DANISH
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Research and development efforts on optimizing key parameters in industrial insect production

EAAP 2018, 29 August

Lars-Henrik Lau Heckmann, Technology manager, DTI

Insect value chain @DTI

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Main challenges of the insect industry

- **Upscaling (industrial level)**
- **Legal barriers (EU) in feed and food**
- **Consumer acceptance**

Generic production process

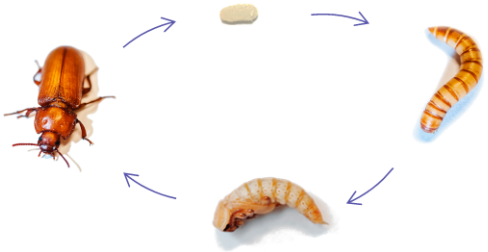
Culture: Eggs/larvae transfer to production

Production (0.5-2 mths)

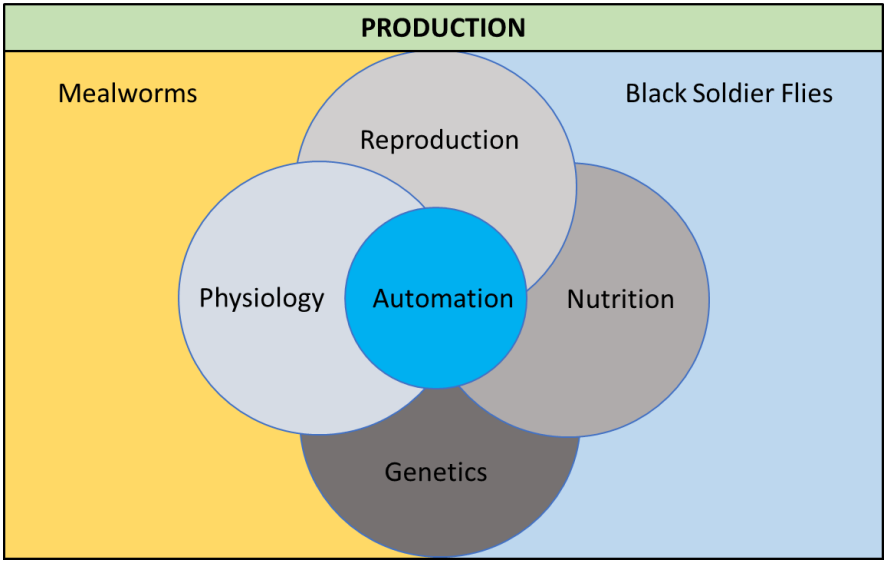
Harvest of larvae

Processing (drying, grinding)

~5-10% larvae back to culture



Focus areas of DTI Insect Production Team



Danish public R&D projects 2017/18 (>100k €)

DTI lead highlighted in bold

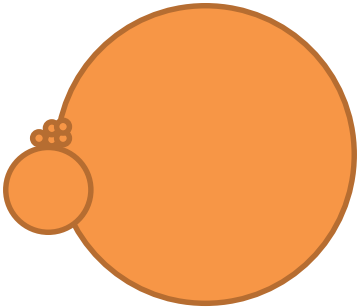
Black Solider Fly (BSF)

- **WICE (390k €, MUDP)**
- SUPERIOR (375k €, MU<DP)
- Green Biorefining (360k €, F&I)
- BIOFISK (~100k €, Interreg/EU)

>7M € portfolio

Crickets

- GREEINSECT (1.34M €, DANIDA)
- Syngja (200k €, IFD)
- Synjga2 (185 €, FFI)



Mealworms

- **inVALUABLE (3.7M €, IFD)**
- **SUSMEAL (1.1M €, IFD, Eurostars)**
- **VALIN (175k €, GUDP)**
- Wholi Foods (~100k €, IFD)
- ENORM (~100k €, IFD)
- NLF (135k €, IFD)
- Ikadan (135k €, IFD)

Black Soldier Fly (*Hermetia illucens*)

