



HOKKAIDO UNIVERSITY

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Locust Outbreaks and Studies on Phase Polyphenism

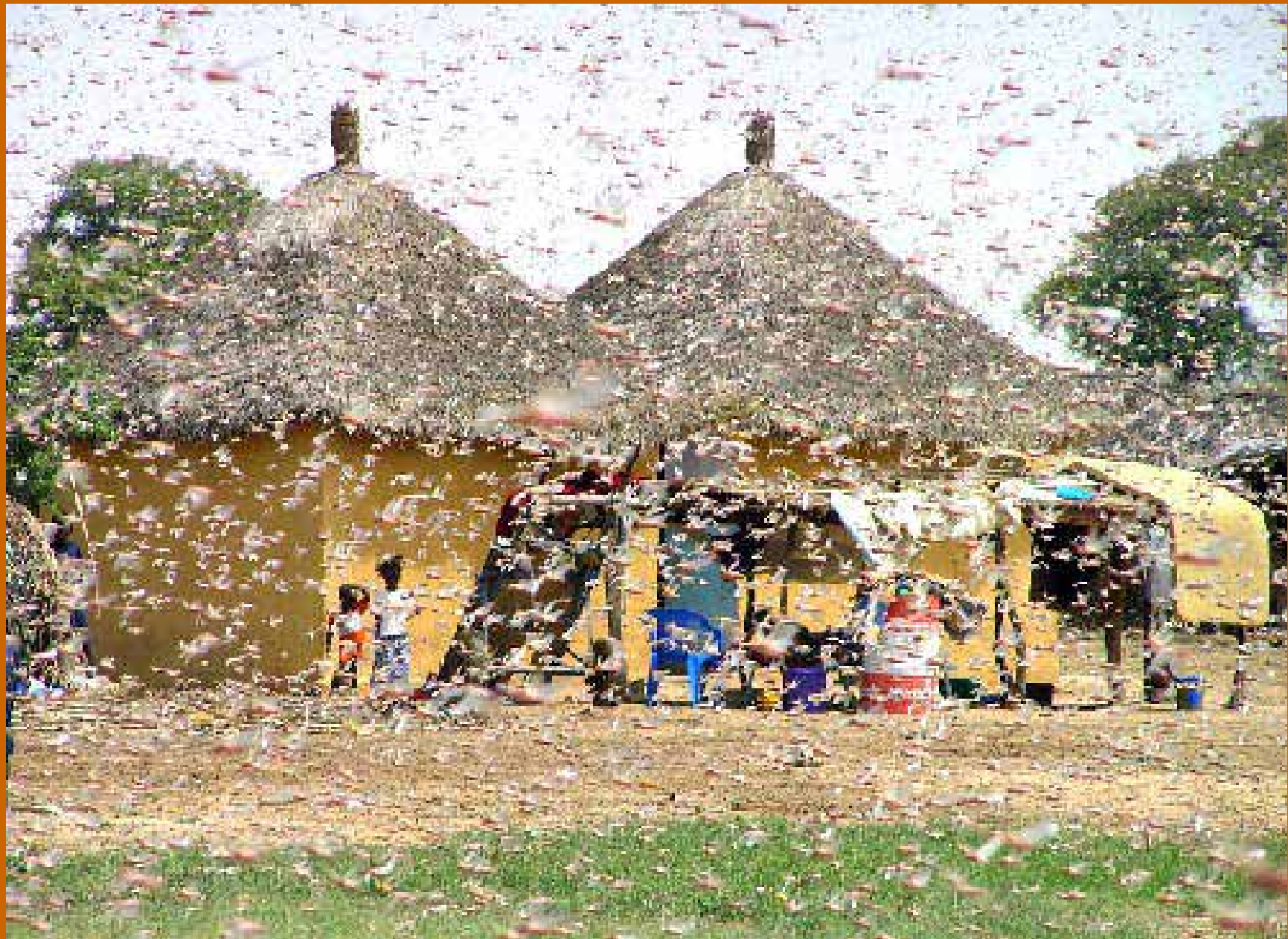


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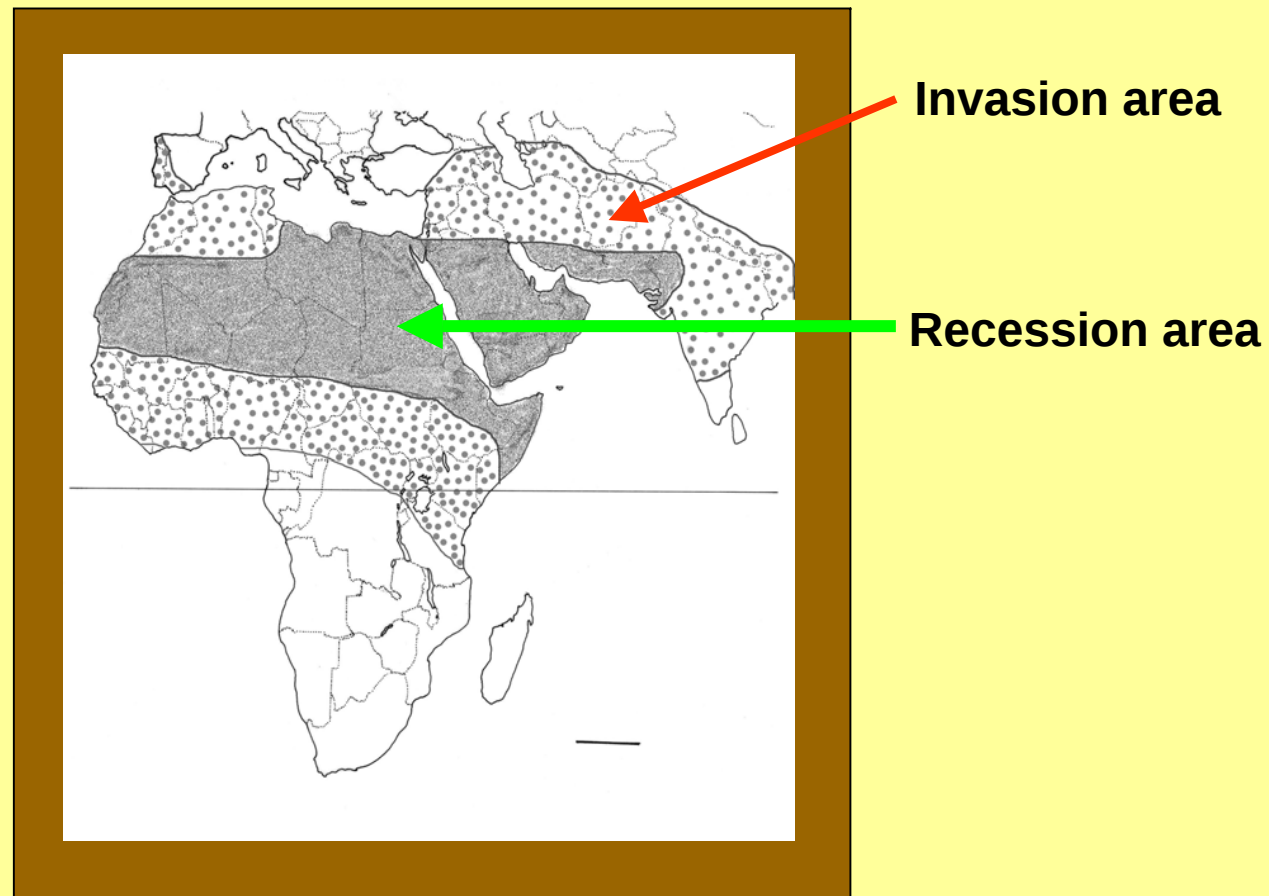
