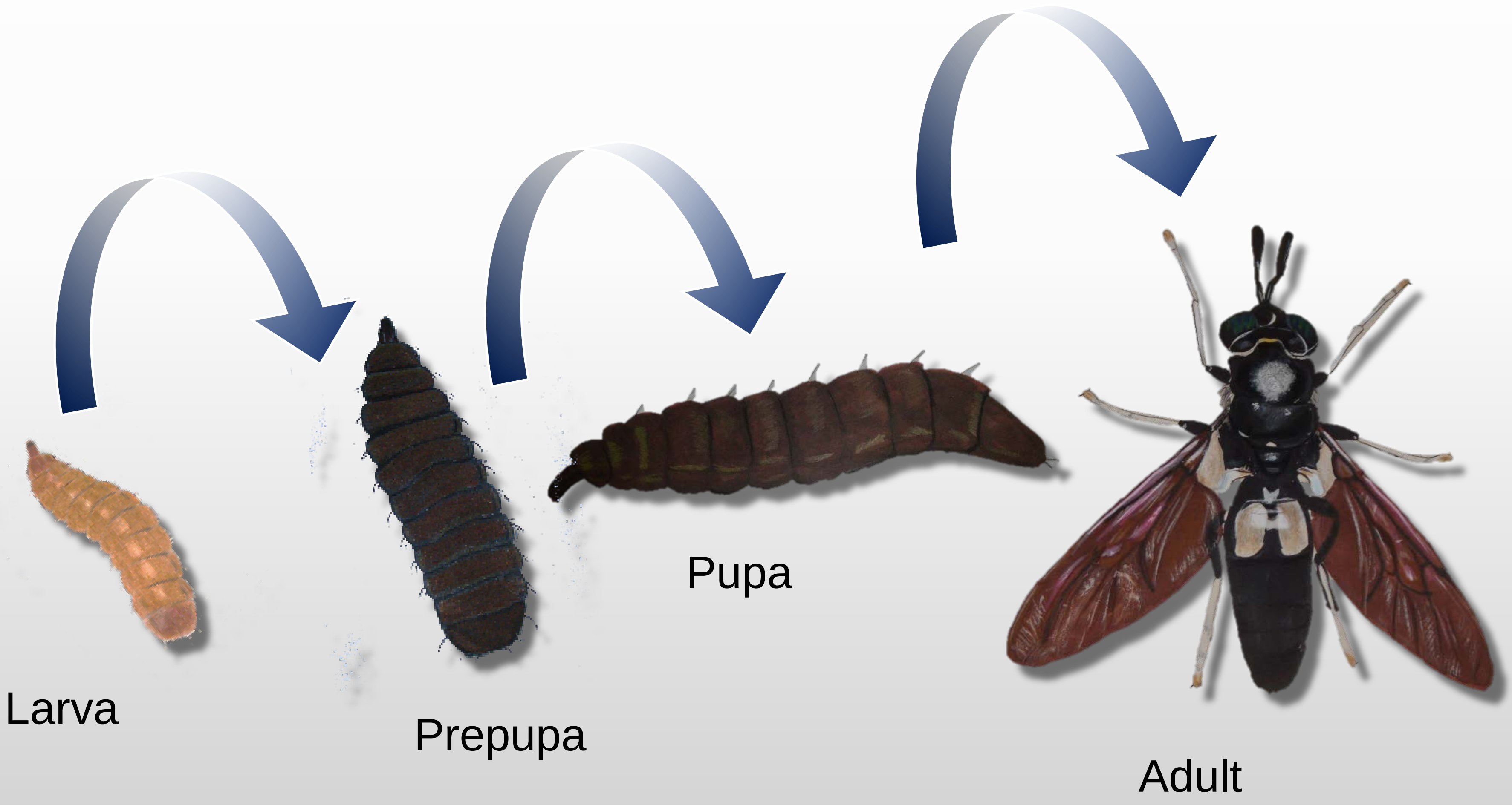


After exposure, larva, prepupa, and pupa were maintained at 28 ° C with a photoperiod of 12:12(L:D)



Back to 28 °C (totally 13 days old)

Survival and fecundity were recorded daily for each individual until the death of the entire cohort (at 28 ° C)