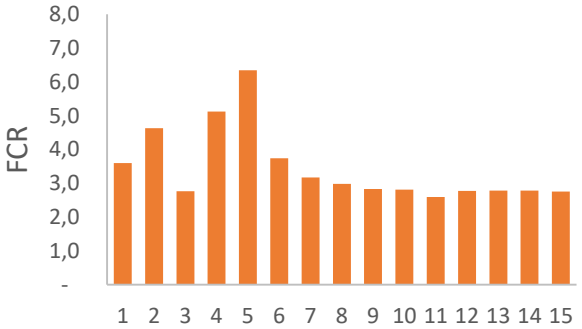
- Assessment of the suitability of different feeding substrates
- Optimization of BSFL growth and Feed Conversion Ratio (FCR)
- Optimization of reproductive output

Performance of BSFL reared on different substrates

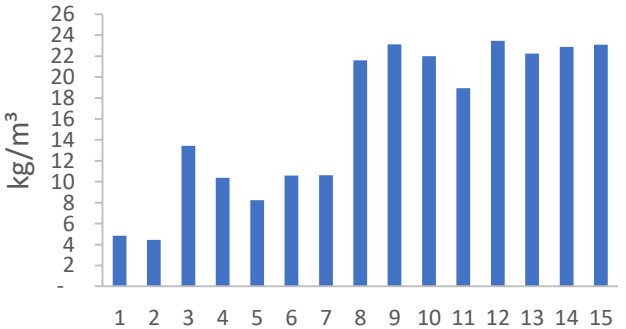
Substrates tested (Project)	Applicability	FCR (dry matter)
Grass, lucerne and red clover (Green Biorefining)	N/A (tested individually at 100% inclusion level)	-
Spent grains + different carbohydrate-rich by-products (SUPERIOR)	Medium-high	-
Dairy by-products (SUPERIOR)	Medium	-
Beach cast + spent grains (BIOFISK)	Low	7-10
Beach cast + catering waste (BIOFISK)	Medium	3-7
Catering waste (WICE)	High	1.6-2.4
Chicken feed	High	2.0-2.8

Optimization of BSFL reared on chicken feed

Feeding amount, feeding frequency, feed conditioning, larval density

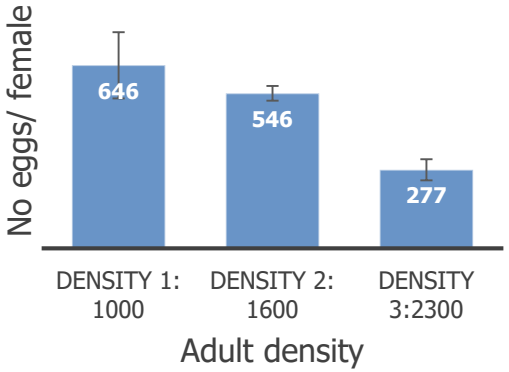


FCR (dry matter basis) of BSFL batches produced between September 2017- August 2018

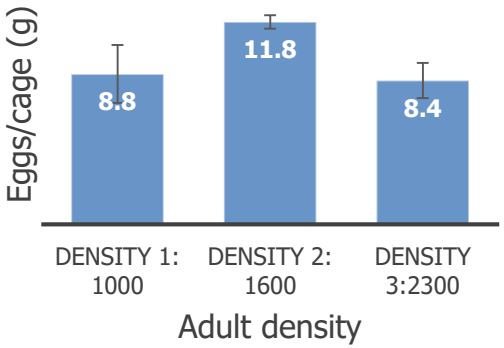


Larval biomass (dry matter basis) of BSFL batches produced between September 2017- August 2018

Reproduction of BSF – optimizing fly density



Production of eggs per female at different fly densities (avg±sd)



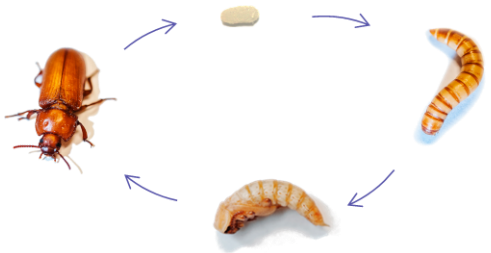
Total egg production per cage at different fly densities (avg±sd)