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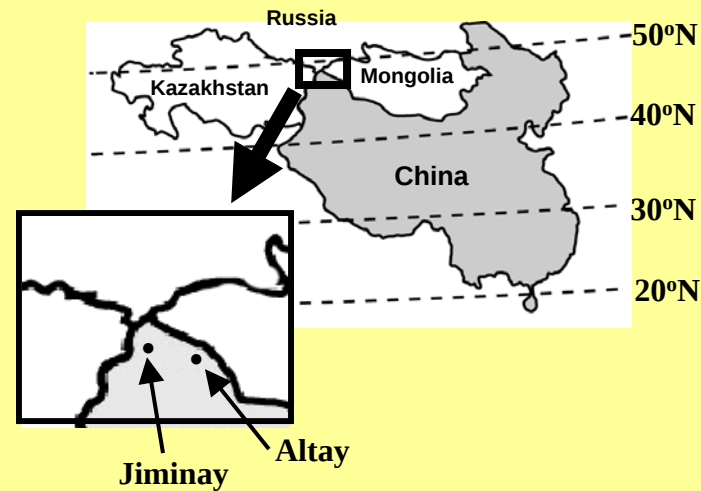
(FAO EMPRESS)

Distribution range of desert locusts

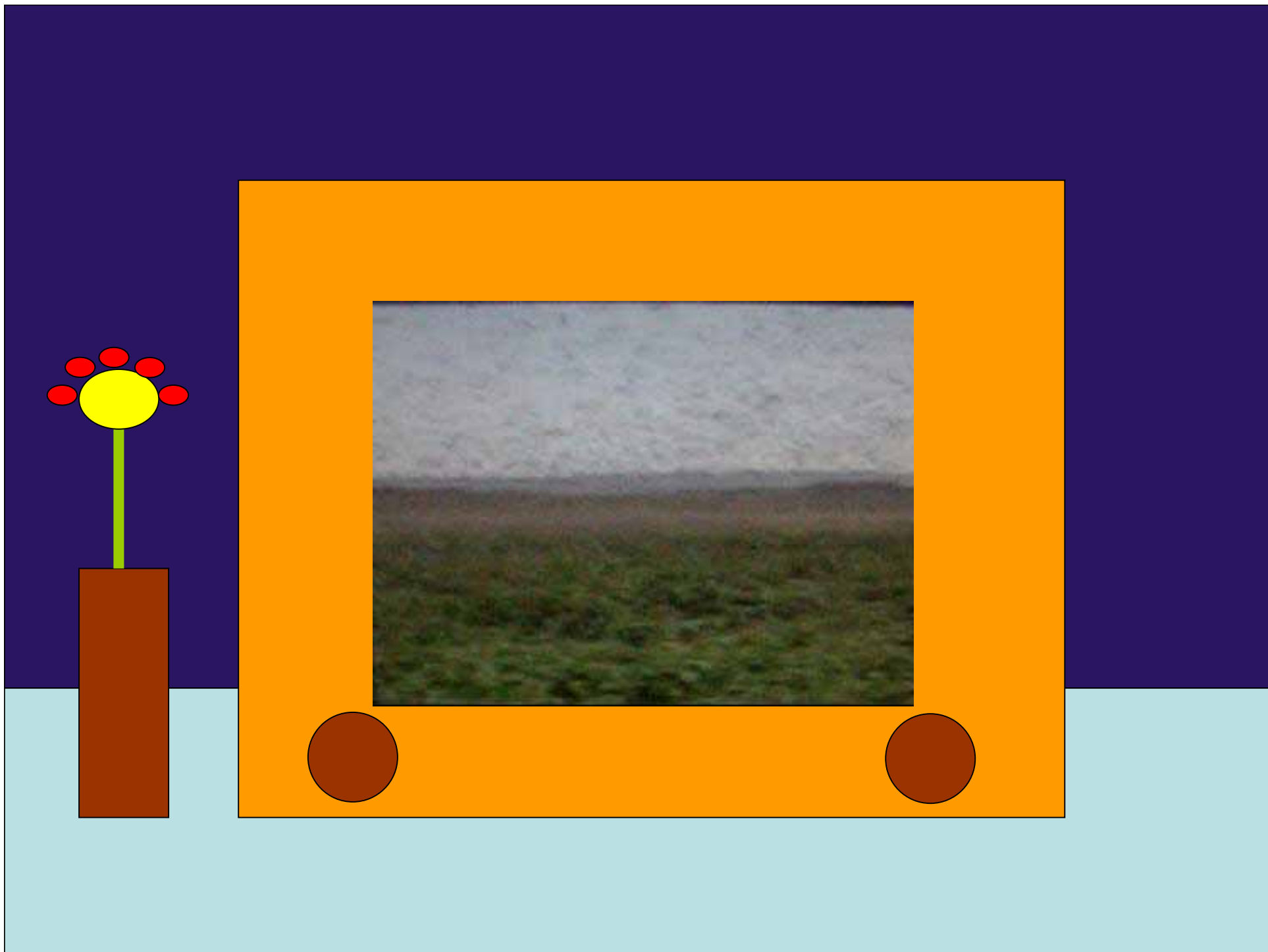
20 % of the entire land surface on earth !!