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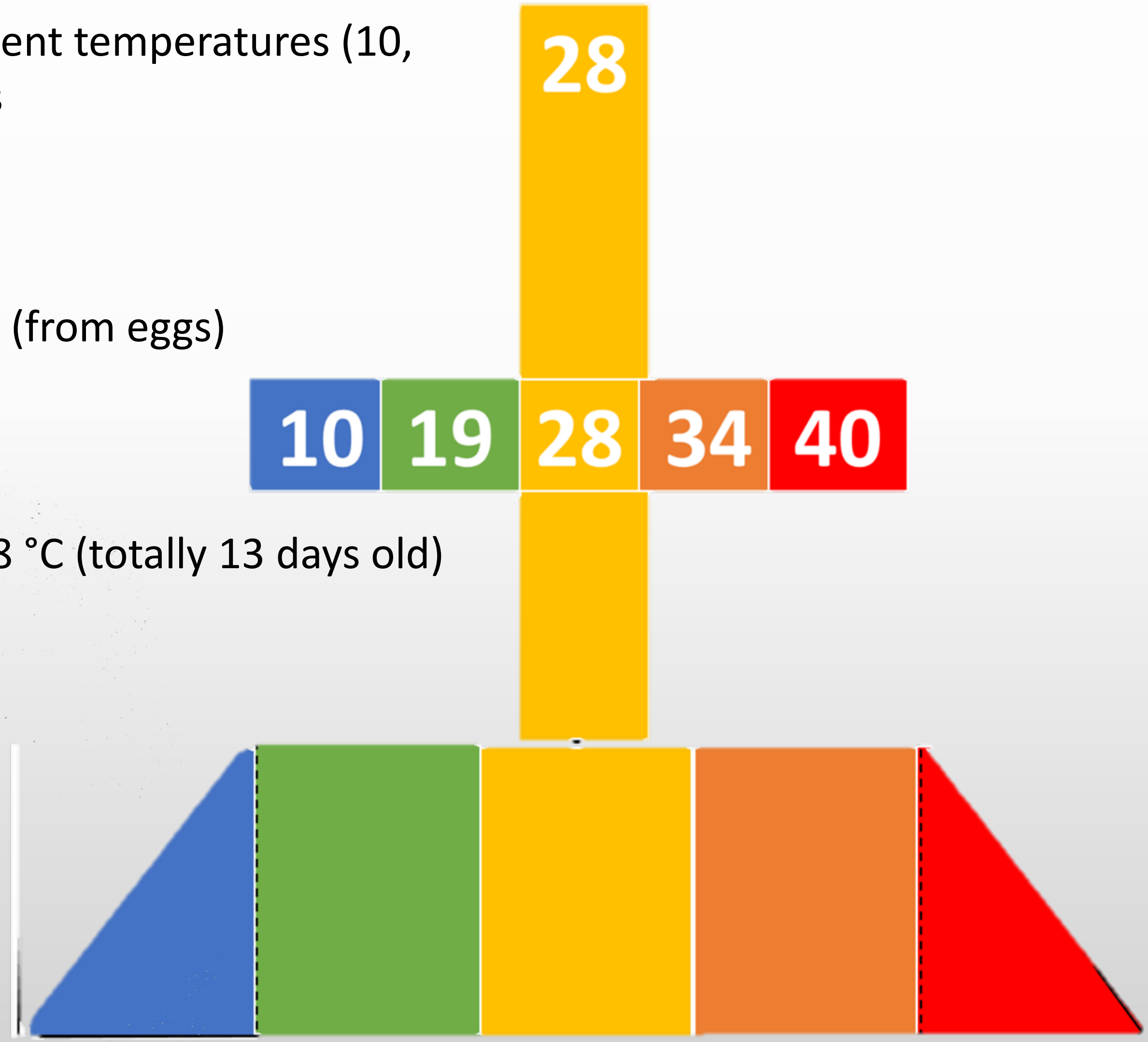
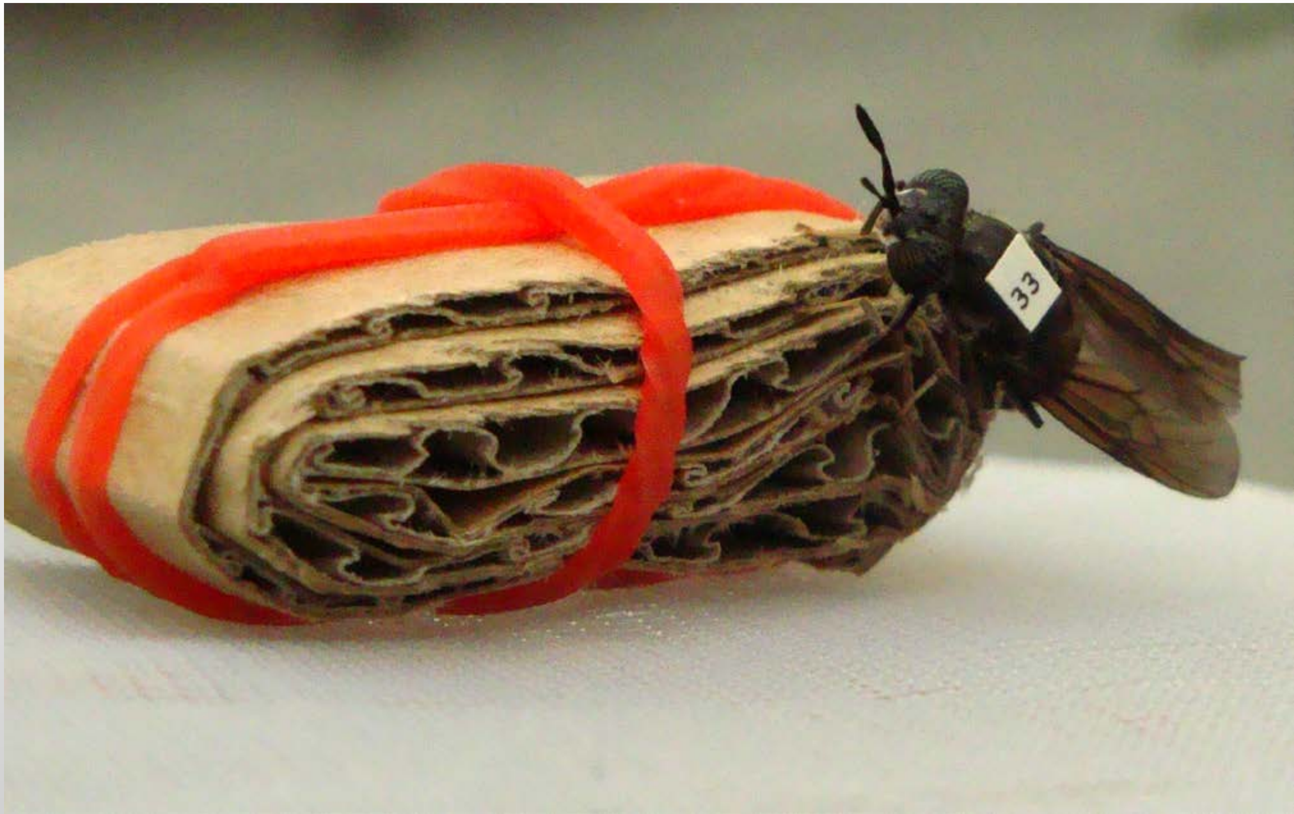


