

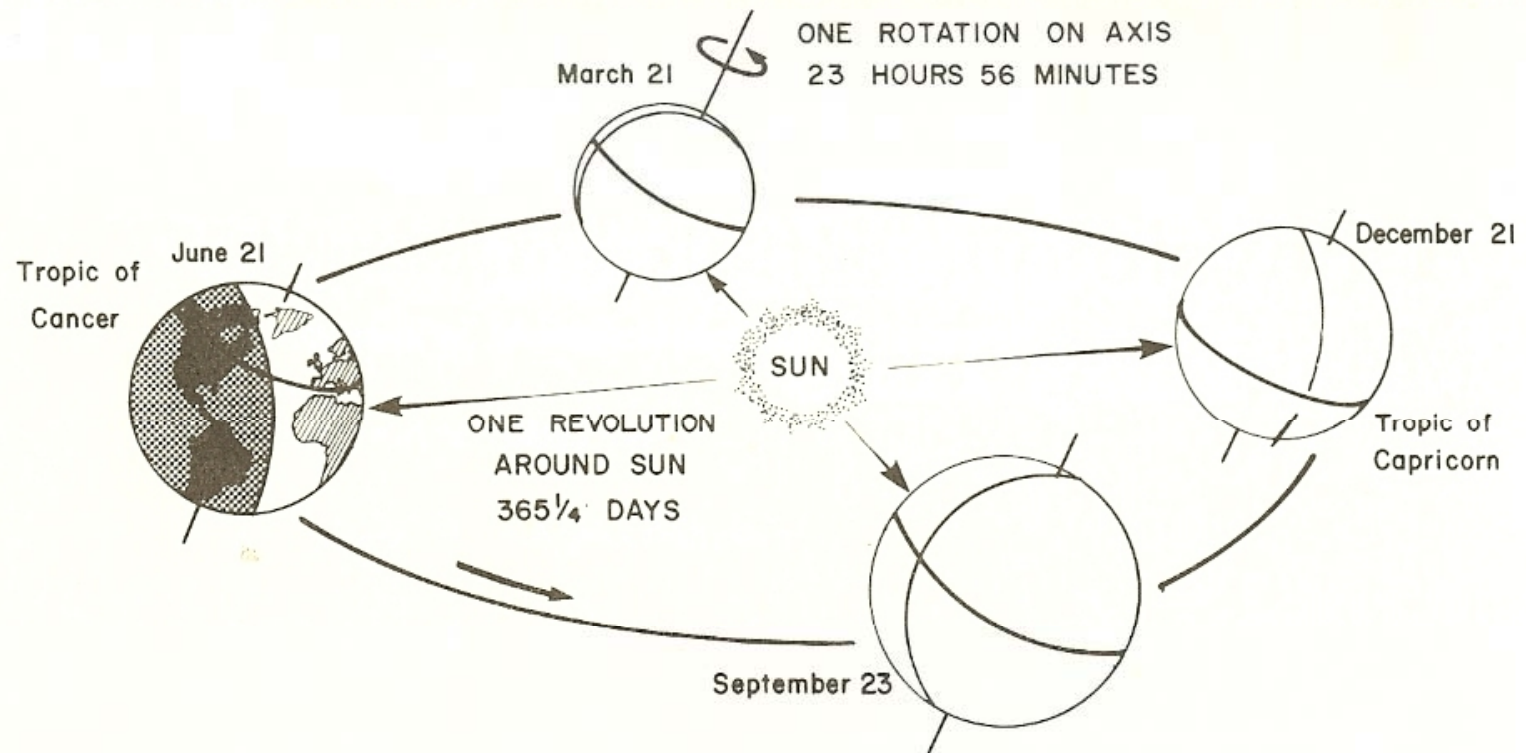


HOKKAIDO UNIVERSITY

Title	Life on a Rotating Planet : Challenge and Opportunity
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cosmic cycles



Life on a rotating planet

challenge and opportunity

• the day	24 h
• the week	7 days
• the month	29.53 days
• the year	365.25 days
• precession	~23,000 years



Suslik = European ground squirrel

MCTQ - Munich ChronoType Questionnaire

On workdays (don't fill out if you are retired)...

