Locust Outbreaks and Studies on Phase Polyphenism

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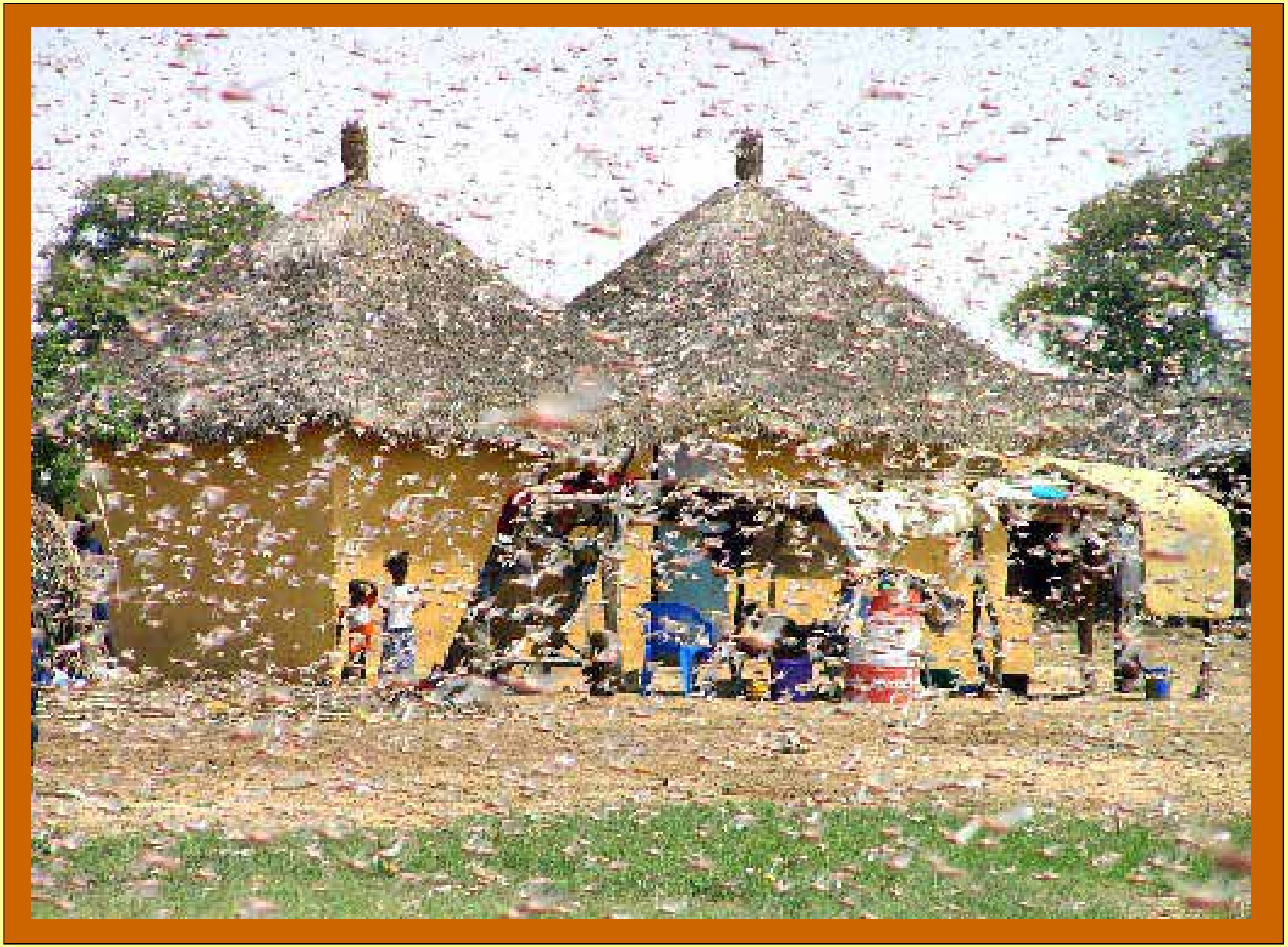
(FAO EMPRESS)



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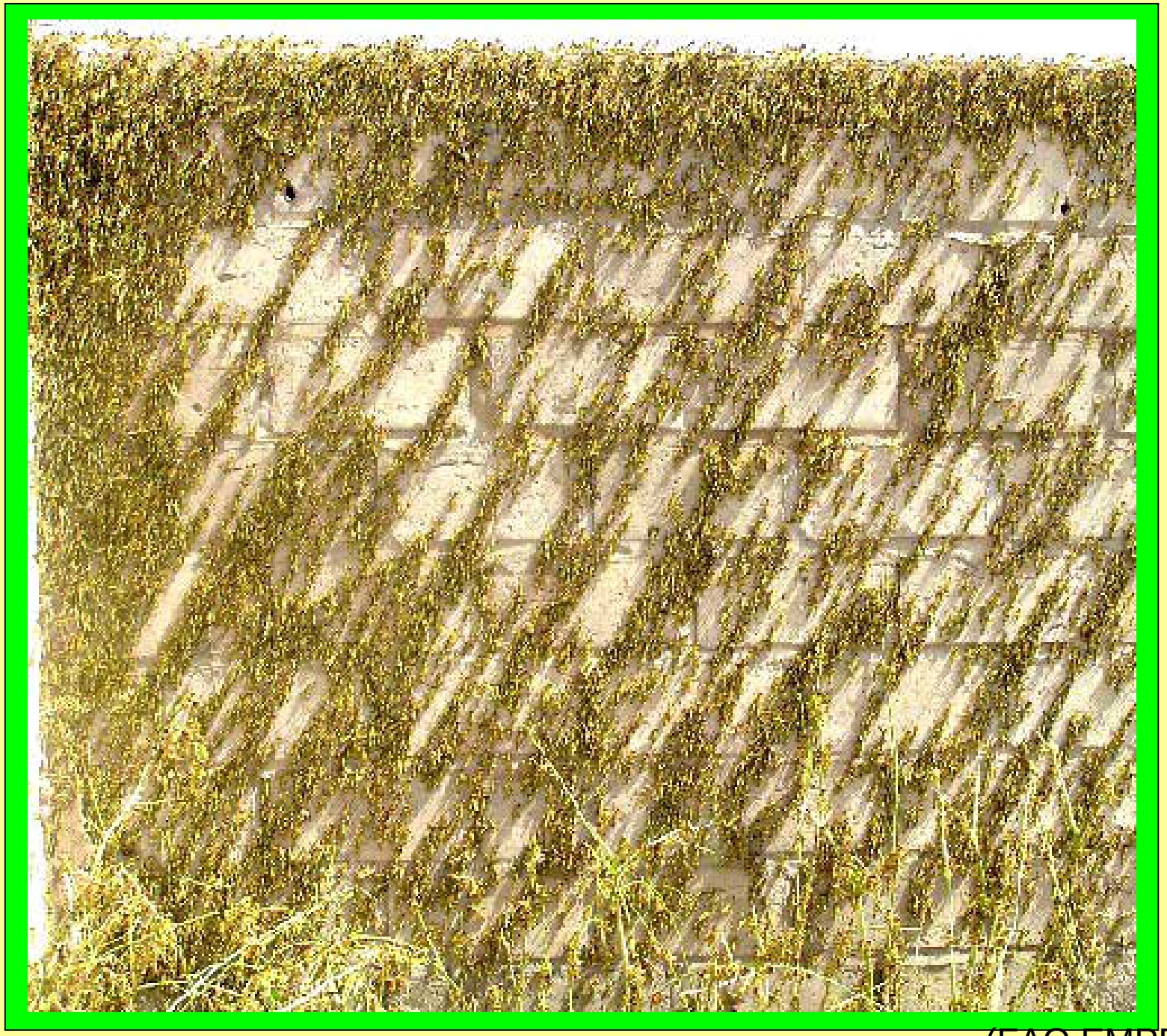