Production estimation for 1 m³ reproduction cage

	Egg production (g)	Neonate production (kg)	Larval production (kg)
Density 2 (4000 adults/m^3)	29.5	2.4	134

Common mealworm (*Tenebrio molitor*)

- Reproduction (adult density and egg production)
- Larval growth and biomass output
- GHG and heat production
- Computational Fluid Dynamic (CFD) modelling



Tenebrio reproduction @ lab-scale

RESEARCH ARTICLE

Impact of density, reproduction period and age on fecundity of the yellow mealworm *Tenebrio molitor* (Coleoptera: Tenebrionidae)

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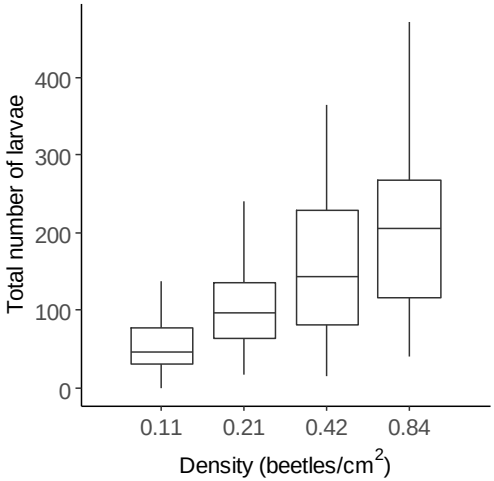
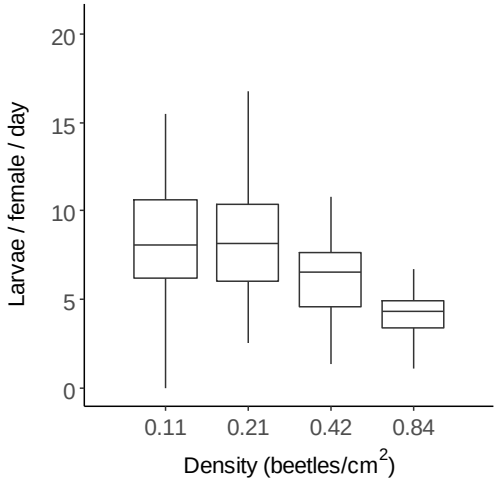
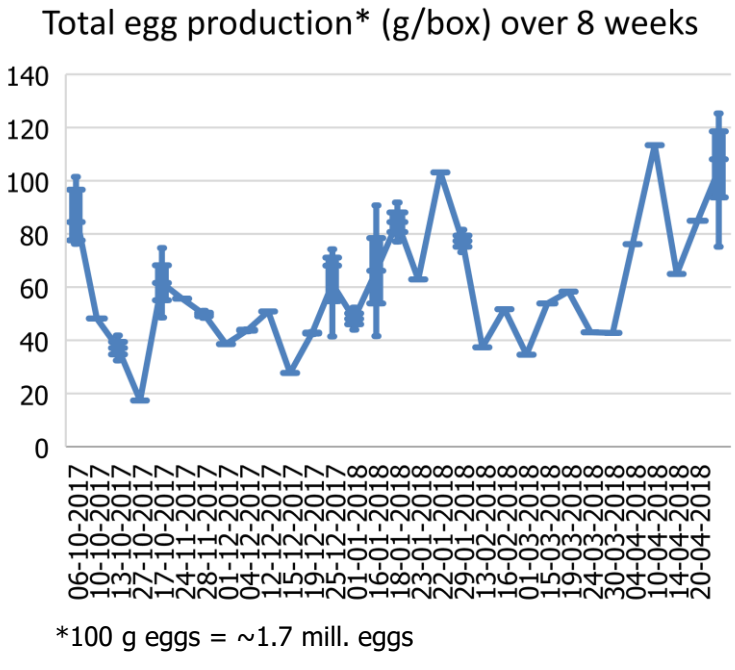
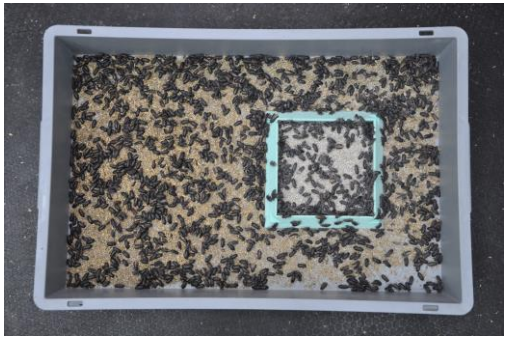