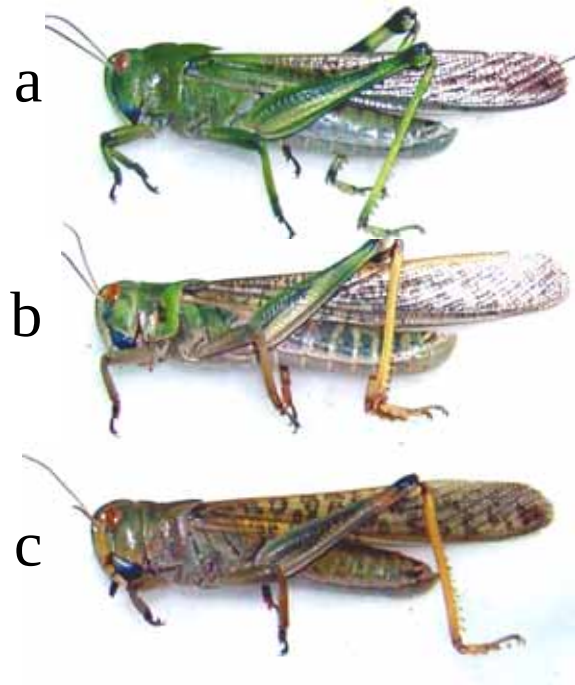


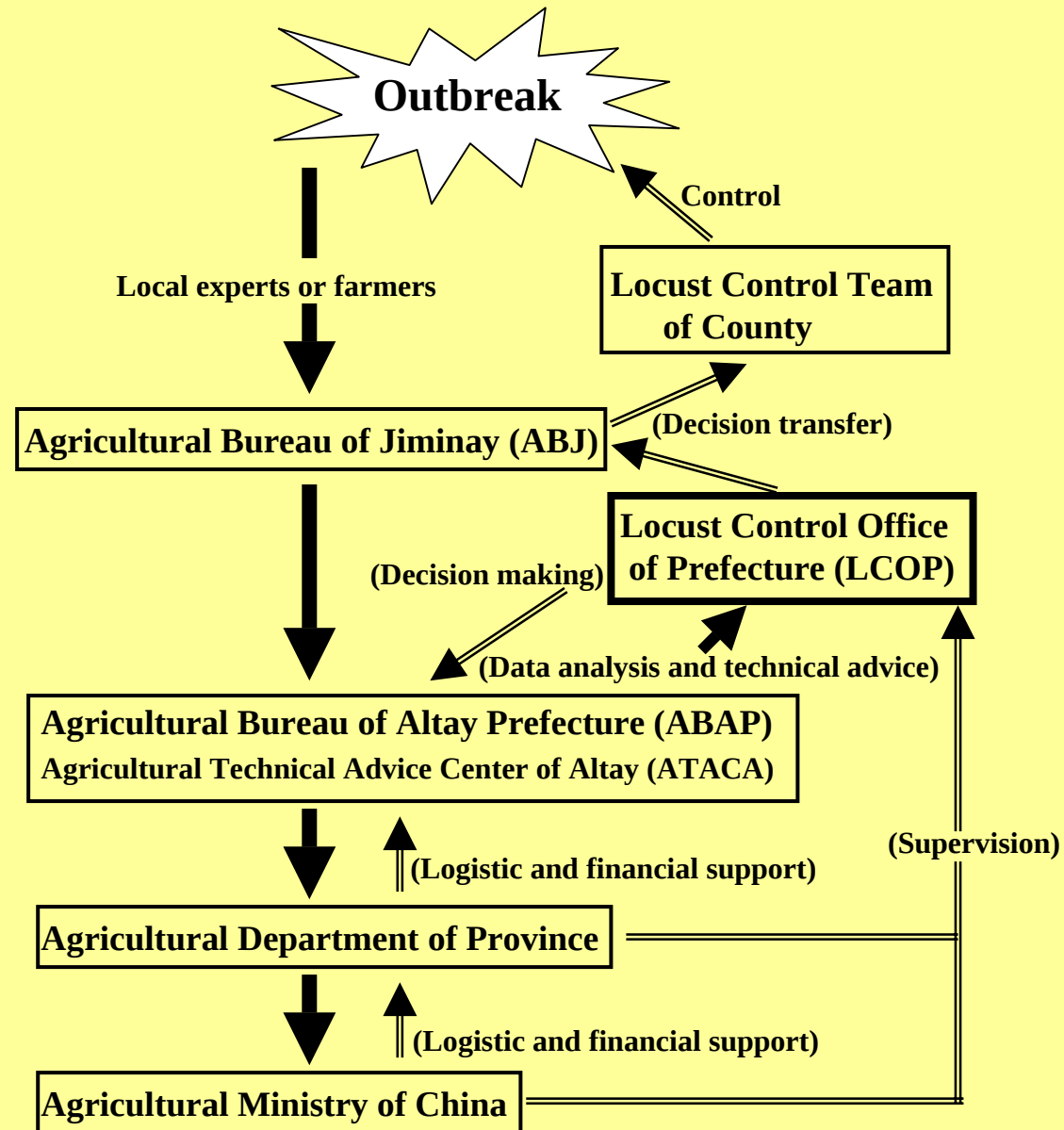
Outbreaks of the migratory locust, *Locusta migratoria* in Kazakhstan and China in 2003-4











➡ **Flow of outbreak information**
 ==➡ **Flow of action**

How much do locusts eat ?