I get up at ... 7:00 o'clock

I need ... _____ min to wake up

I regularly wake up ... before the alarm ☐ with the alarm ☐

From ... _____ o'clock, I am fully awake

At around ... _____ o'clock, I have an energy dip

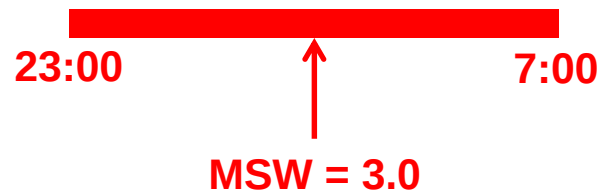
On nights before workdays, I go to bed at ... 22:55 o'clock ...

... and it then takes me ... 5 min to fall asleep

If I get the chance, I like to take a siesta/nap ... correct ☐ not correct ☐

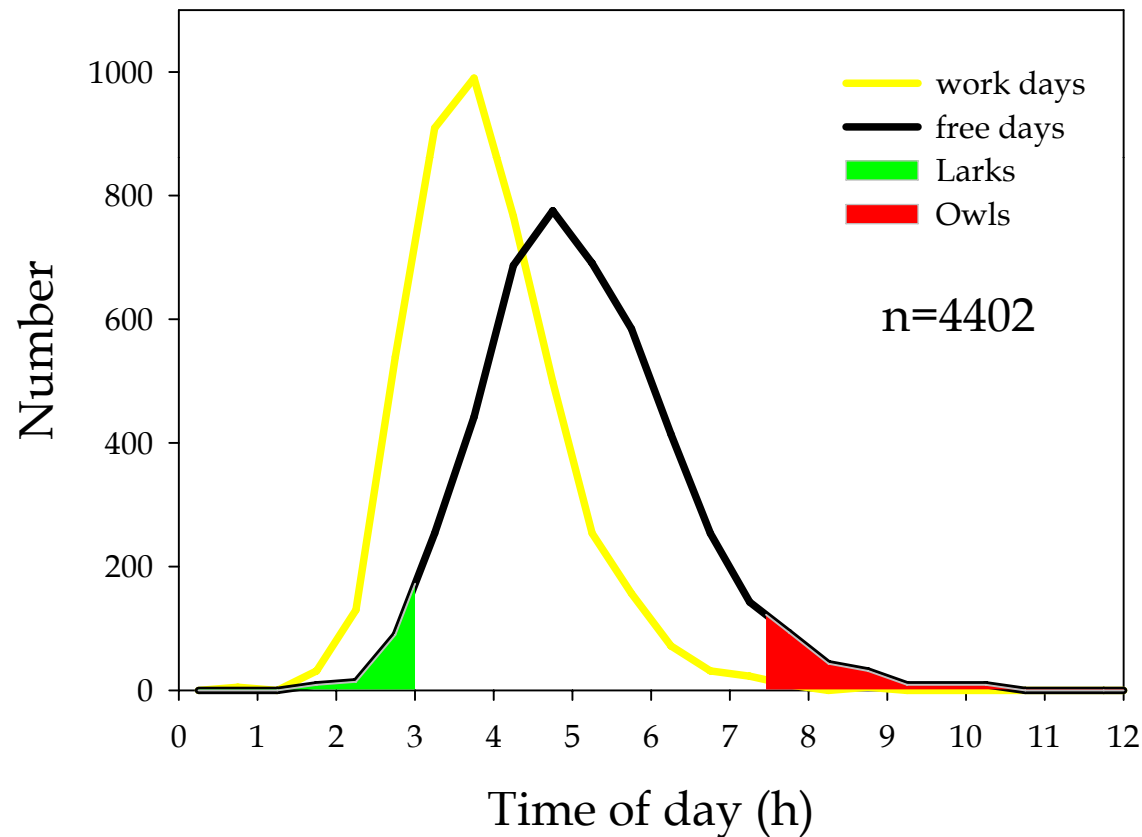
if "correct": I then sleep for ... _____ min

