Honey bee nutrition and energetic aspects

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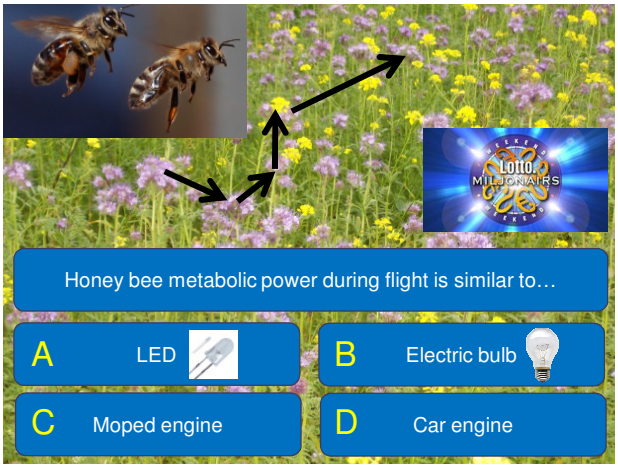
Honey bee nutrition and energetic aspects

- 1. Carbohydrates
  - – fuel energy-intensive tasks
- 2. Protein
  - – the materials that make up bees and brood

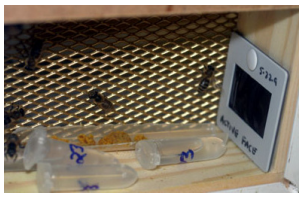
(lipids)
(vitamins)

(minerals)
(water)



Carbohydrates (sugars)

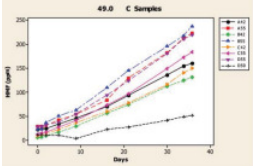
- Adults in cages:
- Sucrose: LT_{50} = 56,3 d
- Honey: LT_{50} = 31,3 d
- High-fructose corn syrup (HFCS) LT_{50} = 37,7 d



Barker & Lehner, 1978

Hydroxymethylfurfural (HMF)

- Heat and acid catalized derivate of sugars
- For example in syrups



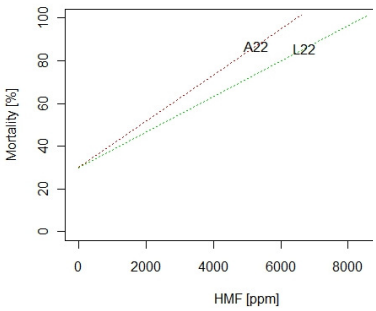
LeBlanc et al., 2009

- Mortality after 20 d:
  - –12,5% (Control)
  - –15,0% (30 ppm HMF)
  - –58,7% (150 ppm HMF)

Jachomiwicz & El Sherbiny, 1975

Rembold & Lackner, 1981; Vandenberg & Shimanuki, 1987; Aupinel et al., 2005

Hydroxymethylfurfural: Adults versus Larvae



Larve:

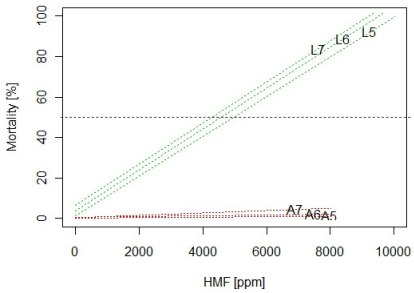
7d exposure

No consumption during pupal stage

Adults:

22d exposure

Hydroxymethylfurfural: Adults versus Larvae



LC_{50} = Concentration that kills 50% of individuals

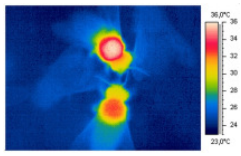
Hydroxymethylfurfural: Adults versus Larvae

- Toxicity of HMF:
  - Concentration
  - Exposition time
- Honey bee larvae are more susceptible than adults:

	Larvae	Adults
7d LC_{50}	4280 ppm	> 80000 ppm

Carbohydrates (sugars)

- Source of energy for
  - Basic metabolism
  - Flight metabolism
  - Thermoregulation
  - Wax production
    - 1 kg wax:
    - ~ 6,5 kg honey (Weiss, 1965)
- Reserves for winter
- Brood