R.F.Chapman(1976)



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

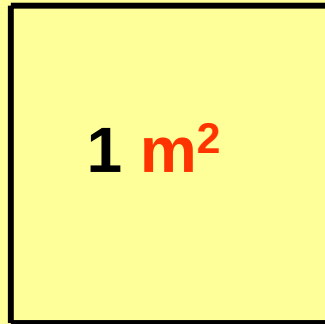
At outbreaks

1 m²

30 ~ 150 locusts per m²

They consume 45 – 225 g of grass
each day

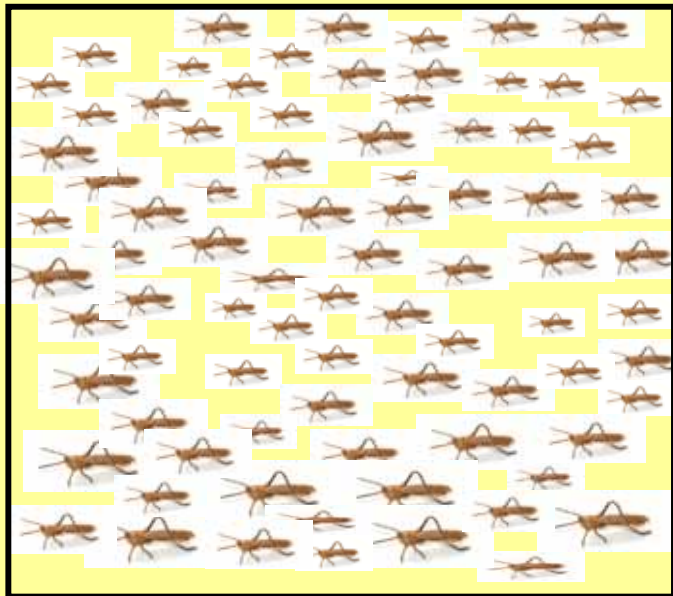
At outbreaks



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.

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



A cow eats 12 kg of grass each day

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

12 kg × 15 cows = 180 kg of grass per day

Locusts eat
800 times more grass
than do cows!



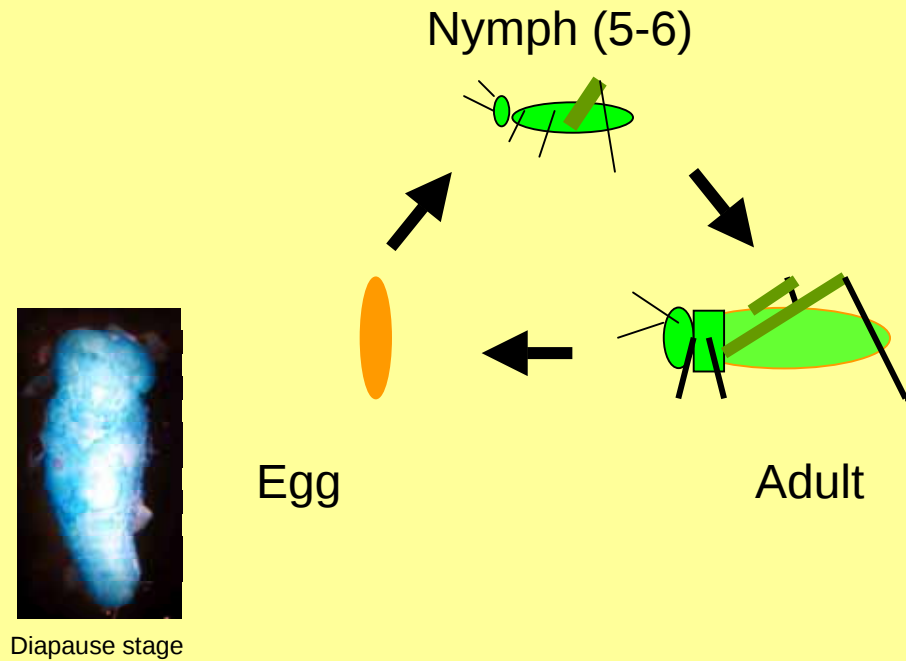
The migratory locust, *Locusta migratoria*, is distributed in a wider range of area than the desert locust. The area includes Africa, Eurasia, Asia and Australia.



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

Geographic adaptation of *Locusta migratoria* in Asia

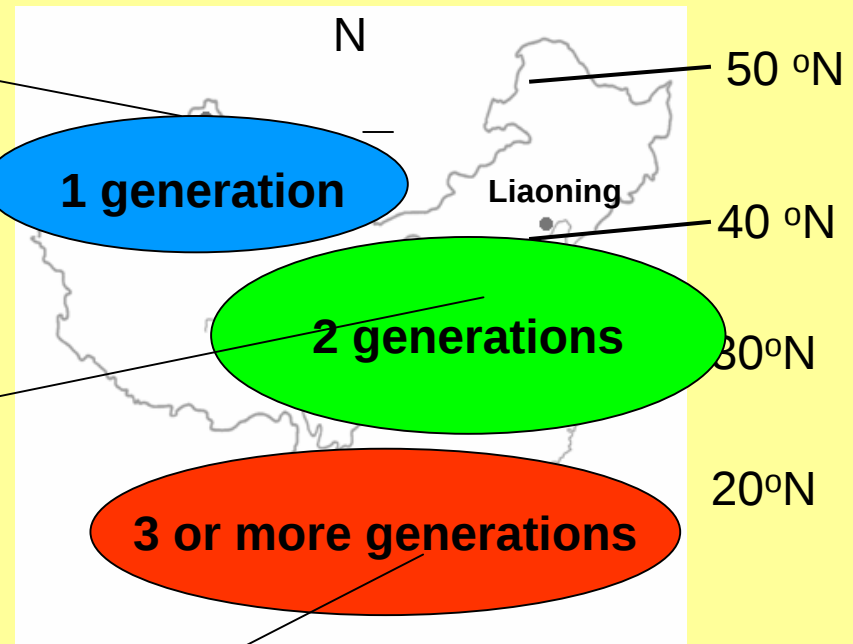
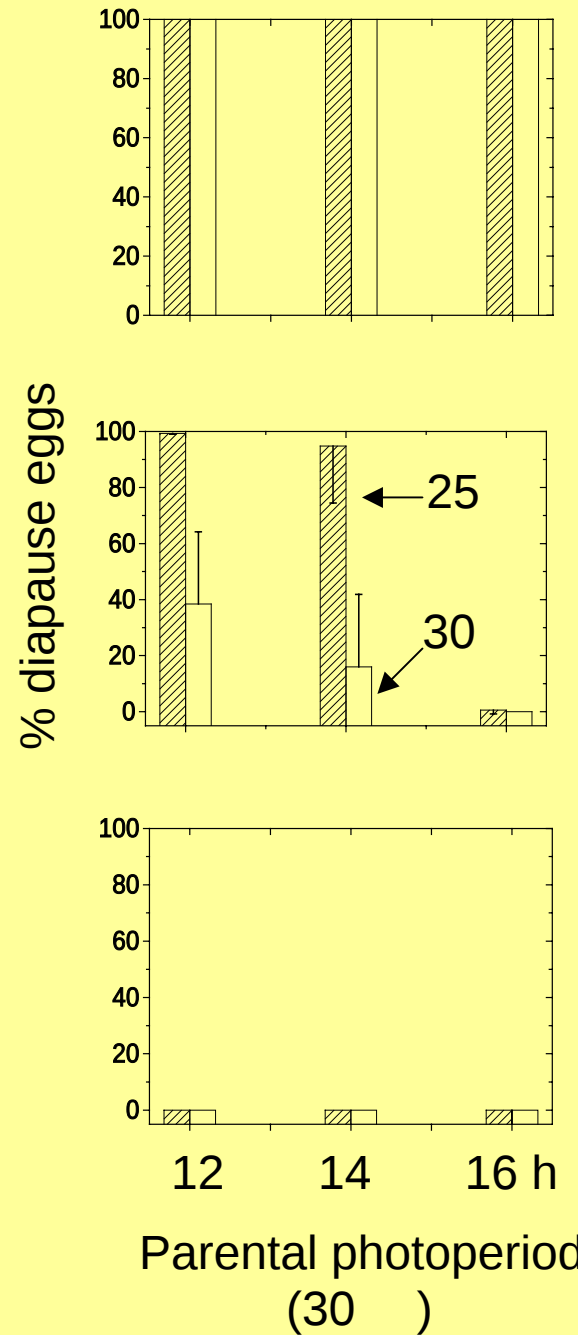
Life history of *Locusta*



