Locust Outbreaks and Studies on Phase Polyphenism

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Distribution range of desert locusts

20% of the entire land surface on earth!!
Outbreaks of the migratory locust, *Locusta migratoria* in Kazakhstan and China in 2003-4
Outbreak

Local experts or farmers

Agricultural Bureau of Jiminay (ABJ)

Locust Control Team of County

Locust Control Office of Prefecture (LCOP)

Agricultural Bureau of Altay Prefecture (ABAP)
Agricultural Technical Advice Center of Altay (ATACA)

Decision making

Decision transfer

Data analysis and technical advice

Agricultural Department of Province

Agricultural Ministry of China

Logistic and financial support

Supervision

Flow of outbreak information

Flow of action
How much do locusts eat?

Each locust eats its own body weight (1.5 g) of vegetation each day.

At outbreaks

1 m²  30–150 locusts per m²

They consume 45 – 225 g of grass each day.
At outbreaks

1 m²

100 locusts per m²

They consume 150 g of grass each day

100,000,000 locusts / km²

Locusts eat 150 t of grass each day.
A cow eats 12 kg of grass each day.

In the tropics, 1 km² of pasture can support 15 cows.

Locusts eat 150 t (150,000 km) of grass each day per km².

$$12 \text{ kg/cow/day} \times 15 \text{ cows} = 180 \text{ kg of grass/cow/day}$$

Locusts eat 800 times more grass than do cows!
The migratory locust, *Locusta migratoria*, is distributed in a wider range of area than the desert locust. The area includes Africa, Eurasia, Asia and Australia.

We investigated how they can survive not only warm regions but also cold Regions.

**Geographic adaptation of *Locusta migratoria* in Asia**
Life history of *Locusta*

1. Unlike *S. gregaria*, *L. migratoria* enters dormancy or diapause in the egg stage and can survive the winter.

**How is diapause controlled?**
Tanaka & Zhu (2008)
Phase polyphenism

Locusts change body color, body dimensions, physiology and behavior in response to changes in population density.

(Uvarov, 1921)
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Solitarius phase</strong></td>
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*Locusta migratoria*
Locusta migratoria
Albino *L. migratoria*
Effects of implantation of various organs from normal nymphs on the body color of albino *L. migratoria*
Dark-Color Inducing Neuropeptide in *Locusta migratoria* and *Schistocerca gregaria*

[His$^7$]-corazonin

MW=1,351.6

pGlu-Thr-Phe-Gln-Tyr-Ser-His-Gly-Trp-Thr-Asn-amide

(Tawfik et al., 1999. PNAS)
A model for the hormonal mechanism controlling the body-color polyphenism in *L. migratoria*

(Tanaka, J. Insect Physiol. 2002)
Body coloration in *Schistocerca gregaria*

(Tanaka, 2001 Arch. Insect Biochem & Physiol.)
### Locusta migratoria

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Morphometrics

- Elytron length
- Hind femur length
- Head width

Graph showing scatter plots for E/F ratio and F/C ratio, with categories for Solitarious and Gregarious.
[His7]-corazonin reduces the number of some sensilla when injected into solitarious nymphs.

**Locusta migratoria**

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Solitary locusts

Gregarious locusts in aggregation
Problems and Locust studies

1. To control locusts, we need to know more about locust biology, particularly the mechanisms controlling phase-related changes in locusts.
   Our institute is investigating the role of corazonin in various traits other than body color, e.g. morphology and behavior.

2. FAO sprayed 1.3 million km² to control locusts in 2003-4. It prevented further damages by locusts to agriculture crops, but environmentally more sound measures are desirable. FAO supports development of biological control.
   Our institute is preparing a proposal to investigate how locust feeding habit such as food preference is controlled in relation to chemical compounds in the food.

3. Locusts change their egg size and progeny characteristics in response to changes in population density, which changes growth and propagation rates.
   Our institute is investigating how these changes are induced at the physiological level to establish a system to approach this phenomenon at the molecular level.
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