H. illucens fecundity

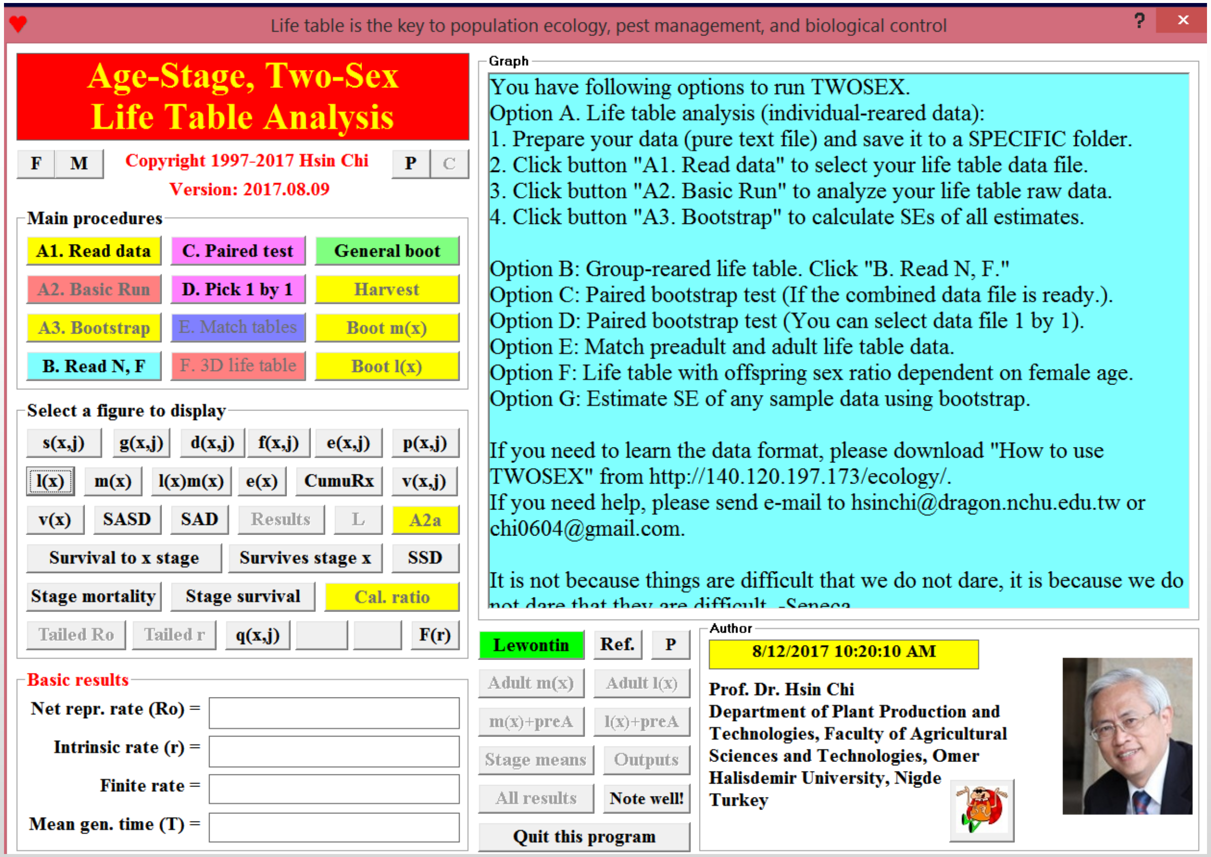
Each surviving adult was marked with its respective number, glued to the thorax with nail polish, and then released into a 1- by 1- by 1-m cage in a 28 °C greenhouse.