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)

Locusta migratoria



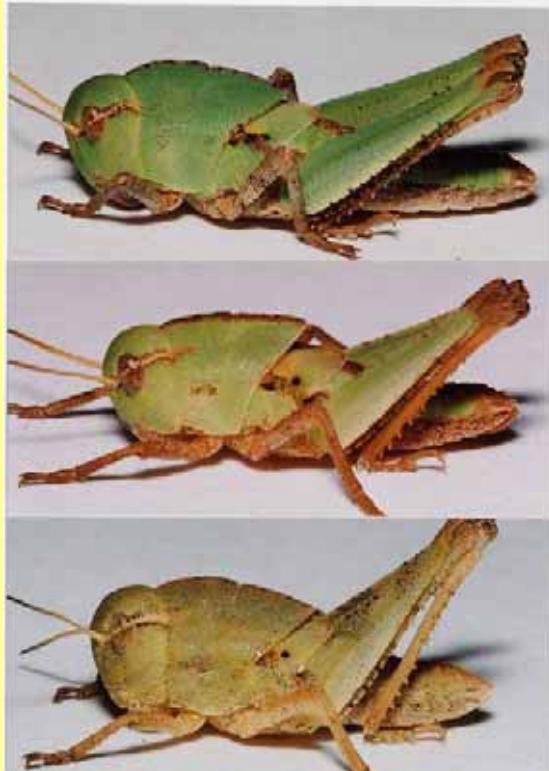
Low density

High density

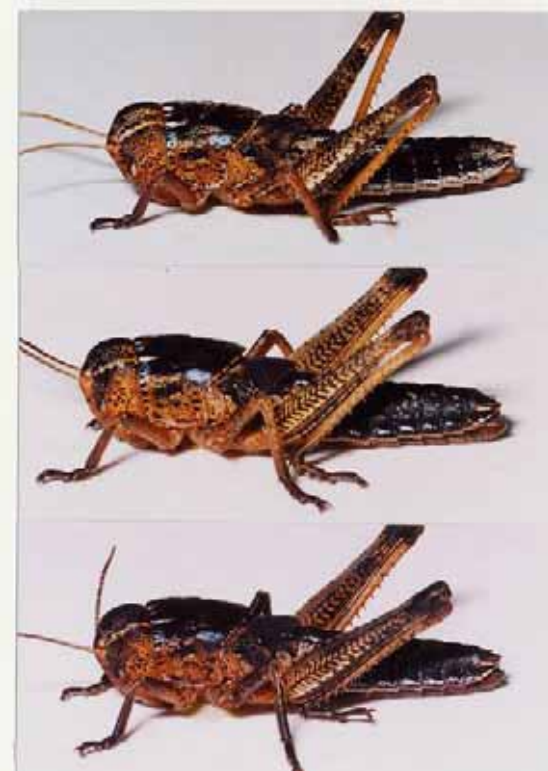
	Solitarious phase	Gregarious phase
Body color	uniformly colored	black patterns
Body shape		
Elytron/Femur	small	large
Femur/Head	large	small
Behavior		
aggregation	sedentary No	migratory Yes