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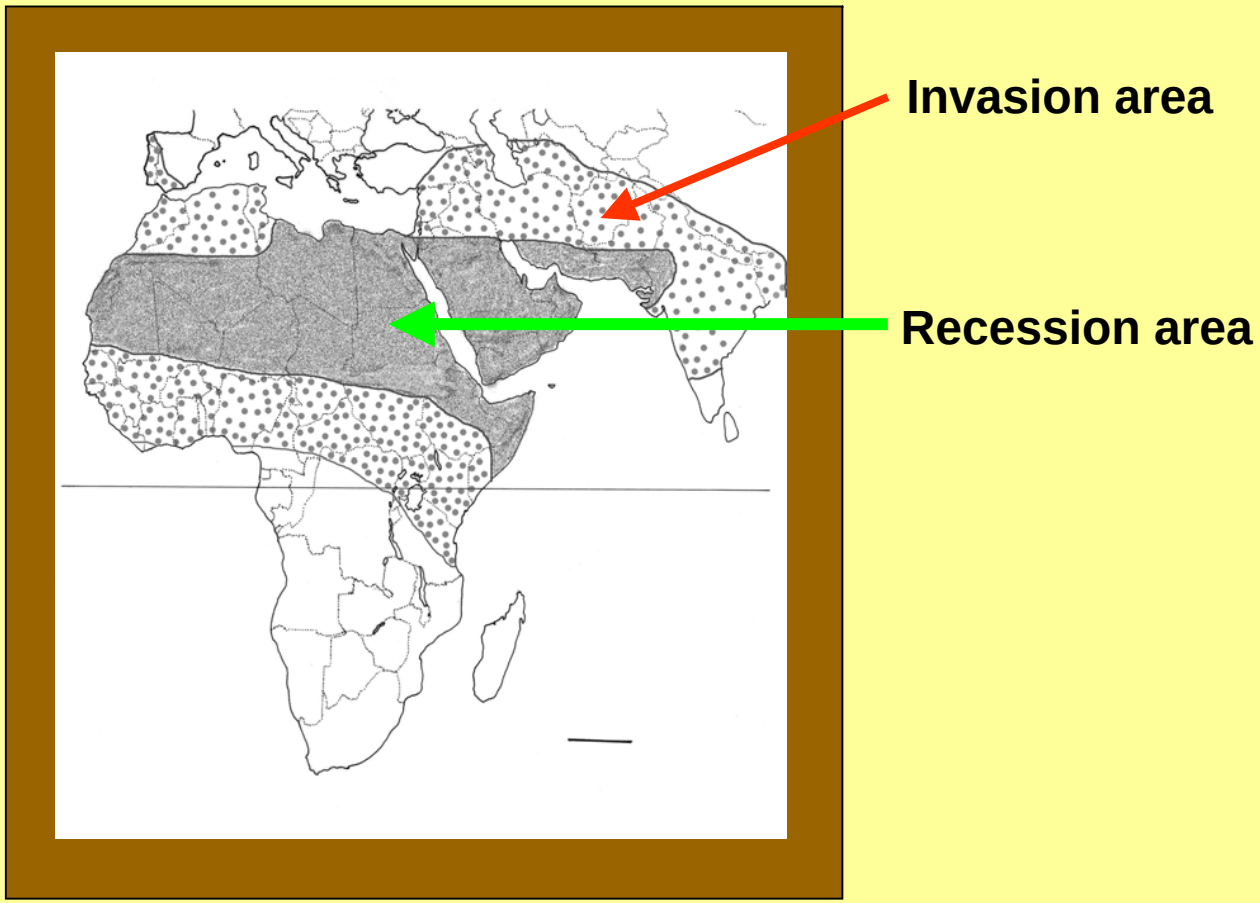
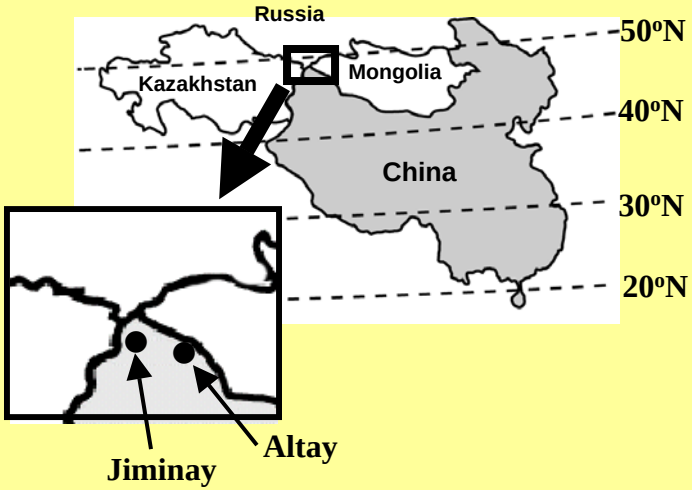
Distribution range of desert locusts