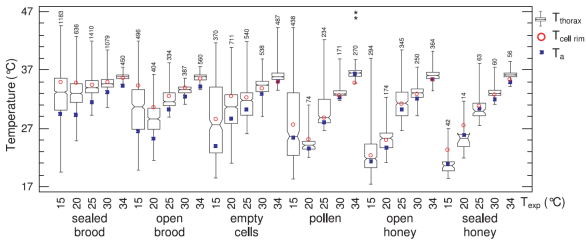
Thermoregulation: Stabentheiner, Kovac, Brodschneider, Plos One, 2010

Carbohydrates (sugars)

Energetic costs of overwintering:

- Weight loss of (small) colonies
  - 0.42 kg / week
  - 0.84 kg / week (breeding colony!)
- Minimum 20 kg weight loss between July and April (Seeley & Visscher, 1985)

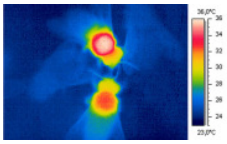
Thermoregulation

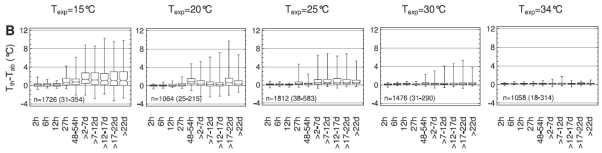


Stabentheiner et al., 2010

Thermoregulation

- Ability developed above age of 2 days

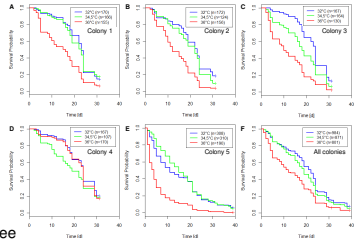




Stabentheiner et al., 2010

Thermoregulation

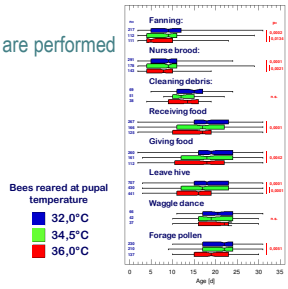
- **Pupal temperature homeostasis affects**
  - „cleverness“ of adult bees (Tautz et al., 2003; Groh et al., 2004)
  - Longevity of adult bees



Brodschneider et al., 2010 Eurbee

Thermoregulation

- **Pupal temperature homeostasis affects**
  - „cleverness“ of adult bees (Tautz et al., 2003; Groh et al., 2004)
  - Longevity of adult bees
  - Age at which several tasks are performed



Brodschneider et al., 2010 Eurbee

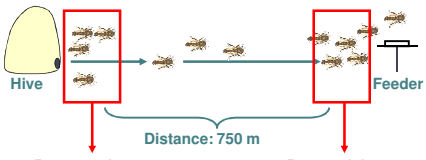
Thermoregulation before flight

… Energetic costs of foraging?

Energetic costs of flight

1 Establish the setup

2 Taking the samples



Heran & Crailsheim 1988

Energetic costs of flight

Worker consumption: mg sugar / h

Heran & Crailsheim 1988

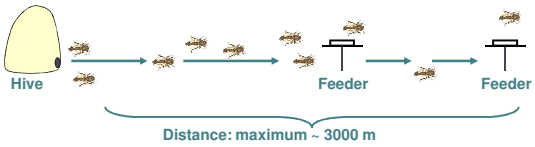
Free flight (750 m)