Locusta migratoria

LOW DENSITY



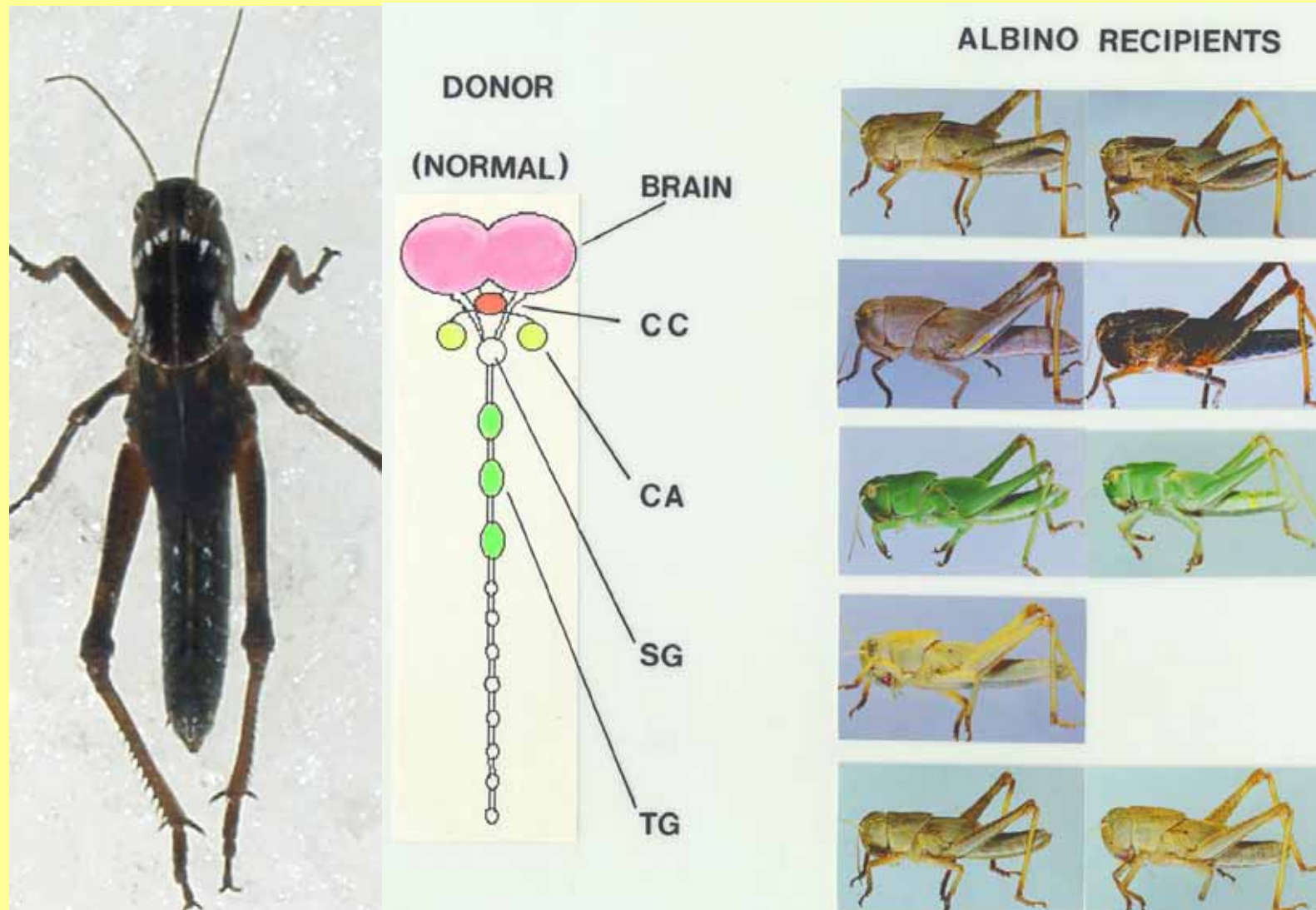
HIGH DENSITY



Albino *L. migratoria*



Effects of implantation of various organs from normal nymphs on the body color of albino *L. migratoria*



(Tanaka, Zool. Sci., 1993)

Dark-Color Inducing Neuropeptide in *Locusta migratoria* and *Schistocerca gregaria*



[His⁷]-corazonin

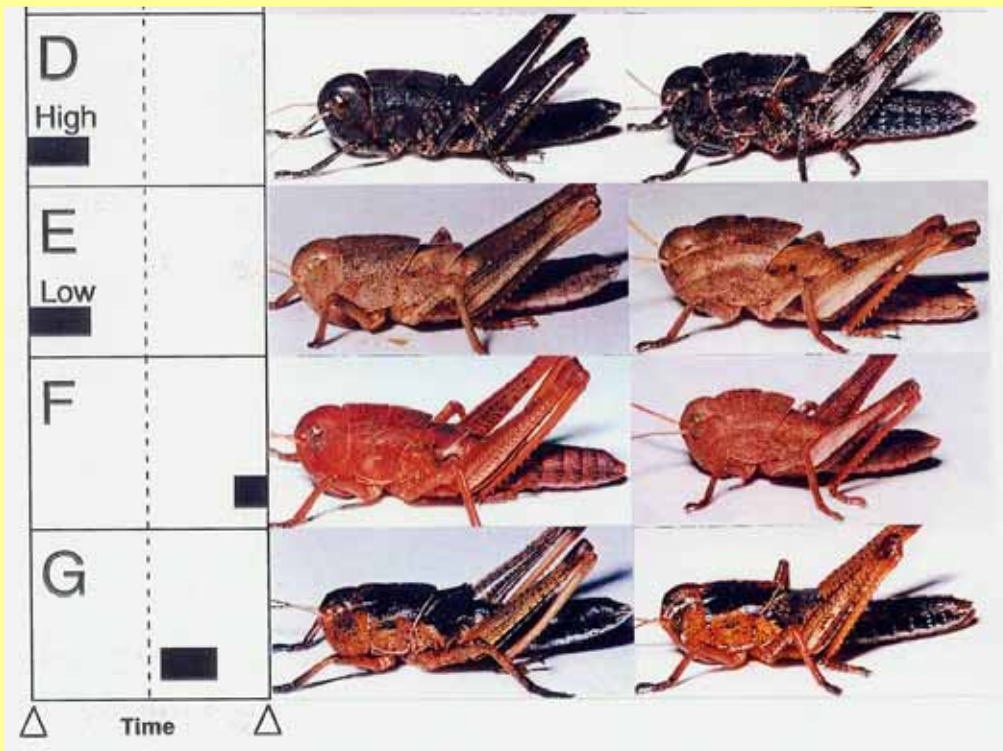
MW=1,351.6

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

(Tawfik et al., 1999. PNAS)