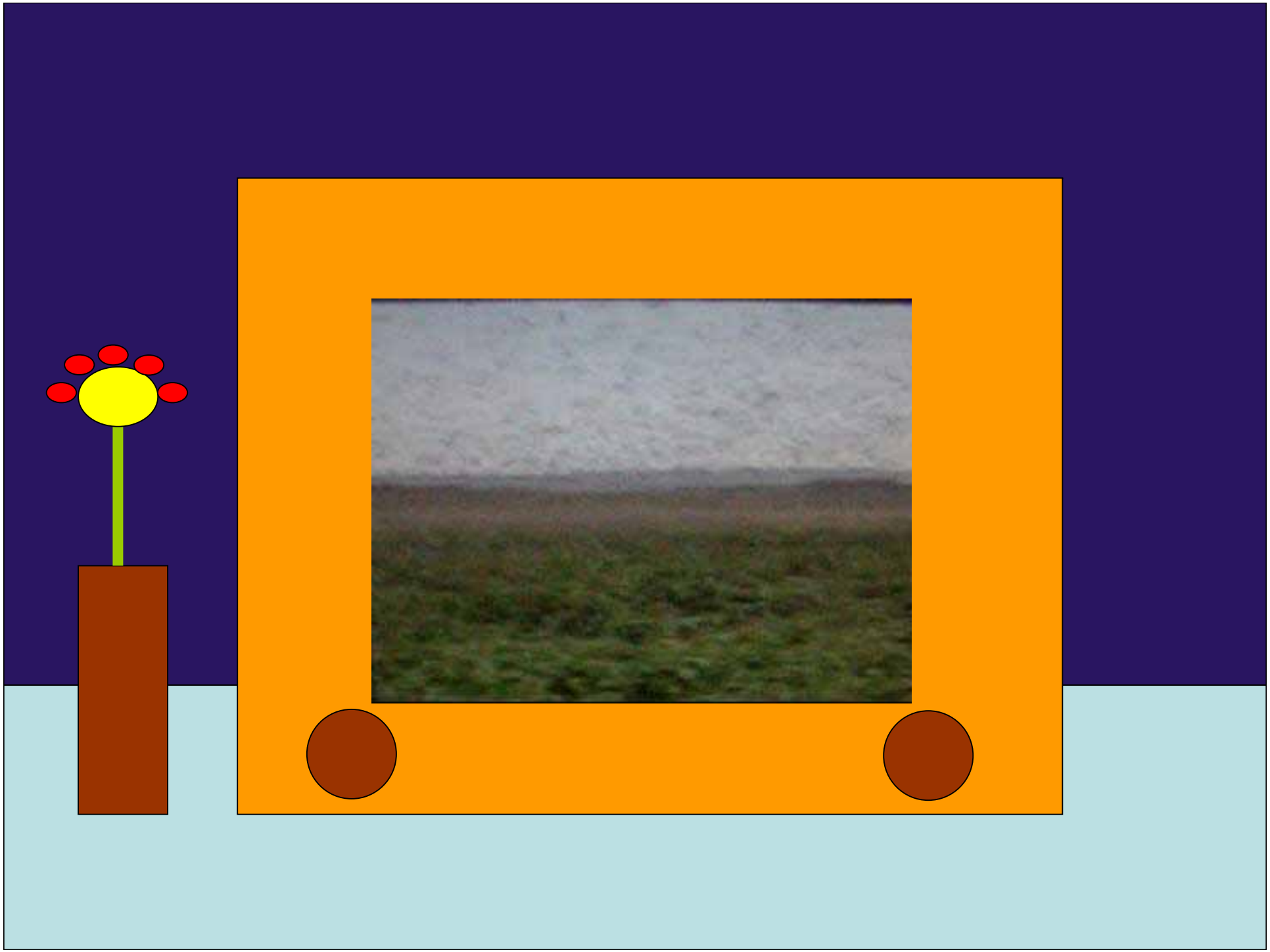
20 % of the entire land surface on earth !!

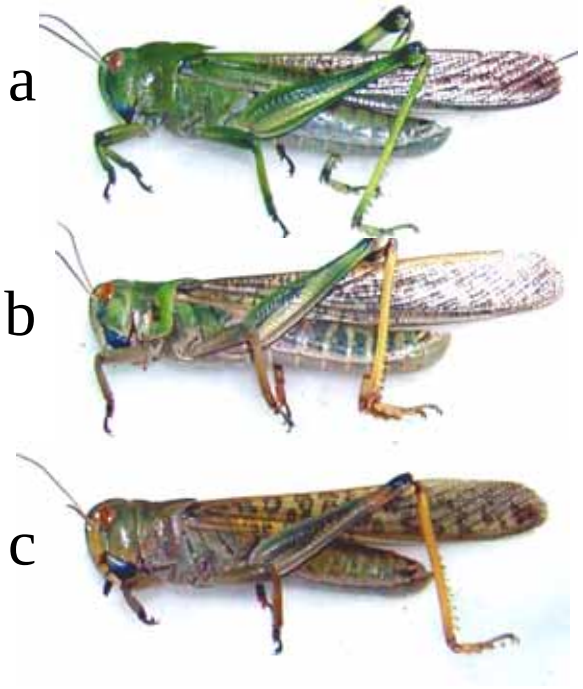


Outbreaks of the migratory locust, *Locusta migratoria* in Kazakhstan and China in 2003-4




a
b
c
d




a
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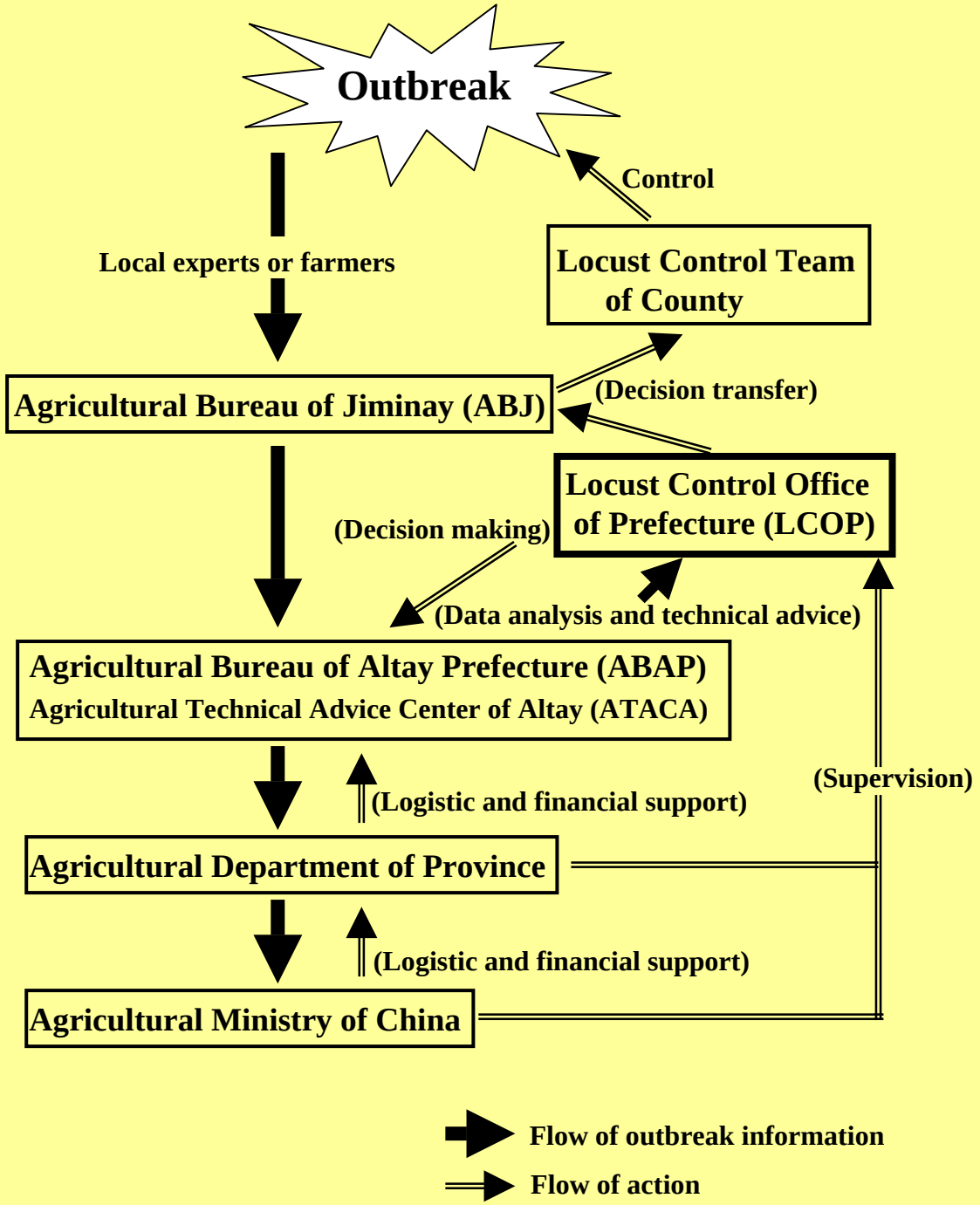