if "not correct": because I would feel terrible afterwards ☐

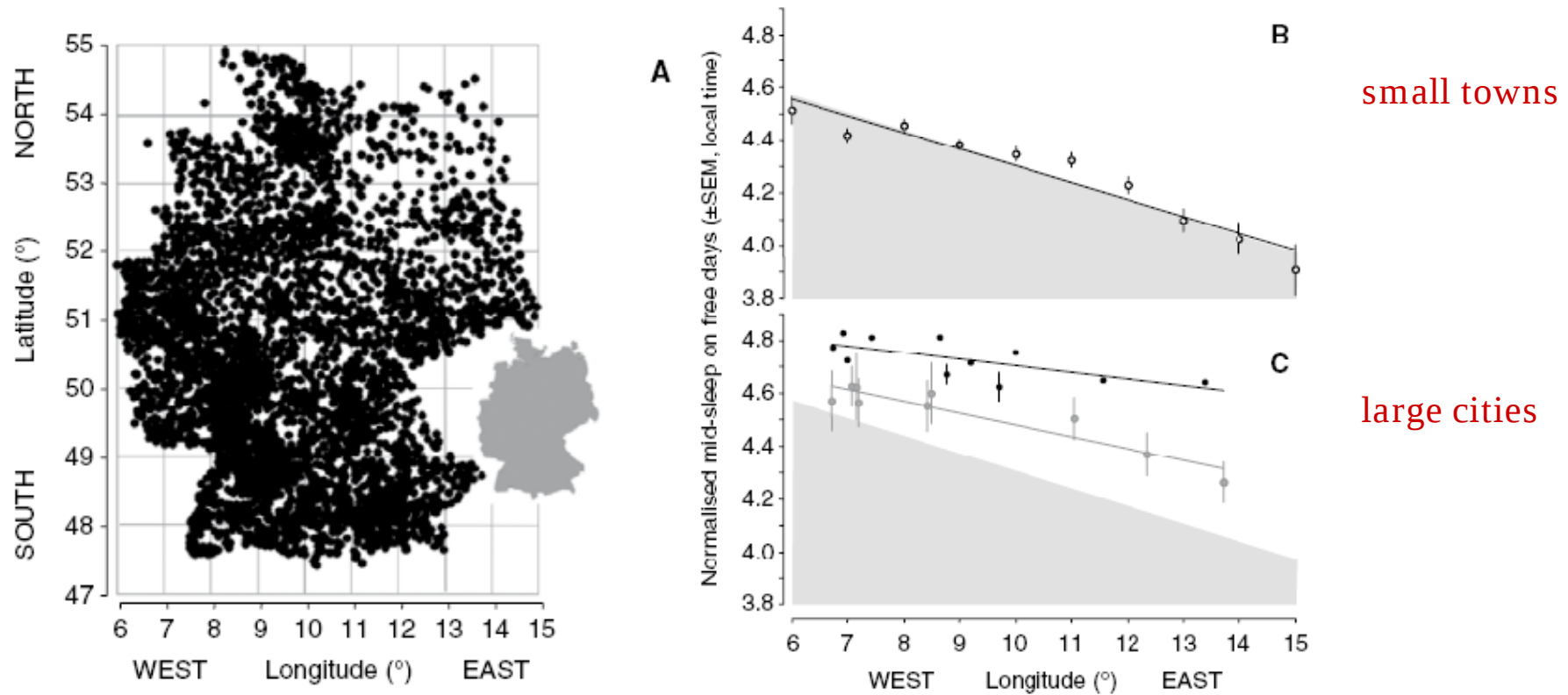


timing of sleep: variation in the population

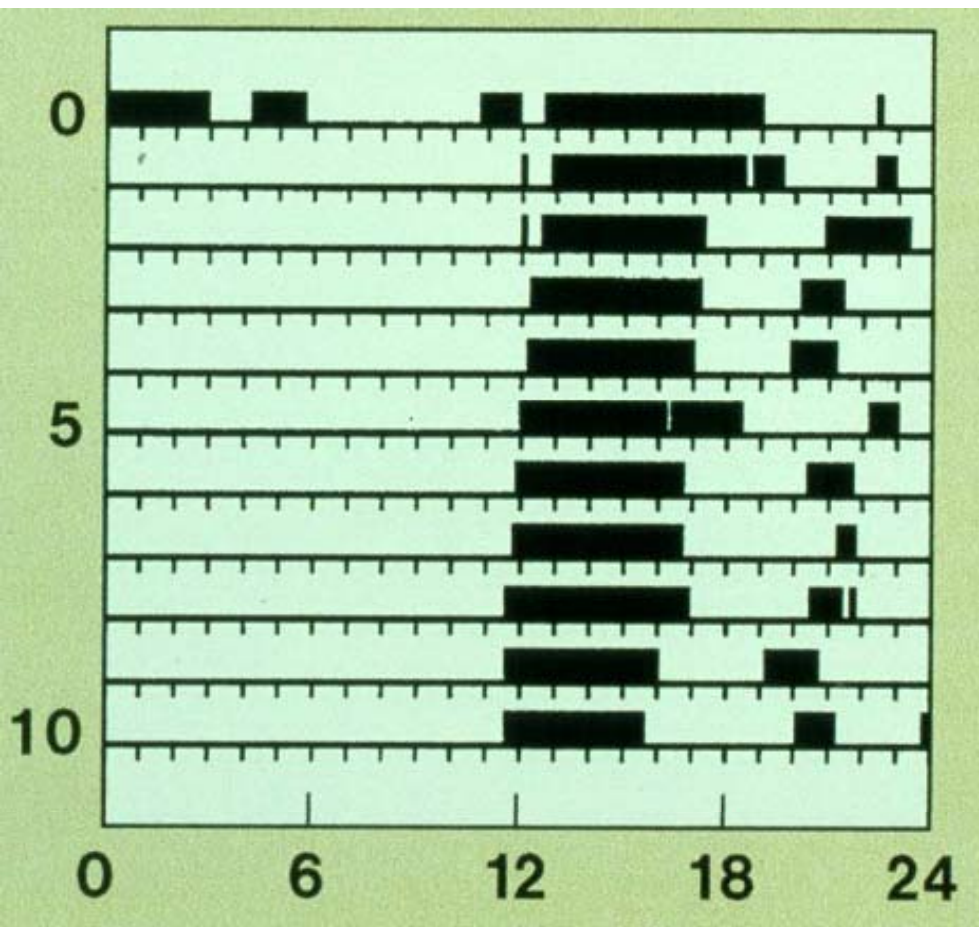