Albino

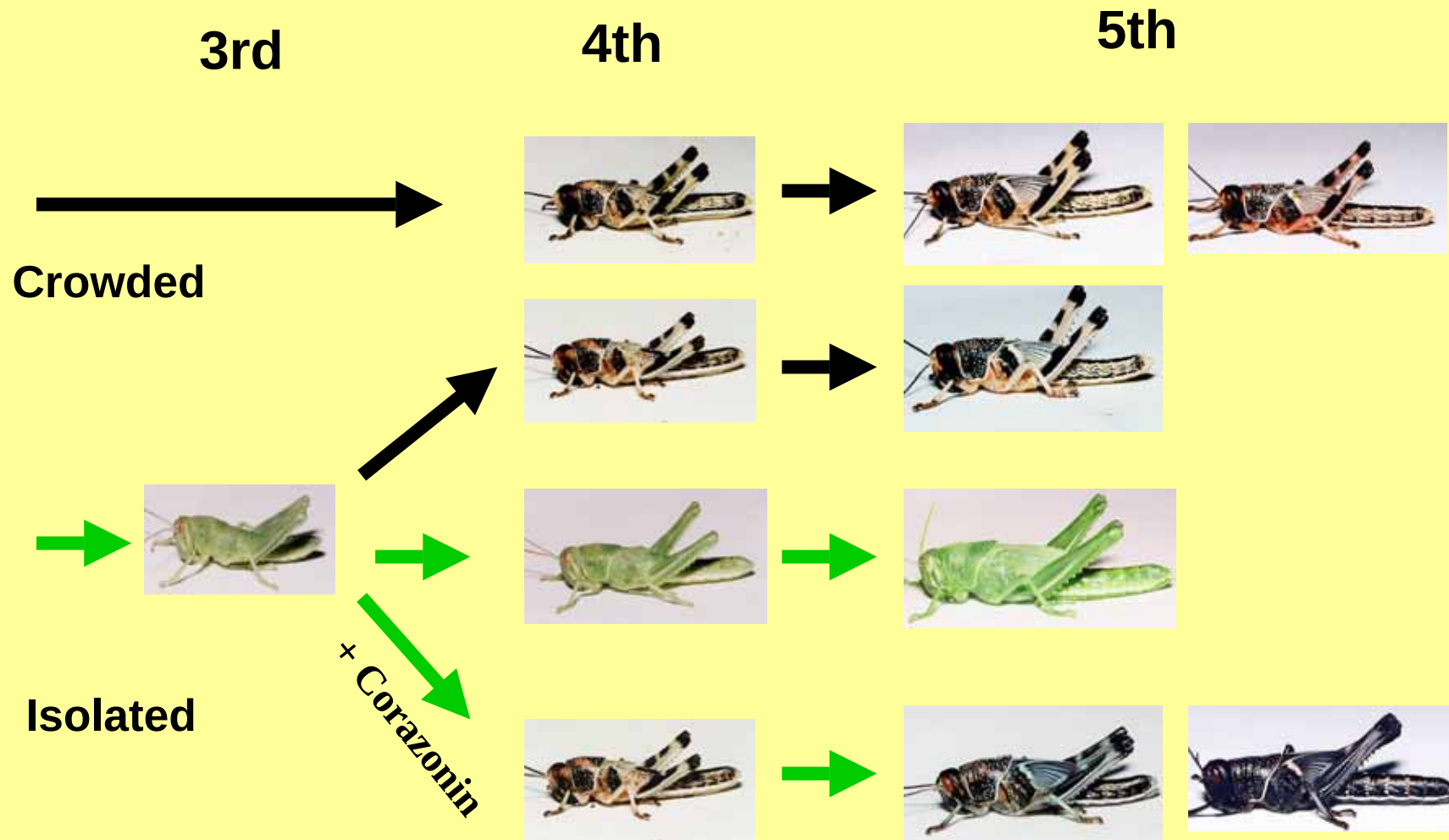
Normal



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



Low density

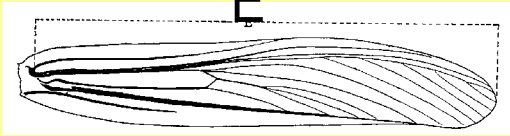
High density

	Solitarious phase	Gregarious phase
Body color	uniformly colored	black patterns
Body shape		
Elytron/Femur	small	large
Femur/Head	large	small
Behavior	sedentary	migratory
aggregation	No	Yes

Morphometrics

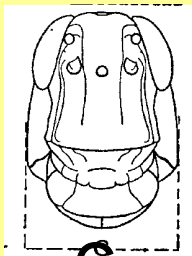
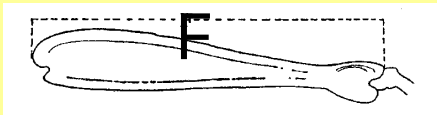
Elytron length

