Immunity of farmed insects: Basic and applied aspects

Andreas Vilcinskas (s)
Fraunhofer Institute for Insect Biotechnology and Bioresources, Department of Bioresources, Ohlebergsweg 12, 35392 Giessen, Germany
Institute for Insect Biotechnology, Justus-Liebig University of Giessen, Heinrich-Buff-Ring 26-32, 35392 Giessen, Germany

Opdræt af spiselige insekter er opstået som en lovende og alternativ produktion af af proteinrig mad og foder. Den industrielle produktion af insektafledt protein er mere omkostningseffektiv og energieffektiv end husdyrbrug eller akvakultur, og den giver et lavere miljømæssig aftryk.

Massedyrkning af opdrættede insekter og mikrobiel kontaminering af deres diæt fremmer imidlertid spredte patogener og parasitter. Anvendelsen af antibiotika i husdyrbrug er blevet anerkendt, som en væsentlig årsag til den stigende forekomst af antibiotikaresistente humane patogener.

Formålet med vores præsentation er at vise fordelene ved insektopdræt versus husdyrbrug ud over økonomiske argumenter og et gavnligt miljømæssigt aftryk til at omfatte muligheder, der muliggør industriel proteinproduktion uden afhængighed af antibiotika.

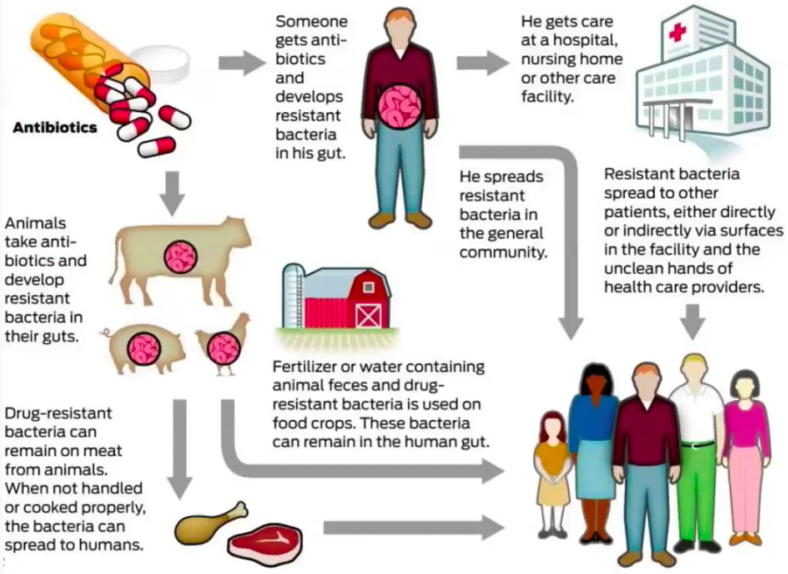
Insekter har et kraftigt medfødt immunsystem, der omfatter syntesen af et bredt spektrum af antimikrobielle peptider. Disse immunitetsrelaterede effektormolekyler bidrager til bekæmpelse af insekternes tarmmikrobiota, rengøring af tarmen før forpupning og til selvmedicinering.

Præsentationen vil kort opsummere vores nuværende viden om medfødt immunitet hos opdrættede insekter eller nært beslægtede modelinsekter og fokusere på funktioner, der er lovende for udvikling af strategier for at forhindre udbrud af infektioner uden anvendelse af antibiotika, og derved opnå fordelagtige overførselseffekter for forbrugeren.

Indsigt i transgenerationsimmun-priming og ernæringsimmunologi hos opdrættede insekter såsom sort soldatfluen Hermetia illucens og melormen Tenebrio molitor vil blive fremhævet, er vigtige for at forstå hvilken rolle som insekters mikrobiologi i tarmen, og derved det betydningen af tilsætning af gavnlige mikrober til kosten.

The application of antibiotics is a major reason for the increasing prevalence of antibiotic-resistant human pathogens.

How antibiotic resistance spreads



Source: Centers for Disease Control and Prevention

Todd Trumbull / The Chronicle

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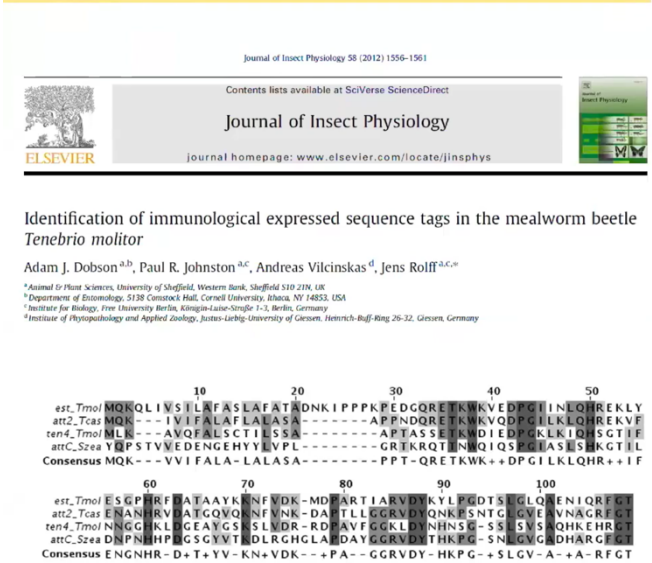
Immunity in the mealworm *Tenebrio molitor*



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Identification of immunological expressed sequence tags in the mealworm beetle *Tenebrio molitor*