H. illucens fecundity

Cups filled with decomposing kitchen scraps were used as an attractant for oviposition



Data were collected and analyzed based on an age-stage, two-sex life table



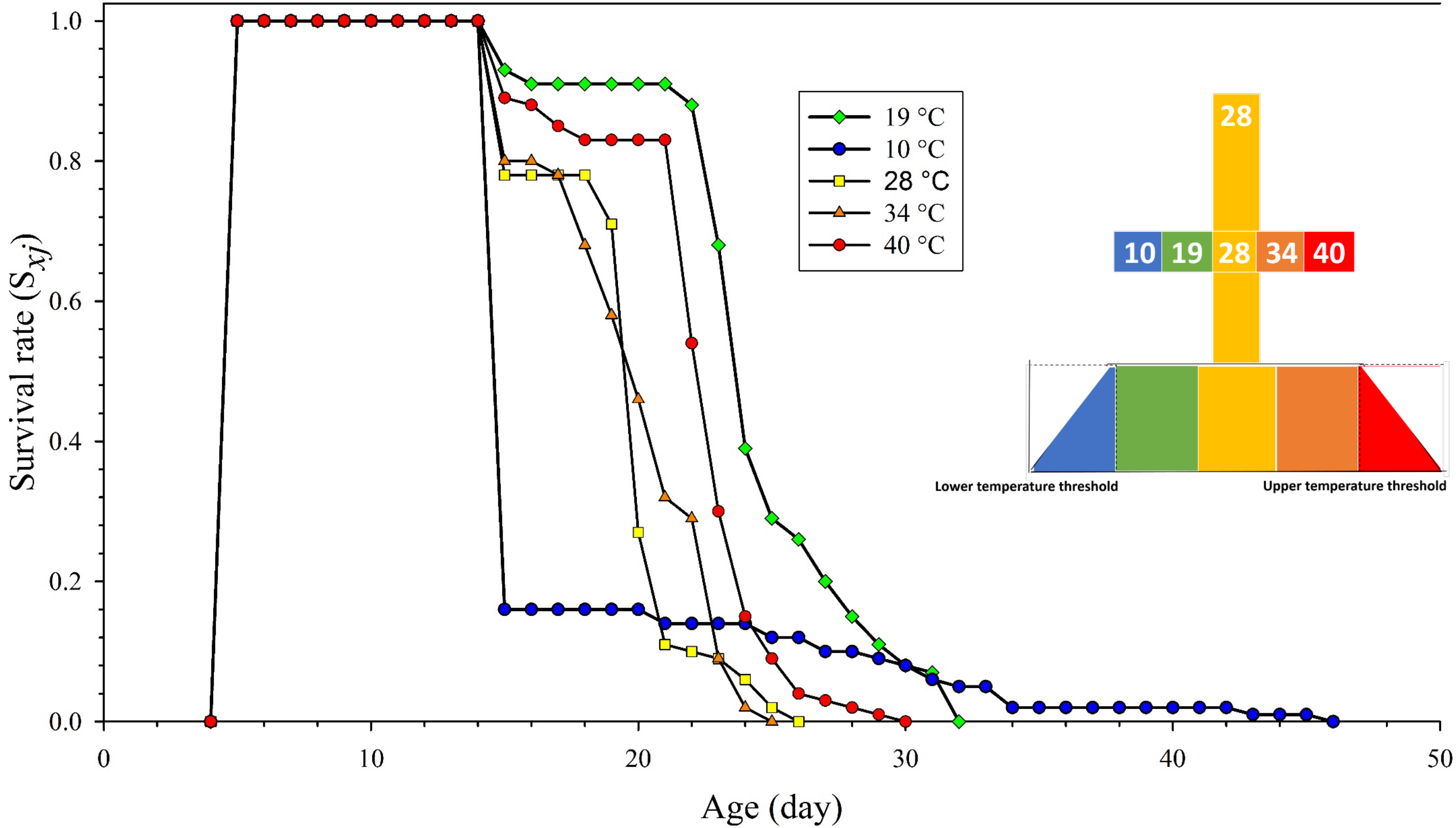
Population parameters of *H. illucens* reared on artificial diet at 10, 19, 28, 34, and 40 °C estimated by the paired bootstrap test method

Population parameter	10 Mean ± SE	19 Mean ± SE	28 Mean ± SE	34 Mean ± SE	40 Mean ± SE
Intrinsic rate of increase (r) (day^{-1})	0.040± 0.008	0.097± 0.004	0.085± 0.005	0.096± 0.006	0.079± 0.004
Finite rate of increase λ (day^{-1})	1.041± 0.009	1.102± 0.005	1.088± 0.006	1.101± 0.007	1.082± 0.004
Net reproduction rate (R_0) (offspring)	**18.06± 11.31 c**	**244.89 ± 40.279 a**	**213.88± 39.804 b**	**382.07 ± 51.434 a**	**342.9± 51.563 a**
Mean generation time (T) (day)	71.846± 6.886	56.541± 1.951	63.039± 3.498	61.434 ± 3.998	73.632± 3.545