Midsleep time MCTQ Groningen 2003



humans follow the sun, not social time



“circadian” rhythms: endogenous

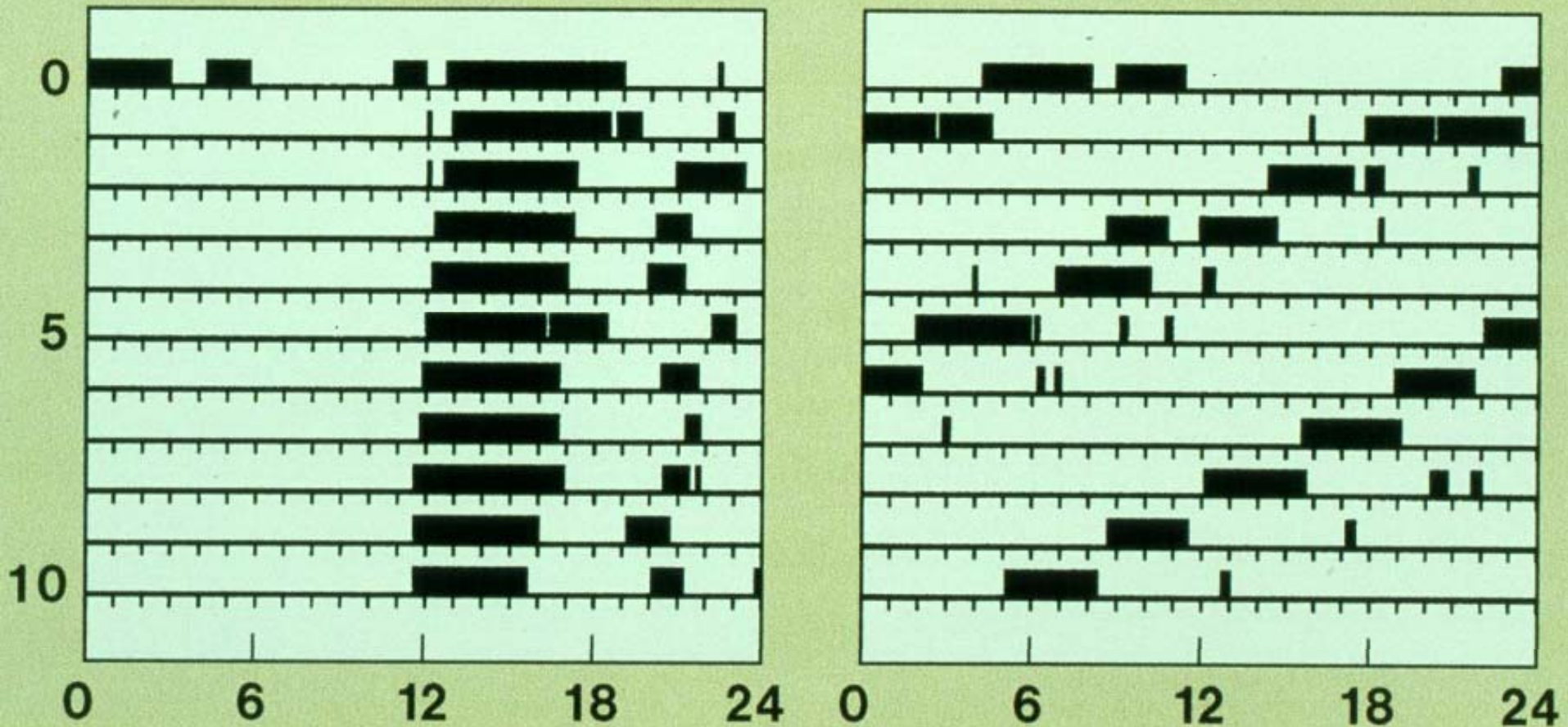


Syrian hamster in
continuous darkness:

cycle lasts less
than 24 h

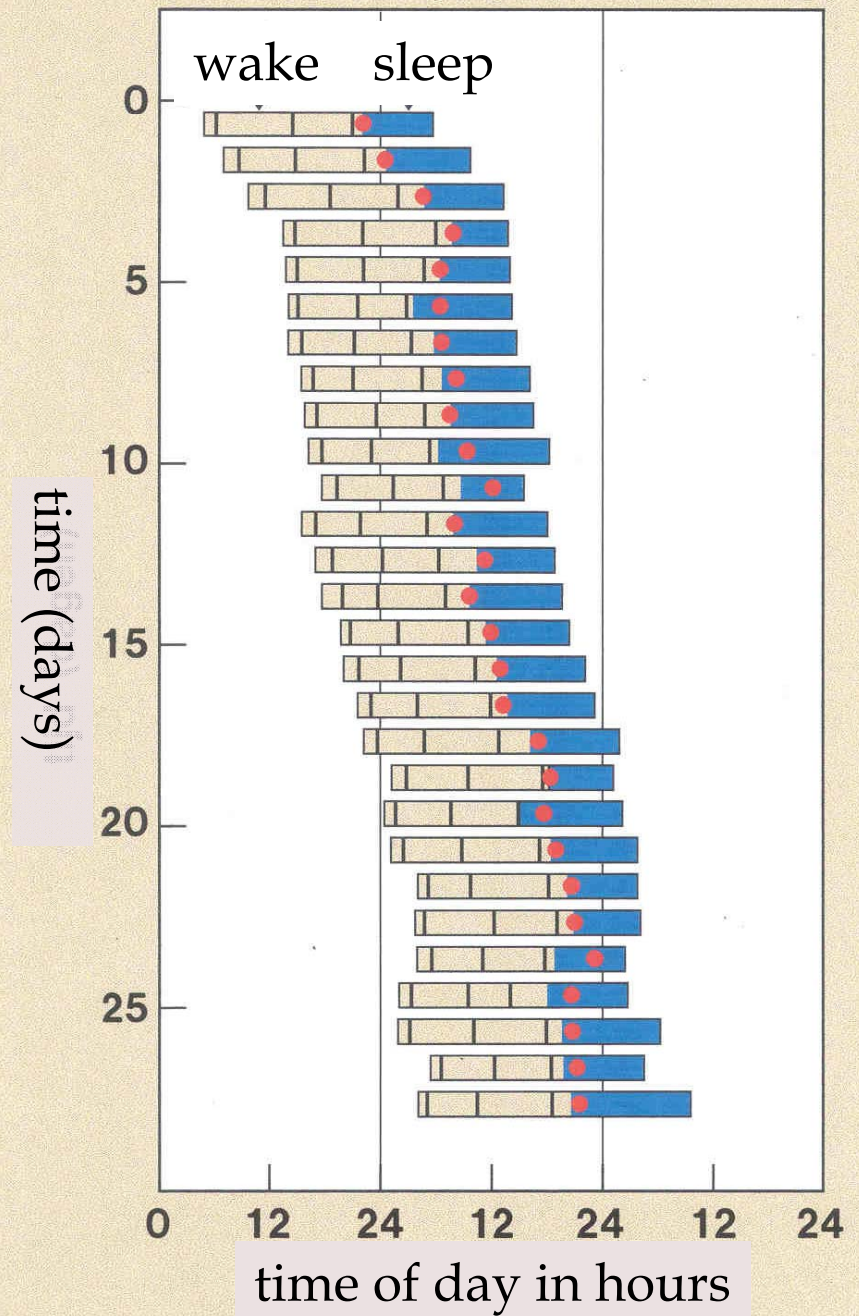
therefore *circa-dian*
= about one day

circadian rhythms: under genetic control



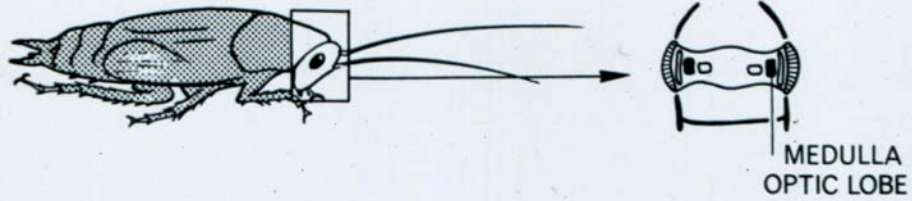
two Syrian hamster brothers: tau ++ and tau --