Outbreak
Control
Local experts or farmers
Locust Control Team of County
Agricultural Bureau of Jiminay (ABJ)
(Decision transfer)
Locust Control Office of Prefecture (LCOP)
(Decision making)
(Data analysis and technical advice)
Agricultural Bureau of Altay Prefecture (ABAP)
Agricultural Technical Advice Center of Altay (ATACA)
(Logistic and financial support)
(Supervision)
Agricultural Department of Province
(Logistic and financial support)
Agricultural Ministry of China
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 m^2

30～150 locusts per m^2

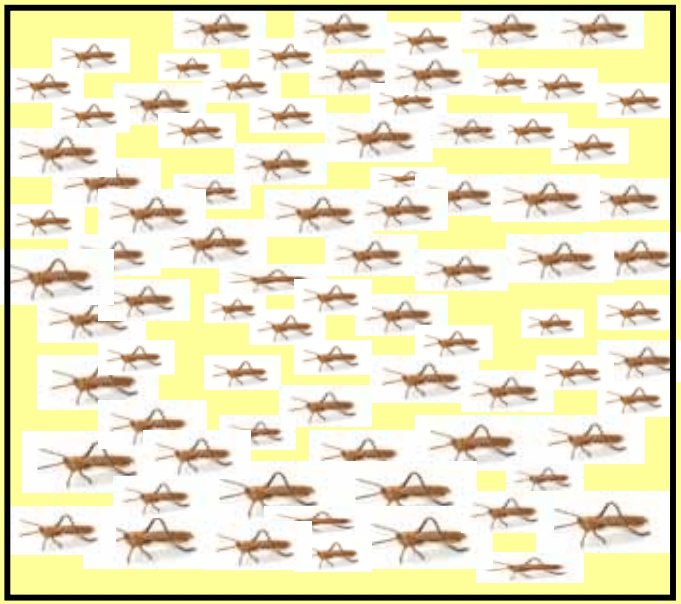
They consume 45 – 225 g of grass each day

At outbreaks

1 m^2

100 locusts per m^2

They consume 150 g of grass each day



100,000,000 locusts / km^2

Locusts eat 150 t of grass each day.

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

A cow eats 12 kg of grass each day

Locusts eat 800 times more grass than do cows !

In the tropics [illegible] are can support 15 cows.

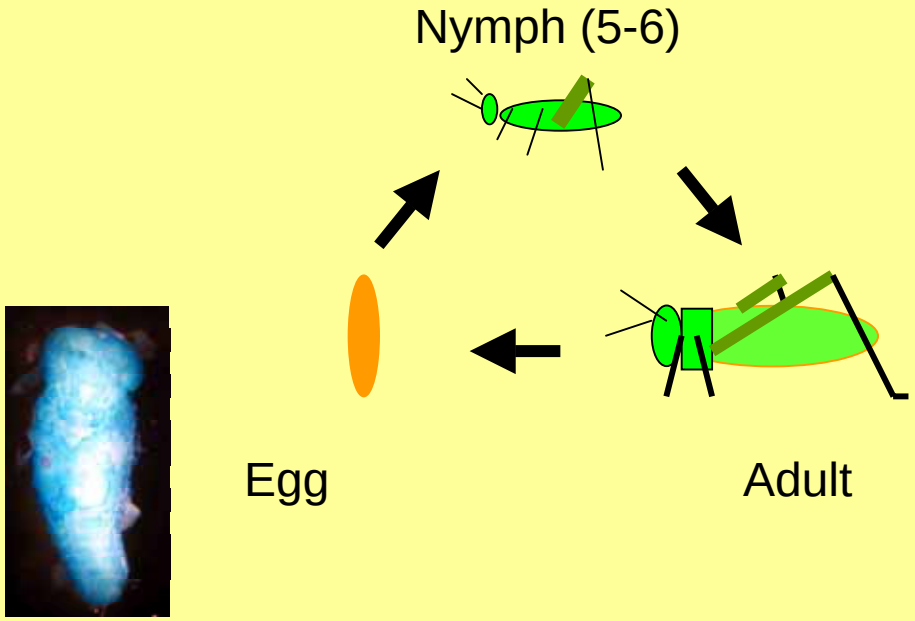
12kg x 15 cows =180 kg [illegible] grass per day