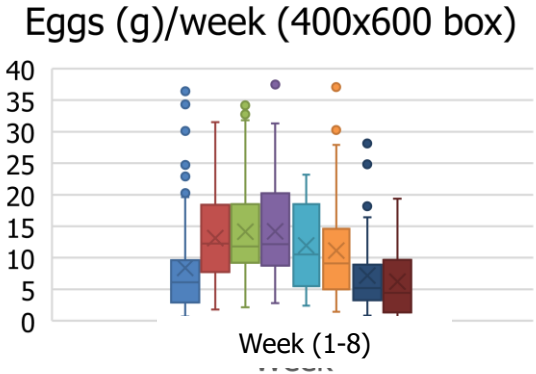


Tenebrio reproduction @ pilot-scale



*100 g eggs = ~1.7 mill. eggs





Tenebrio larval growth and respiration @ lab-scale

Contents lists available at ScienceDirect

Journal of Insect Physiology

journal homepage: www.elsevier.com/locate/jinsphys

Role of temperature on growth and metabolic rate in the tenebrionid beetles *Alphitobius diaperinus* and *Tenebrio molitor*

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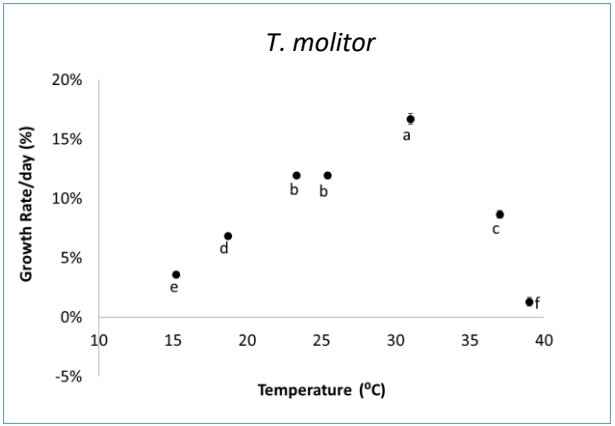
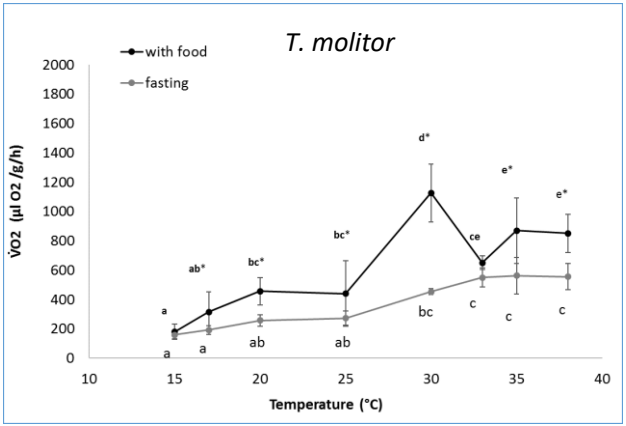
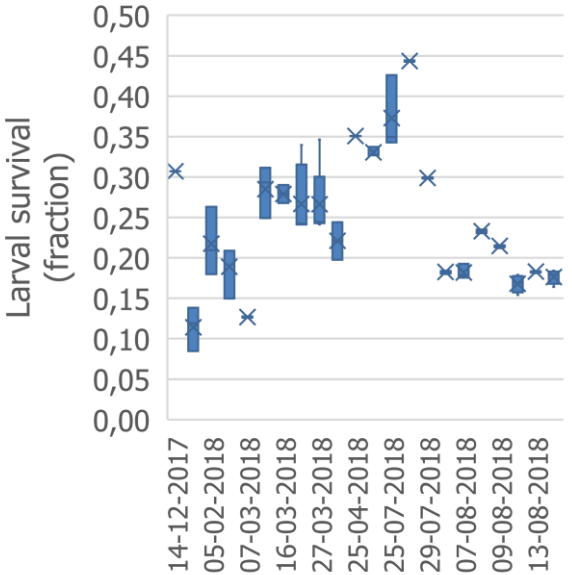
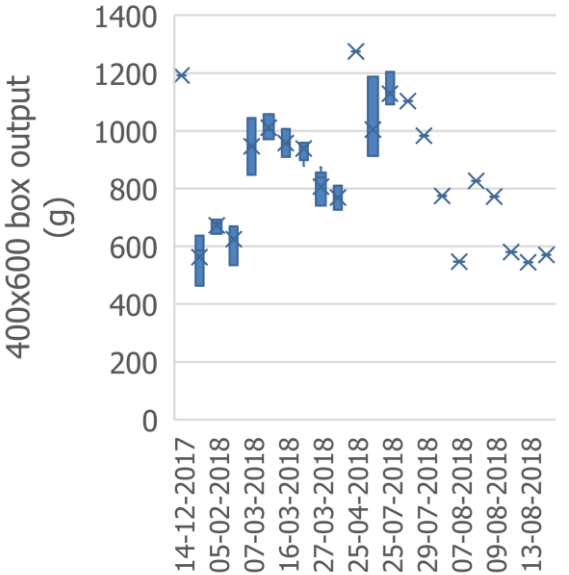
[b] Proti-Farm R&D BV, 3852 AB Ermelo, The Netherlands
[c] Danish Technological Institute, Life Science, 8000 Aarhus C, Denmark