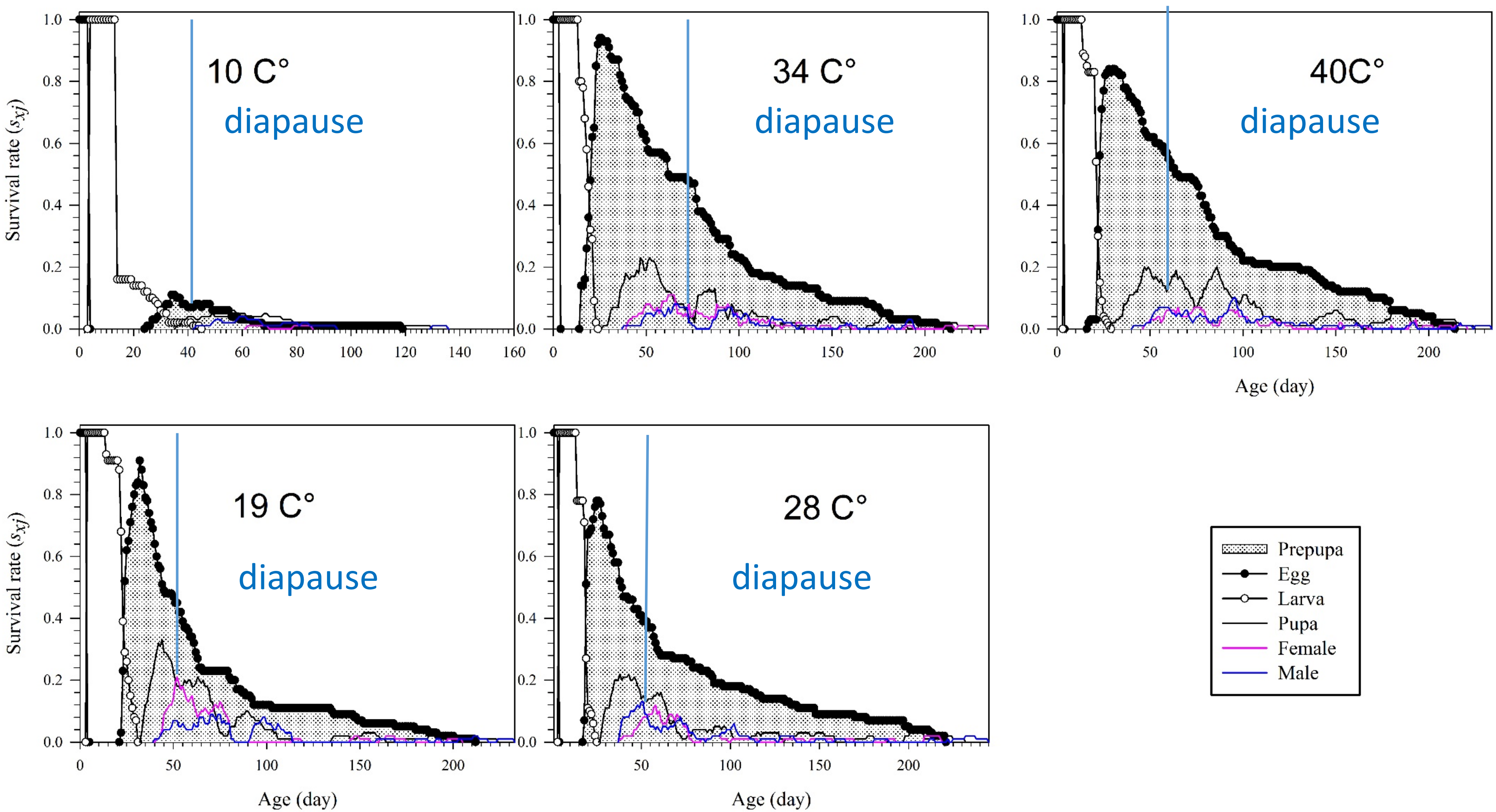
Stage-specific duration (days) of H. illucens reared in artificial diet at 10, 19, 28, 34, and 40 °C

Stage	10 Mean ± SE	19 Mean ± SE	28 Mean ± SE	34 Mean ± SE	40 Mean ± SE
Larvae	**27.54 ± 1.67 a**	**20.42±0.294 b**	**15.74± 0.188 e**	**15.13±0.3 e**	**18.21±0.213 c**
Prepupae	22.62 ± 4.56	40.96±4.201	53.64±5.909	60.6 ±4.487	66±5.255
Pupae	14.17 ± 1.12	12.32±0.299	12.32±0.252	11.37±0.293	14.97 ±0.327
Fecundity (eggs/female)	-	499.78± 65.019	578.05±77.653	707.54±69.866	762 ±78.762