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

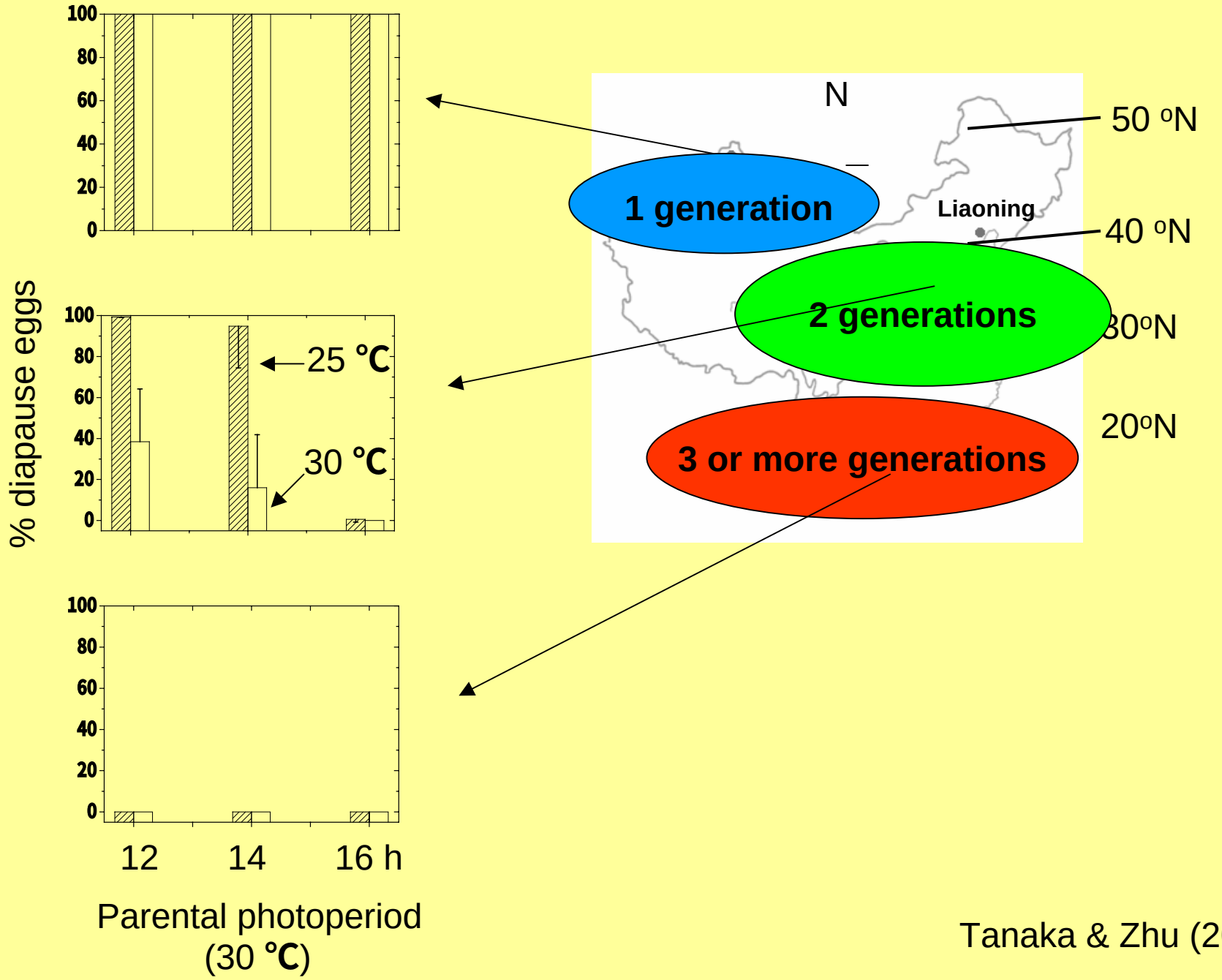
Life history of *Locusta*



Diapause stage

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

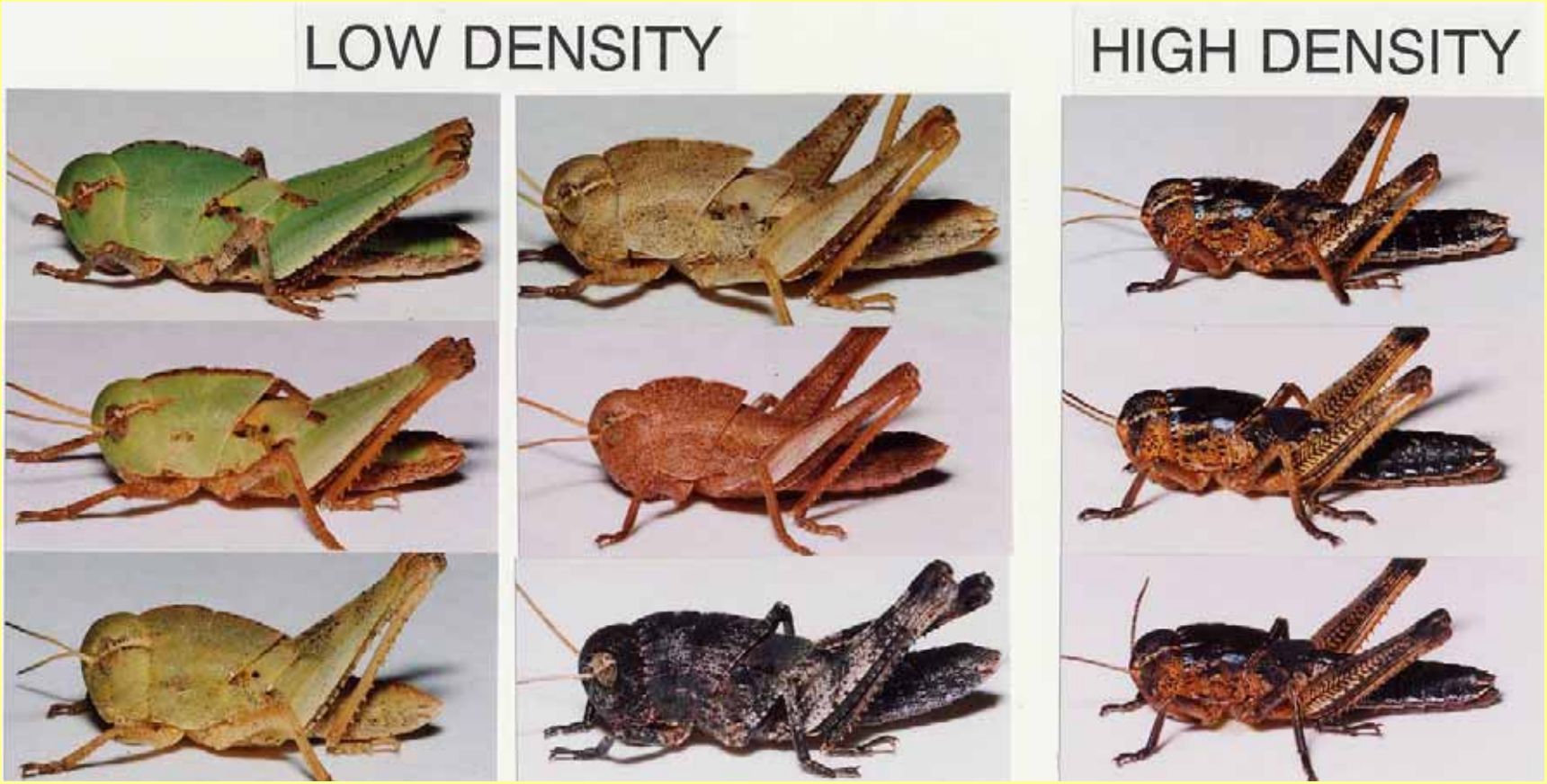
Locusts change body color, body dimensions, physiology and behavior in response to changes in population density.

(Uvarov, 1921)

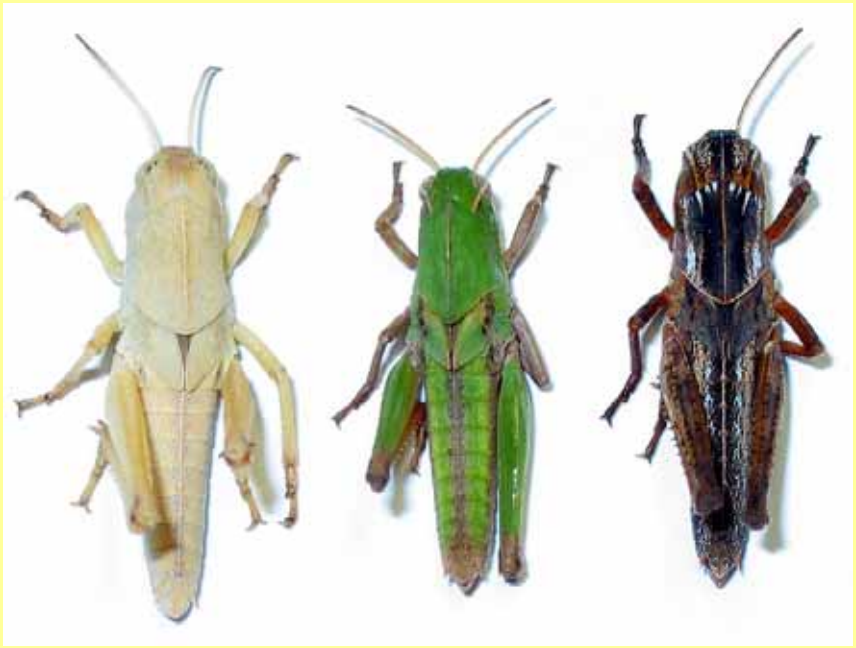
Locusta migratoria

	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	sedentary	migratory
aggregation	No	Yes