14,1 mg sugar/h
7,8 m/sec

+45 mg load

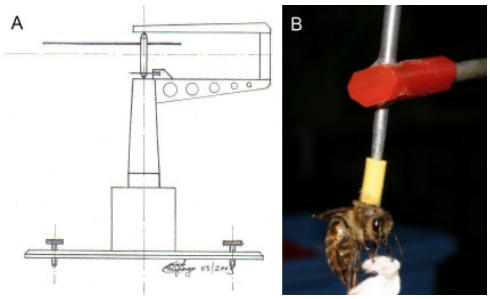
14,5 mg sugar/h
6 m/sec

Energetic costs of flight: Water

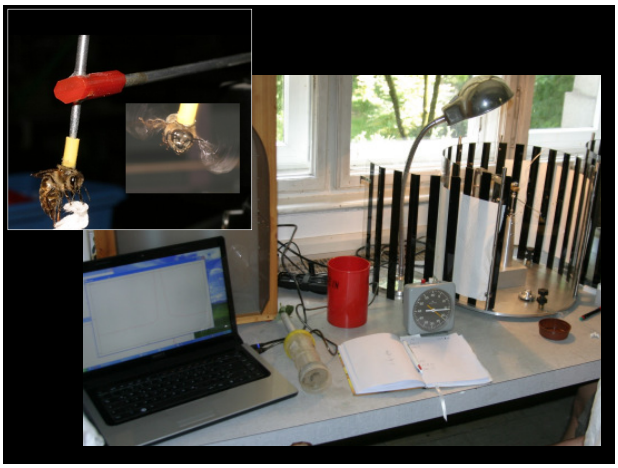


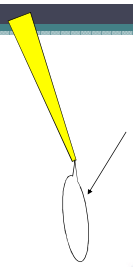
Visscher, Crailsheim, Sherman, 1996

Flight mill



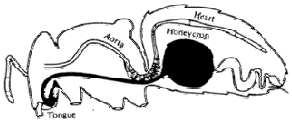
Brodschneider et al., 2009; Scheiner et al., 2013





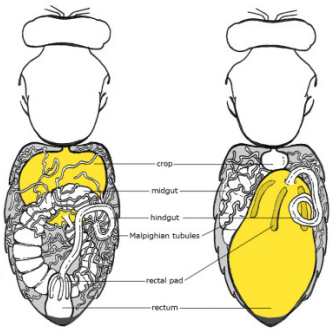
Defined feeding!

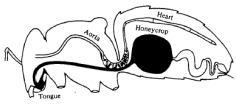
(e.g. 10µl of 1M or 2M glucose-solution



Honey crop

Sugar utilization





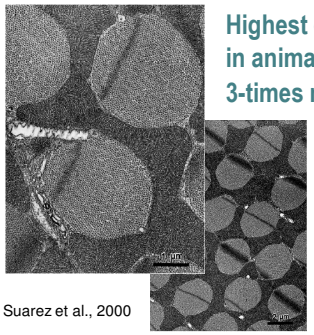
Honey crop

Proventriculus (valve)

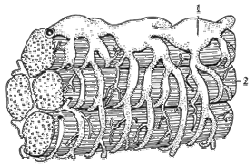
Midgut: digestion

Transport to flight muscle in the thorax

Sugar utilization: the engine (flight muscle)

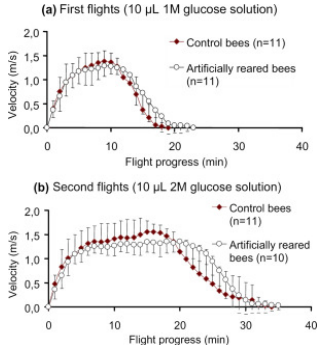


Highest density of mitochondria in animal kingdom! 3-times more than:



Suarez et al., 2000

Flight mill results



Brodschneider et al., 2009

Metabolic power

Amount of utilized sugar is known:

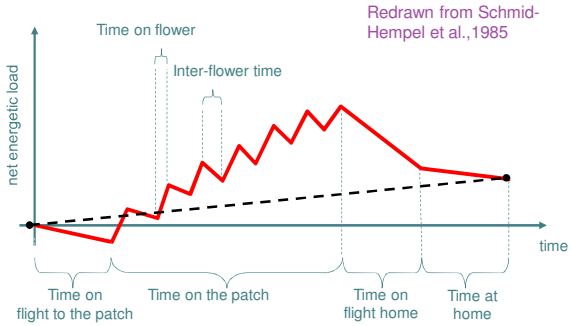
$$\frac{\text{Energy (mJ)}}{\text{time (sec)}}$$

~30 mW

… for a ~75 mg insect!
Compared to a ~75 kg man (me) this would be ~30 kW

Brodschneider et al., 2009

Energetics during foraging



Thank you very much for your attention!

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