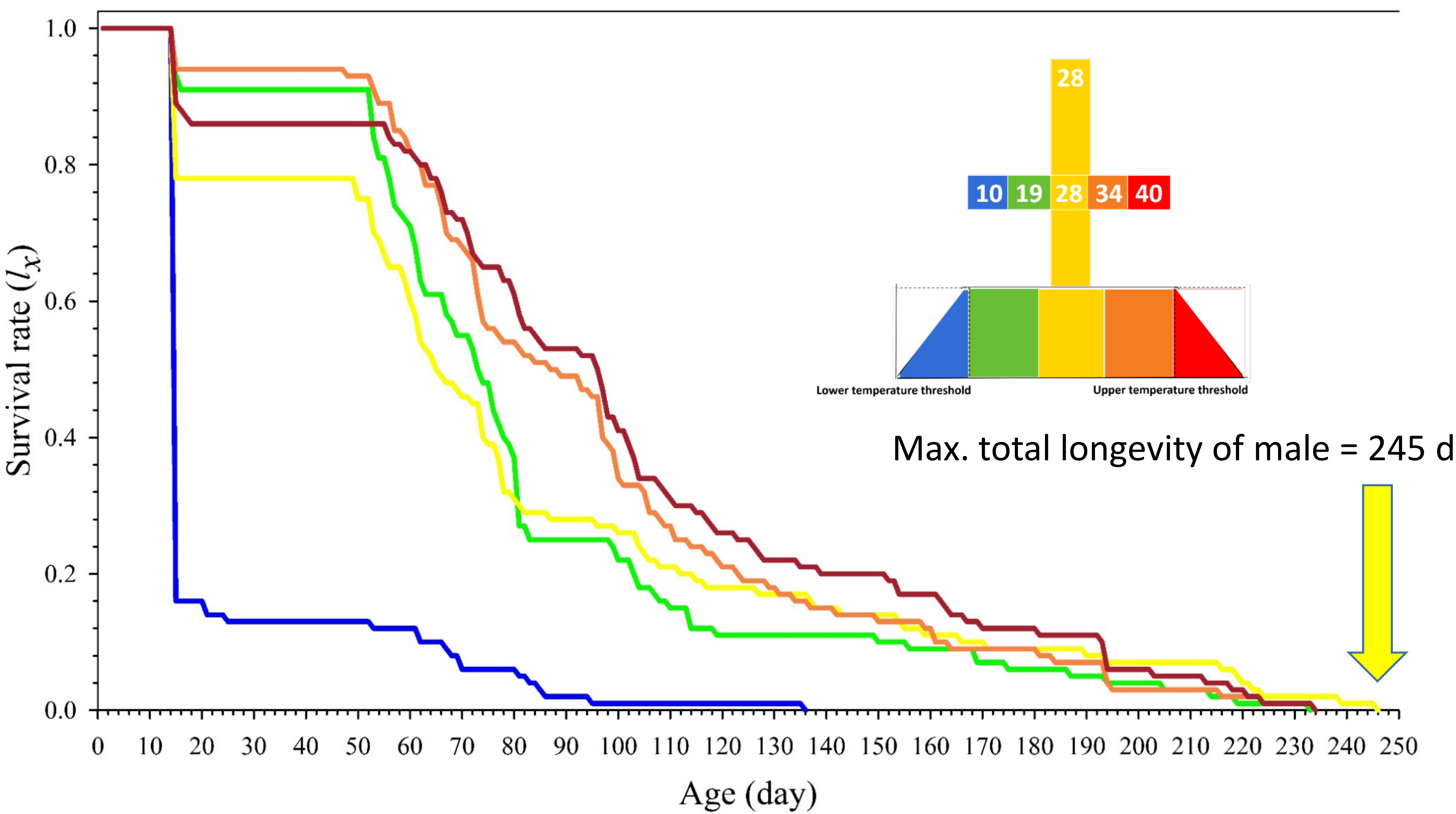
Age-stage-specific survival rate (S_{xj}) of *H. illucens* larva after temperature transfers



Age-stage survival rate (S_{xj}) of *H. illucens*, diapaused and non diapaused individuals included