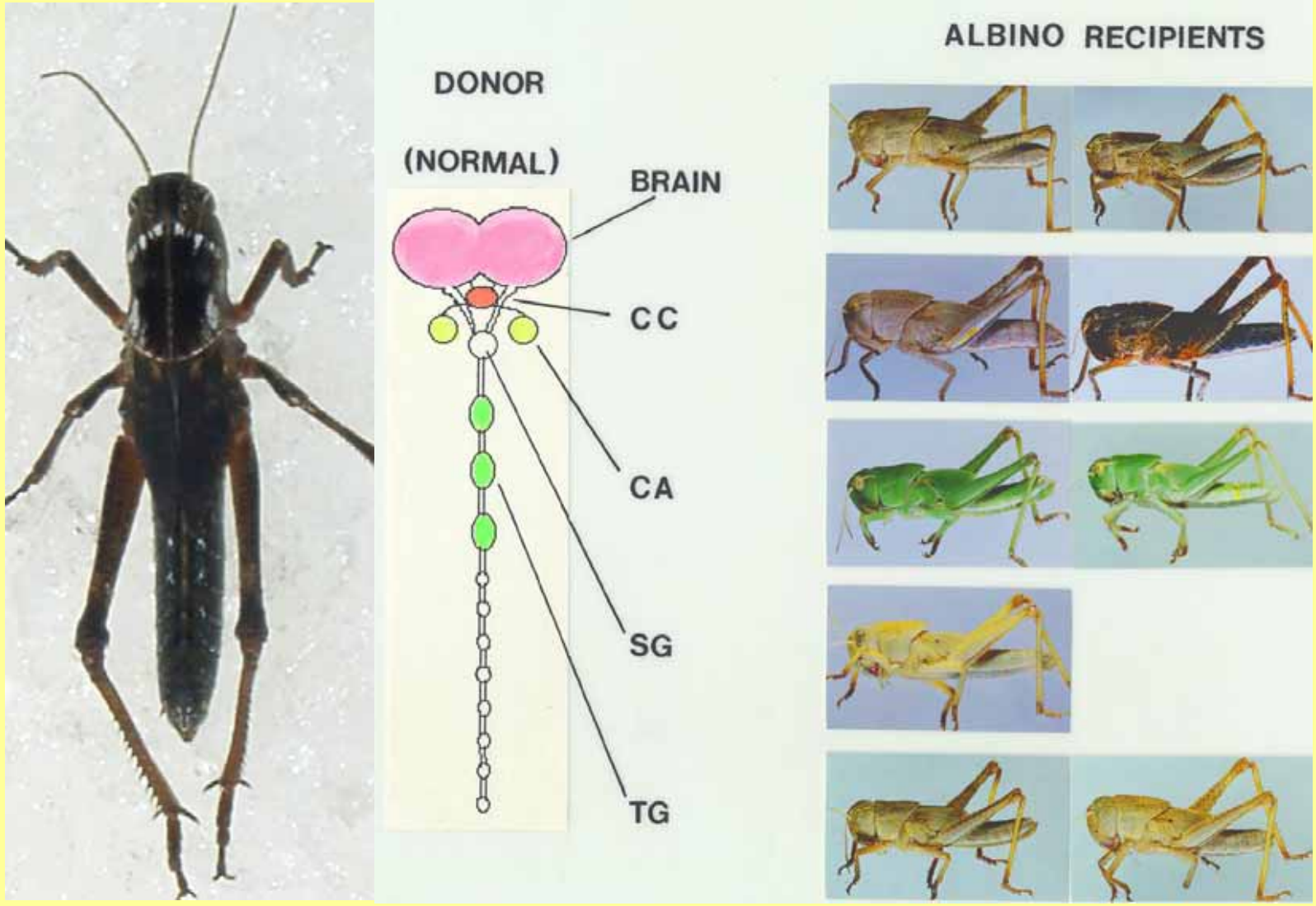
Locusta migratoria



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*

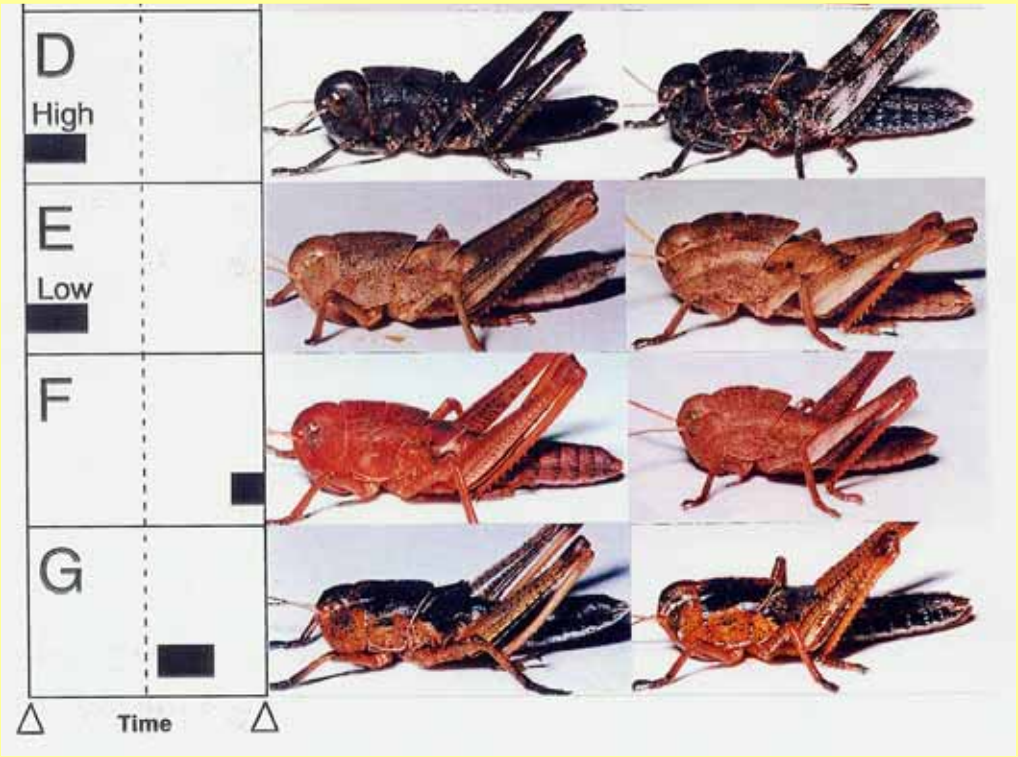
[His^{7}]-corazonin

MW=1,351.6

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

(Tawfik et al., 1999. PNAS)

