KOPPERT BIOLOGICAL SYSTEMS

Applications for Mass-Reared Invertebrates

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AMRQC 2010 conference

"A blueprint for the future"

What do we need to do in order to achieve our Big, Hairy, Audacious Goal to eliminate pesticide usage ?

- professionalize arthropod mass-rearing
  - from a Bug Farm to a Bug Factory ? (EoS, Reliability)
  - from Quality Control to Quality Assurance ? **IMRQA**
  - new technologies ? (e.g. diets, symbionts, selective breeding, molecular tools, …)
- new applications for mass-reared arthropods
  - learn from each other
  - provide a platform to meet and network

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Known Species of Organisms

Vertebrate Animals	**59.811**	**Plants**	**297.326**
Mammals	5.416	Flowering plants (angiosperms)	258.650
Birds	9.956	Conifers (gymnosperms)	980
Reptiles	8.240	Ferns and horsetails	13,025
Amphibians	6.199	Mosses	15.000
		Red and green algae	9.671
Invertebrate Animals	**1.203.375**		
Insects	950.000	**Others**	**28.849**
Molluscs	81.000	Lichens	10.000
Crustaceans	40.000	Mushrooms	16.000
Corals	2.175	Brown algae	2.849
Others	130.200		

TOTAL KNOWN SPECIES **1.600.000**

10 – 30 million species !!!

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Mass-Rearing Arthropods

- Silk worm production (sericulture) started about 2.700 BC in China.
- The profession of mass-rearing arthropods is 4.700 years old.
- Arthropods provide many essential ecological services.
- Arthropods are a huge biological resource.
- What can we *learn* from arthropods ?
  How can we *use* arthropods in a sustainable way ?
  How can mass-rearing arthropods contribute to a sustainable world ?

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Nature as a Resource

Nature as a **Model**

Natuur as **Measure**	**BioUtilization** *Acquire or Use the Product or Producer*	**BioAssisted** *Domesticate the Producer*	**BioMimicry** *Emulate the Producer*
Well-adapted	Sustainable Harvest	Natural Breeding	Mimicking form, process AND ecosystem
Mal-adapted	Unsustainable Harvest	Transgenics	Mimicking form alone. "Heat, Beat & Treat" Proces.
	Harvest	***Harness***	***Harmony***

Biologist at the Design Table, June 2008, Dupuyer, Montana

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Example : Abalone Nacre

Nature as **Model**

Natuur as **Measure**	**BioUtilization** *Acquire or Use the Product or Producer*	**BioAssisted** *Domesticate the Producer*	**BioMimicry** *Emulate the Producer*
Well-adapted	Sustainable Harvest of wild abalone for nacre	Natural Breeding of abalone for farming	Mimicry of nacre self-assembly process
Mal-adapted	Over-harvesting of wild abalone for nacre	Using genetic engineering of abalone to create "better"nacre	Production of high-tech ceramics using "Heat, Beat & Treat" Proces.

Biologist at the Design Table, June 2008, Dupuyer, Montana

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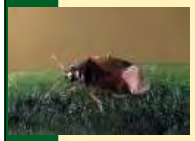
Biological Control Agents

- parasites and predators for classical biological control and augmentative biological control
- Sterile Insect Technique (SIT) (incl. F1 sterility) Incompatible Insect Technique (IIT)
- *in vivo* production of insect viruses on Lepidoptera
- *in vivo* production of insect pathogenic nematodes

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Pollination

- honeybees (Apis spp.)
- bumblebees (Bombus spp.)
- stingless bees (Melipona spp., Trigona spp., etc.)
- solitary bees (blue mason bees (Osmia spp.), alfalfa leafcutter bees (*Megachile rotundata*), …)
- blowflies (Calliphoridae)


Trigona carbonaria


http://www.abc.net.au/science/scribblyqum/may2003/default.htm

Research

- biological research
- plant breeding
- semiochemicals research
- pesticide research
  - screening and testing insecticides and acaricides
  - side-effect testing of pesticides on non-target arthropods

Education, Fun, Celebration

- educational purposes (e.g. Ladybug Changing Room)
- pet insects (e.g. walking sticks)
- insect zoo's, butterfly gardens
- butterfly releases
  - weddings
  - burial cerimonies

http://www.carolina.com

Fishing Bait

- fly maggots, fly casters
- crickets
- mealworms
- earthworms
- other : wax-worms, cockroaches, bloodworms, …

Pet Food

- reptiles
- fish, aquariums
- captive birds
- feeding wild birds
- feeding zoo animals

mealworms, wax-worms, crickets, locusts, fly maggots, superworms, wingless flies, springtails, cockroaches, bloodworms, nematodes, …

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Medical Purposes

- maggot therapy (*Lucillia sericata)*
- leeches
- allergy testing (house dust mites)
- desensitisation
- …

http://thestar.com.my/lifestyle/story.asp?file=/2008/2/23/lifefocus/20185761&sec=lifefocus



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Human Food "entomophagy"

- *How to sustainably feed 9 billion people in 2050 ?*
- crickets, grasshoppers, locusts, termites, beetle larvae, wasp larvae, bee larvae, caterpillars are among about 500 species that form part of the regular diet of people around the world.
- hunting and gathering vs. rearing.
- food conversion

http://www.papua-insects.nl


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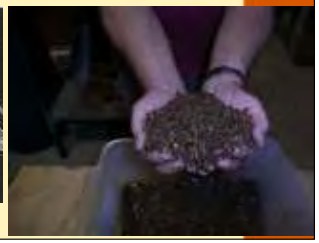
Bioconversion of Manure and Organic Waste

- vermiculture (earthworms)
- decompiculture (e.g. termites, springtails, etc.)
- bioconversion with flies (Black Soldier Fly, Housefly)
- oriculture (oribatid mites)

⇒ **compost + arthropod biomass**





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Animal Feed

- insect proteins
- nutrient recycling : flies
  - mono-gastric animals : poultry, pigs, etc.
    - aquaculture : replacing fish meal

http://www.drgeorgepc.com/OceanGovernance.html


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Production of Useful Compounds

- silk (sericulture), shellac, dies (cocheneal, kermes), enzymes, honey, royal jelly, wax, pollen, propolis, venom, …
- recombinant baculovirus technology for protein expression and production in Lepidoptera

  (viral antigens, esterases, virus-like particles, human growth factors, antibodies, etc.) (Agrivirion, C-perl)



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Mass-Rearing Arthropods for Sustainability

- First time to include mass-rearing of arthropods for other goals than biological control in an AMRQC conference.
- Different businesses, similar rearing issues
  - Cost effectiveness
  - Reliability
  - Quality
- Learn from each other
- Mass-Rearing arthropods contributes to a sustainable world