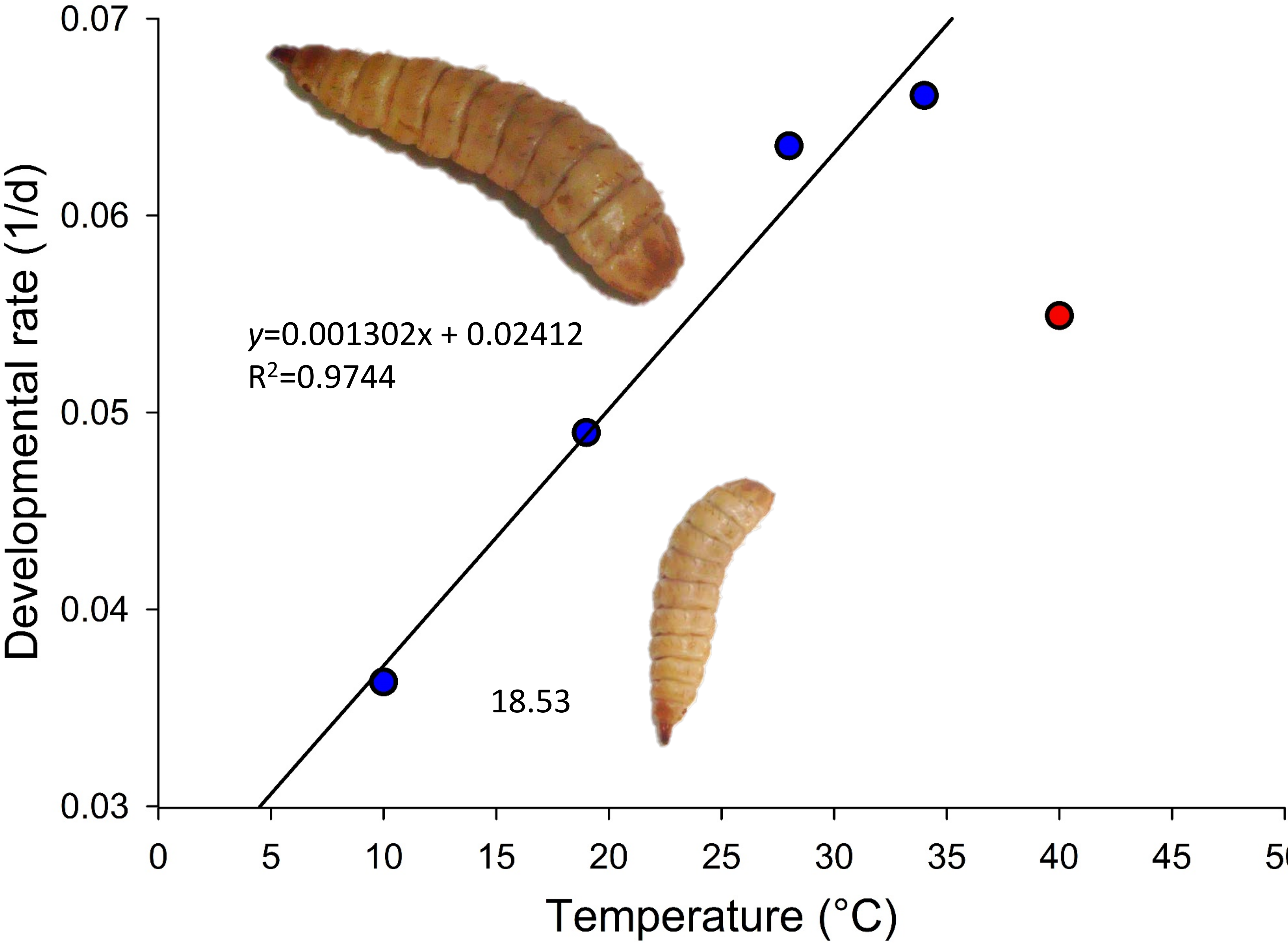


Age-specific survival rate (l_x) individually reared, diapaused and non diapaused individuals included



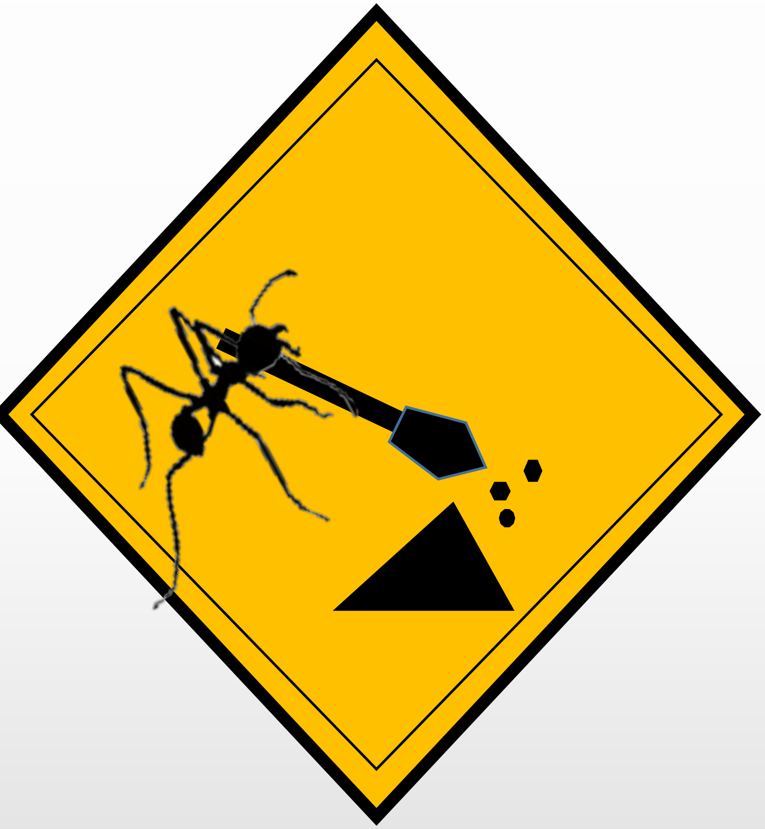
At 10 °C only 2 individuals were females (n=12) and at 34°C 54 were females (n=94), some females were able to lay eggs two times during its adult life span