Tenebrio larval growth @ pilot-scale

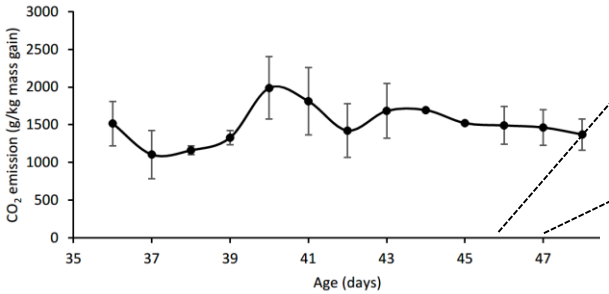




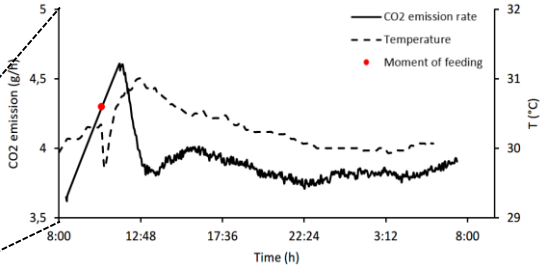
Measurement of key parameters @ pilot-scale

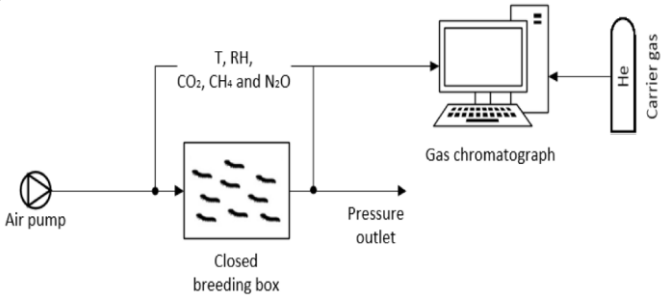
CO_2 and other GHG

GHG emission as CO_2-equiv. of *T. molitor* larvae (age 36-48)