Adam J. Dobson[a,b], Paul R. Johnston[a,c], Andreas Vilcinskas[d], Jens Rolff[a,c,*]

[a] Animal & Plant Sciences, University of Sheffield, Western Bank, Sheffield S10 2TN, UK
[b] Department of Entomology, 5138 Comstock Hall, Cornell University, Ithaca, NY 14853, USA
[c] Institute for Biology, Free University Berlin, Königin-Luise-Straße 1–3, Berlin, Germany
[d] Institute of Phytopathology and Applied Zoology, Justus-Liebig-University of Giessen, Hemrich-Buff-Ring 26-32, Giessen, Germany

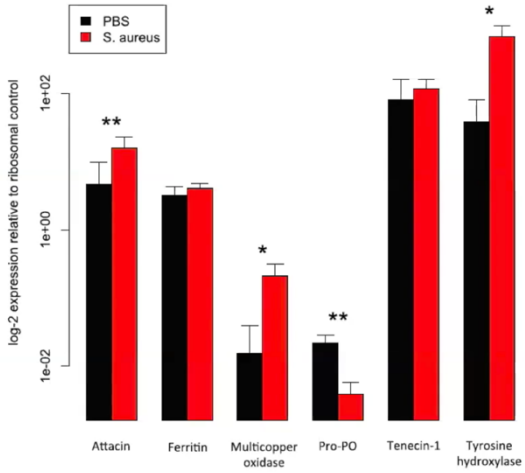

Fig. 2. qPCR of selected immuno responsive genes. Error bars indicate standard deviations across 3 biological replicates (pools of 4 individuals). 2-way ANOVA (treatment * sequence): $F = 63.34$, df = 11,24, $p < 0.0001$. Double asterisks indicate significant sequence-specific effects. Single asterisks indicate marginally significant sequence specific effects (multicopper oxidase: $t = 2.0$, $p = 0.06$. Tyrosine hydroxylase: $t = 1.8$, $p = 0.07$.

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Dobson et al. 2012: Journal of Insect Physiology 58 ,1556-1562

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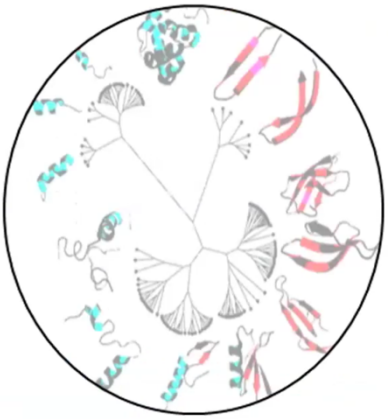
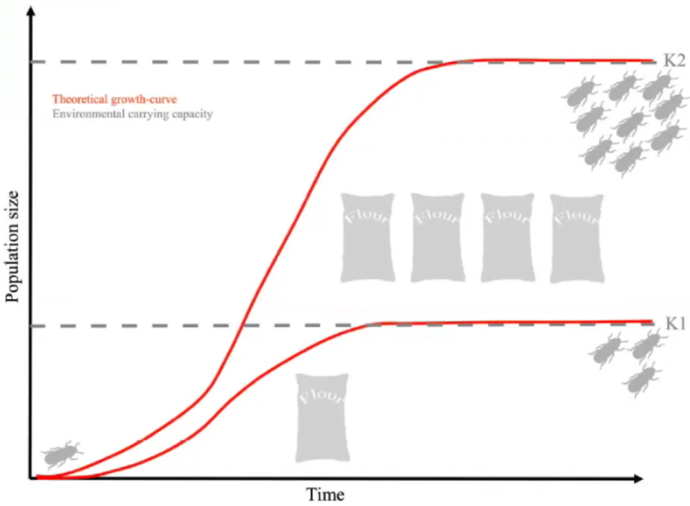
Insects possess an efficient innate immune system…

….which lacks antibodies but comprizes both cellular and humoral defense mechanisms.
…they are protected from infection by a diverse spectrum of antimicrobial peptides



Risk of infection in farmed insects?



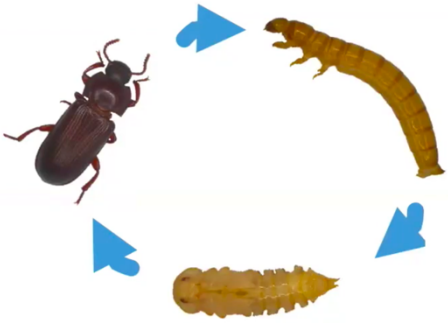


Figure 2: The population growth, measured as population density, does not scale linearly with an increasing environment (flour sacks). If the environment becomes four times larger, population size only becomes three times larger due to intraspecific competition for resources and the spreading of infections. Adapted and modified from Park [105].

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Take home messages:

- Mass rearing of insects enhances the risk for the outbreak of infections
- Risk of food and feed contamination with human pathogens
- However, we should avoid the use of antibiotics
- Municipal waste should not be used for insect-based food and feed production
- Options to strenghten the immune system of farmed insects at an industrial scale
- Probiotics and nutritional immunology represent promising approaches to prevent the use of antibiotics
- BSF-derived AMPs are developed for applications for food and feed preservation, for boosting the immune system of other farmed insects and as candidates for the develpment novel anti-infectives
- The availablity of sequenced genomes and CRISR/cas or transposon platforms will enable the use of farmed insect as whole animal expression systems for higher added value proteins.
- Some insect-derived AMPs have emerged as candidates for the pre-clinical development of novel antibiotics