E



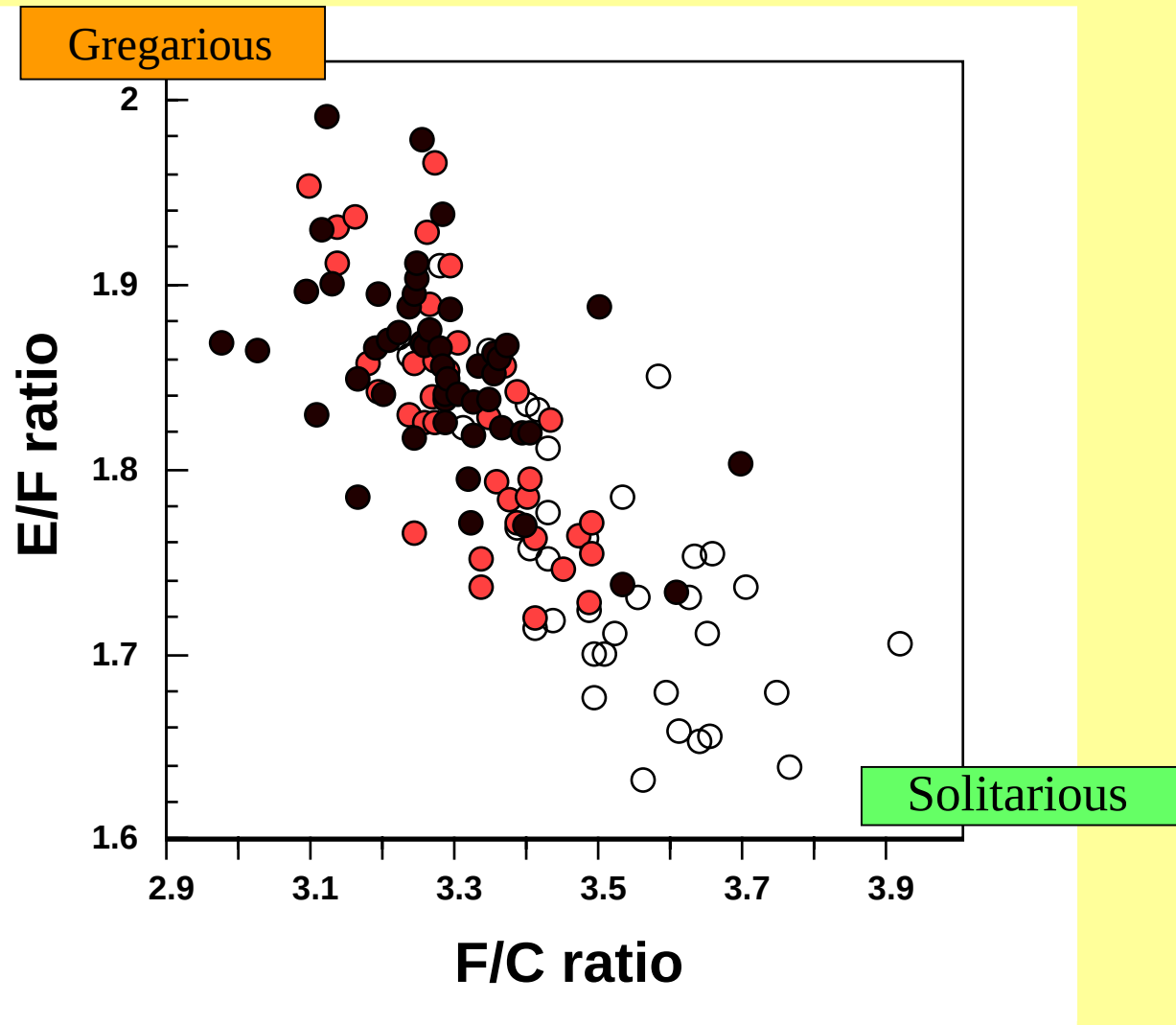
Hind femur length

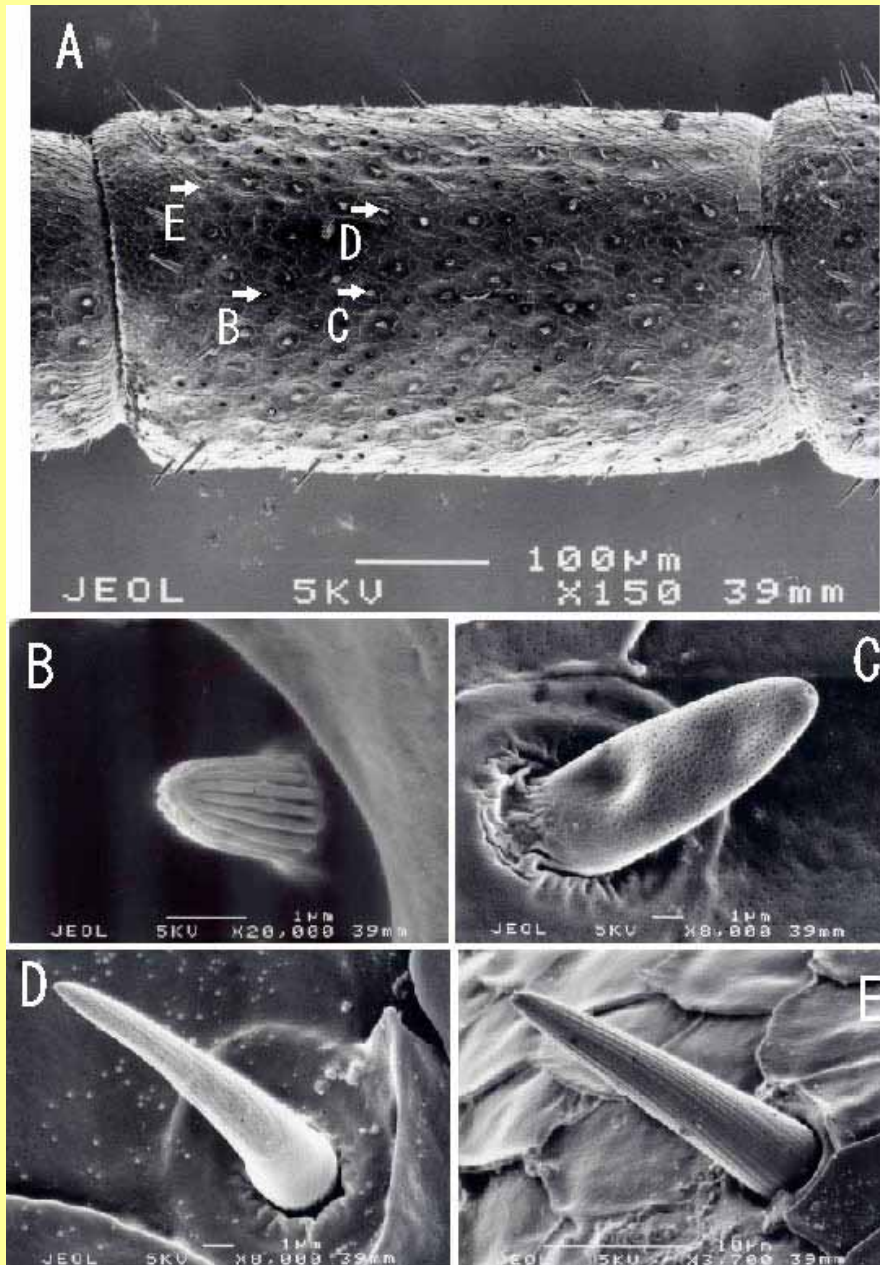
F



C

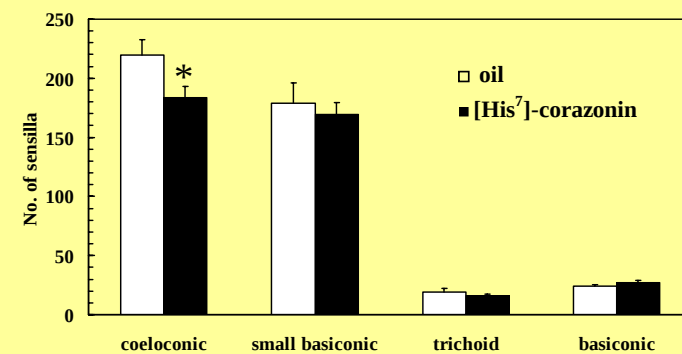
Head width





[His7]-corazonin reduces the number of some sensilla when injected into solitary nymphs.

(Kihara, Hata, Breuer & Tanaka, *Physiol. Entomol.* 2004; Maeno & Tanaka, *J. Insect Physiol.* 2004).



Locusta migratoria



Low density

High density

	Solitarious phase	Gregarious phase
Body color	uniformly colored	black patterns
Body shape		
Pronotum	arched	flat/dented
Elytron/Femur	small	large
Femur/Head	large	small
Behavior	sedentary	migratory
aggregation	No	Yes

Solitarious 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.

Collaborators



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Arigato

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D.-H. Zhu (Central South Forestry university, China)

K. Maeno and K. Harano (NIASO, Japan)