Day 46-47 (high resolution)

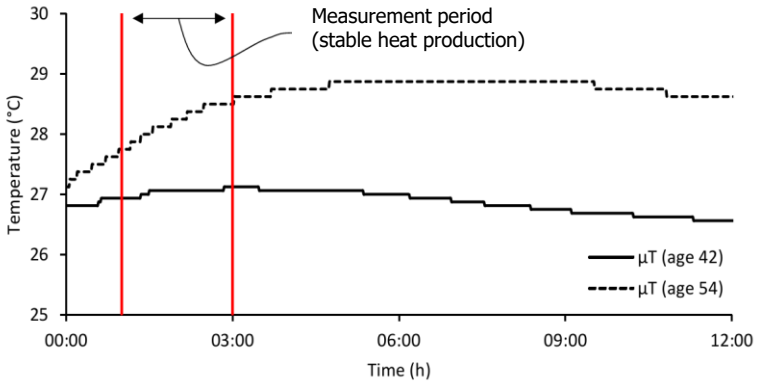




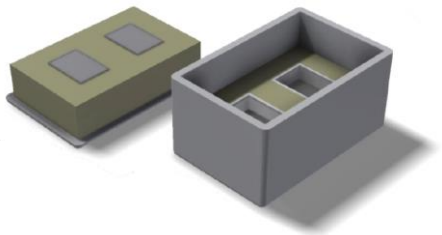
Measurement of key parameters @ pilot-scale

Temperature/heat production

Analysis of heat production of *T. molitor* larvae (age 42 and 54)

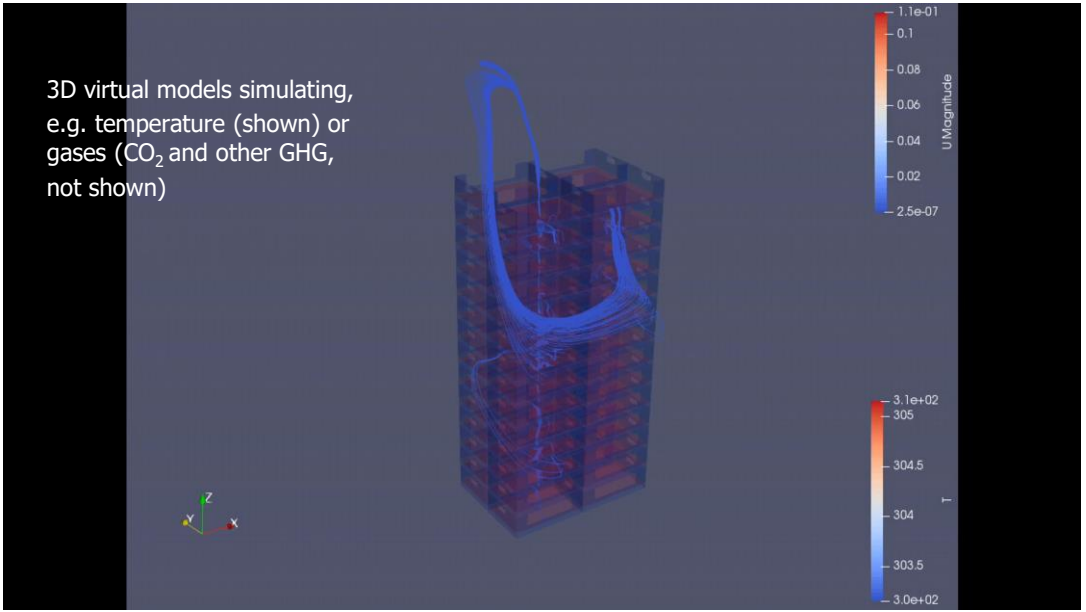


Insulation box for measurement of heat production



Final output: Calculation of heat production over time applicable for assessment at insect production level

CFD modelling: Simulation of key parameters @ large-scale



THANK YOU!

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