Temperature (°C)	Male	Female	Total
10	10	2	12
19	42	49	91
28	40	37	77
34	40	54 40 produce offspring 7 lay eggs two times	94
40	41	45 34 produce offspring 7 lay eggs two times	86

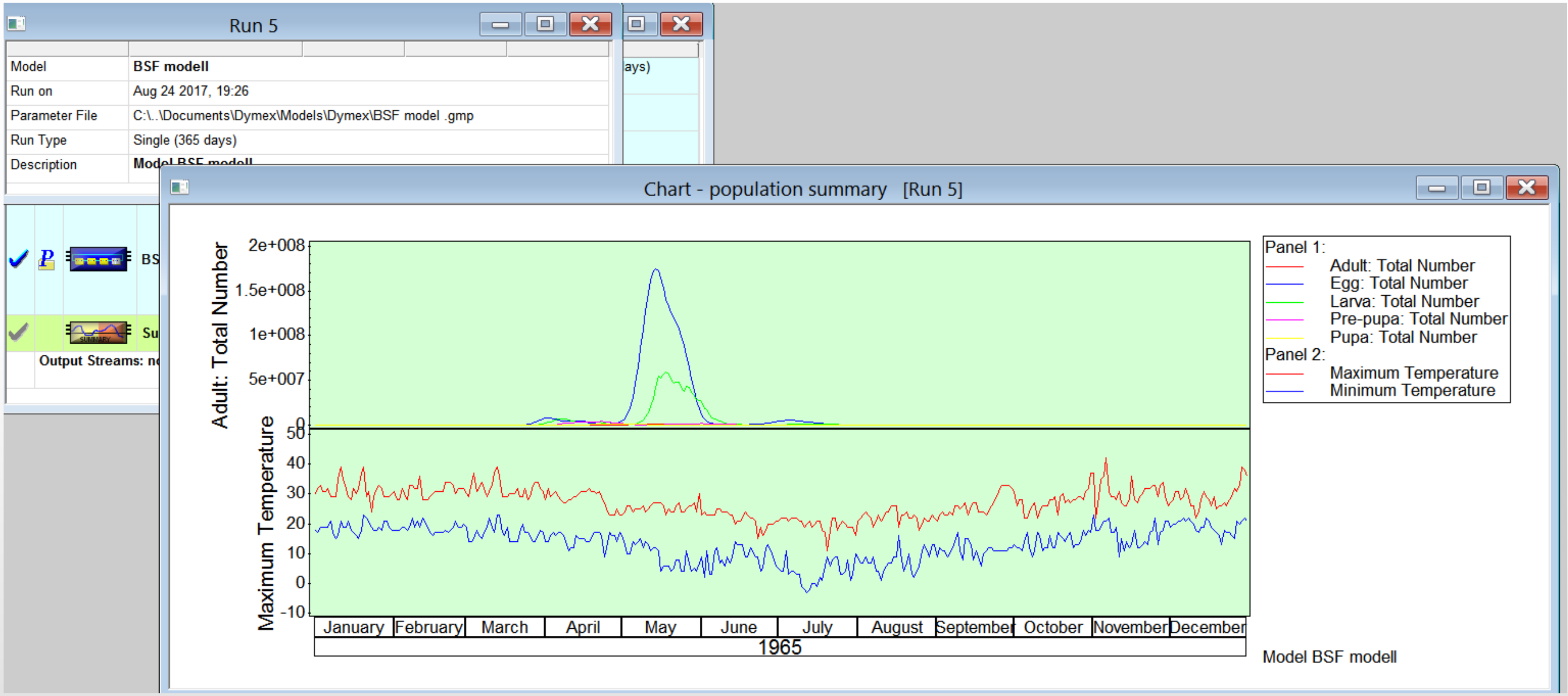


Developmental rate (1/d)
0.07
0.06
0.05
0.04
0.03
y=0.001302x + 0.02412
R2=0.9744
18.53
0
5
10
15
20
25
30
35
40
45
50
Temperature (°C)

Under construction



Up next…DYMEX model



Main findings

- We demonstrated that only a five days exposure to different temperature will influence *H. illucens* life history
- Females are capable to lay eggs two times during its adult life span under favorable conditions.

Conclusions

- The experimental method offers the rapid development of DYMEX models, and avoids many of the pitfalls of using constant temperature development rate studies.
- Additional research is needed to address the causes of diapause initiation and termination
- This study provides new information on oviposition of *H. illucens* exposed to different temperatures and demonstrates the effective use of temperature transfers in this insect.
- The results will be useful in improving current methods of *H. illucens* rearing under controlled conditions.

Special thanks!!

Dirty job

Thank you!

http://muppet.wikia.com/wiki/I_Love_Trash

LOVE AND FOOD AREN'T MEANT TO BE WASTED