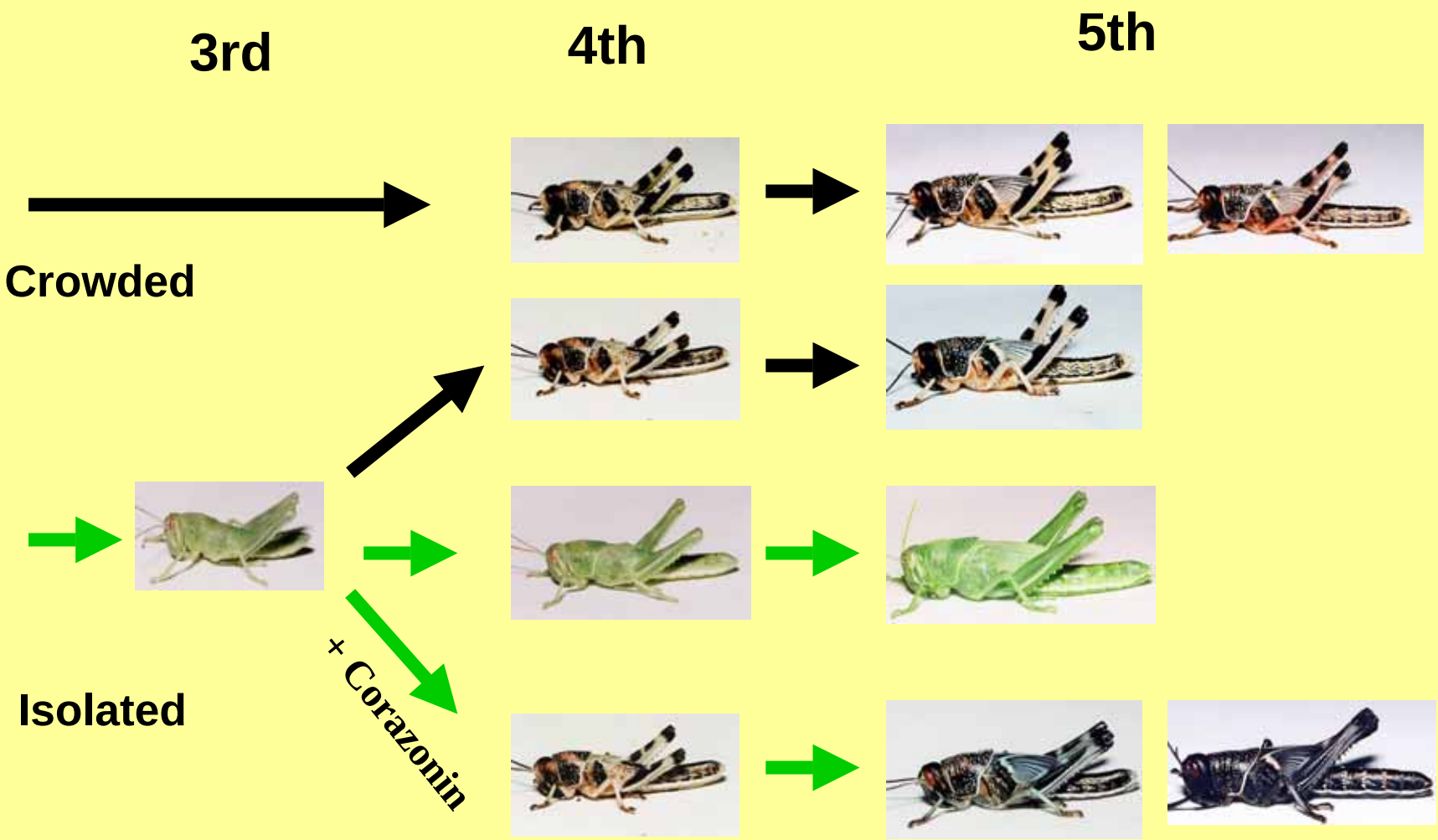
Albino Normal



A model for the hormonal mechanism controlling the body-color polyphenism in *L. migratoria*

(Tanaka, J. Insect Physiol. 2002)

Body coloration in *Schistocerca gregaria*



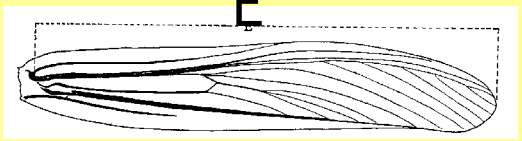
(Tanaka, 2001 Arch. Insect Biochem & Physiol.)

Locusta migratoria

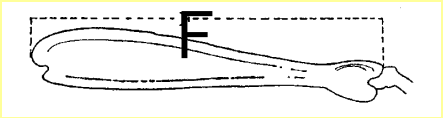
	Low density	High density
	Solitarious phase	**Gregarious phase**
Body color	uniformly colored	black patterns
Body shape		
Elytron/Femur	small	large
Femur/Head	large	small
Behavior	sedentary	migratory
aggregation	No	Yes

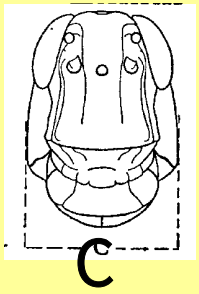
Morphometrics

Elytron length

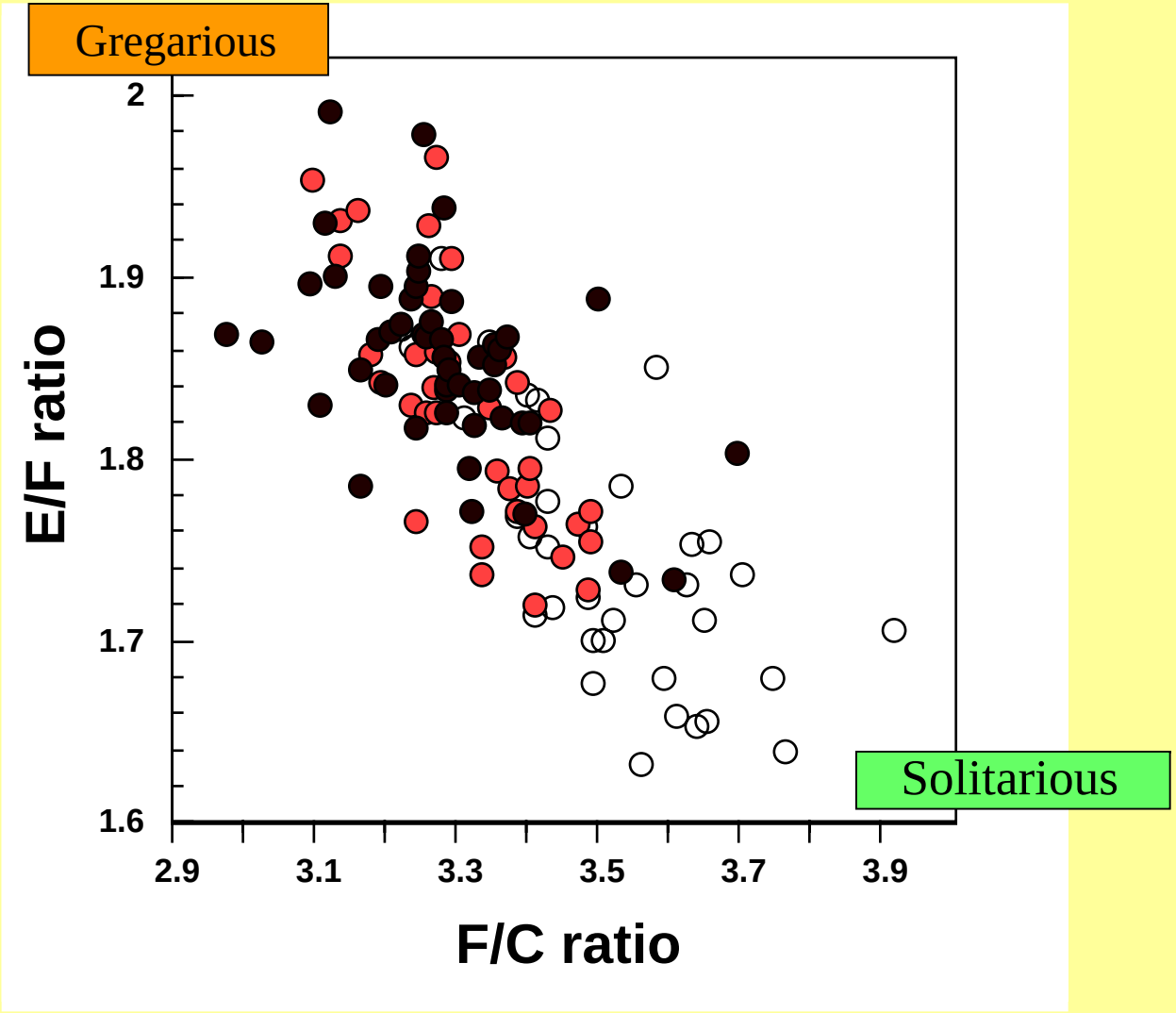


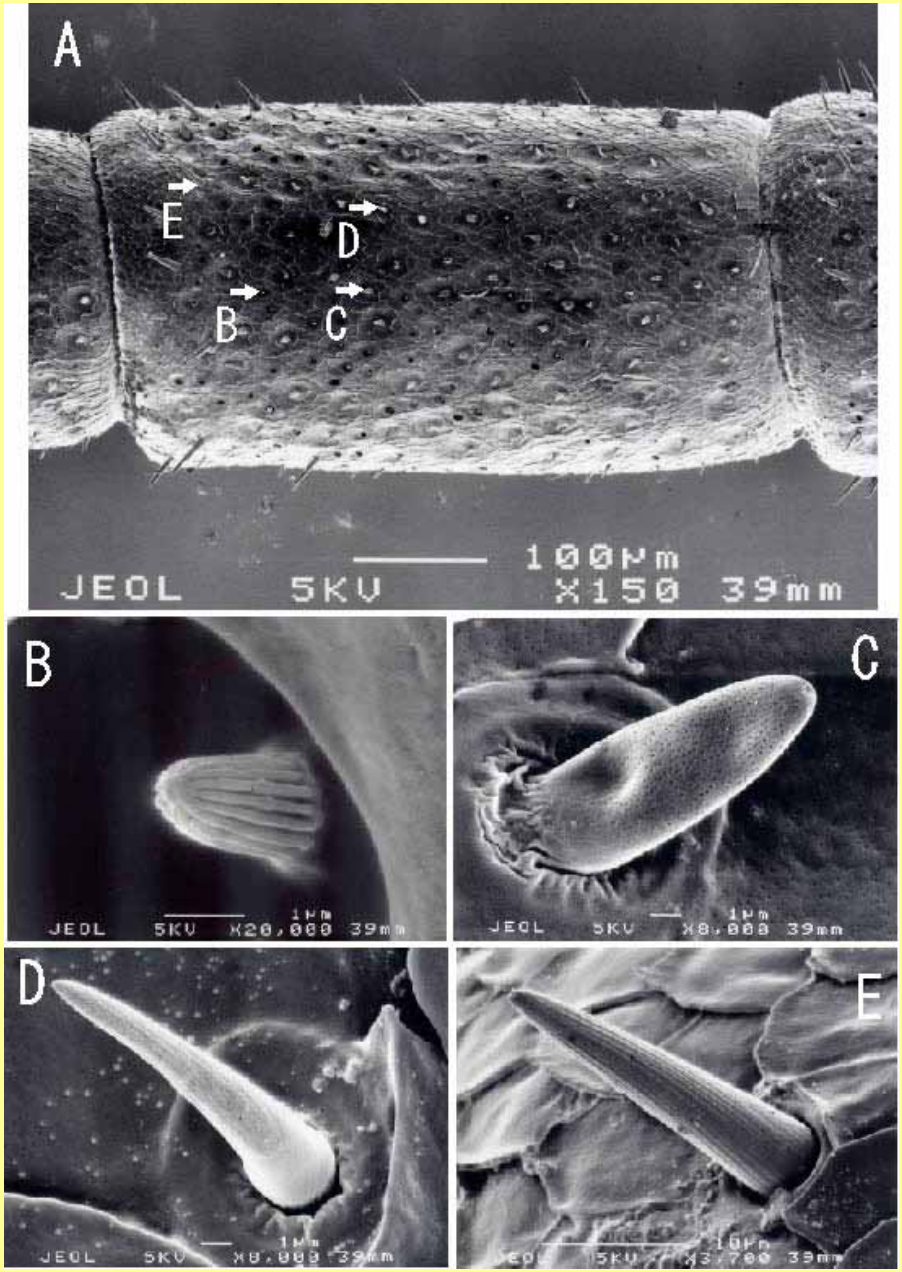
Hind femur length





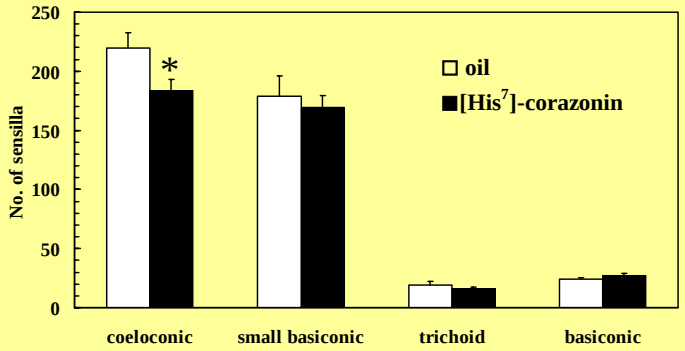
Head width



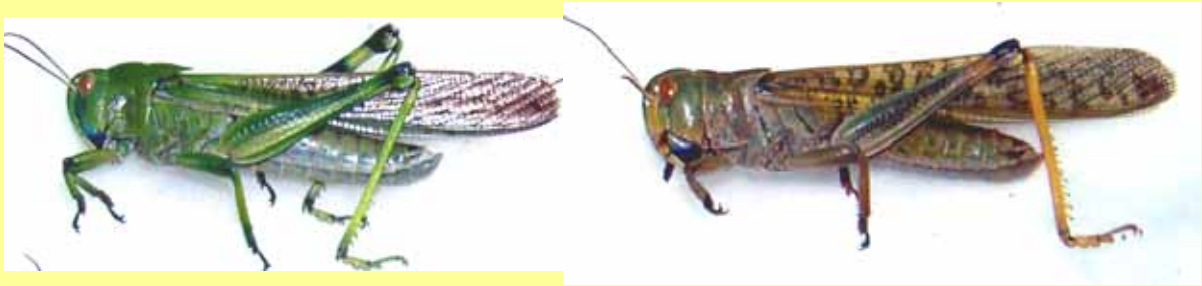


[His7]-corazonin reduces the number of some sensilla when injected into solitarious nymphs.

(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 km^2 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

Arigato

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

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