HUMANS ?

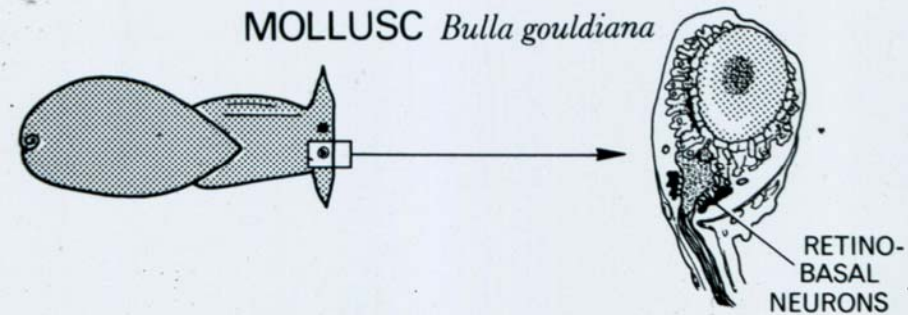


CIRCADIAN PACEMAKERS

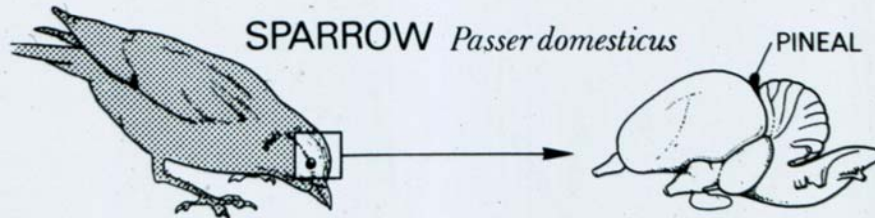
COCKROACH *Leucophaea maderae*



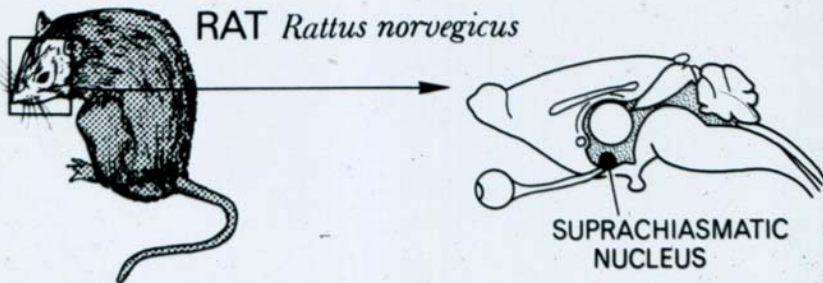
MOLLUSC *Bulla gouldiana*



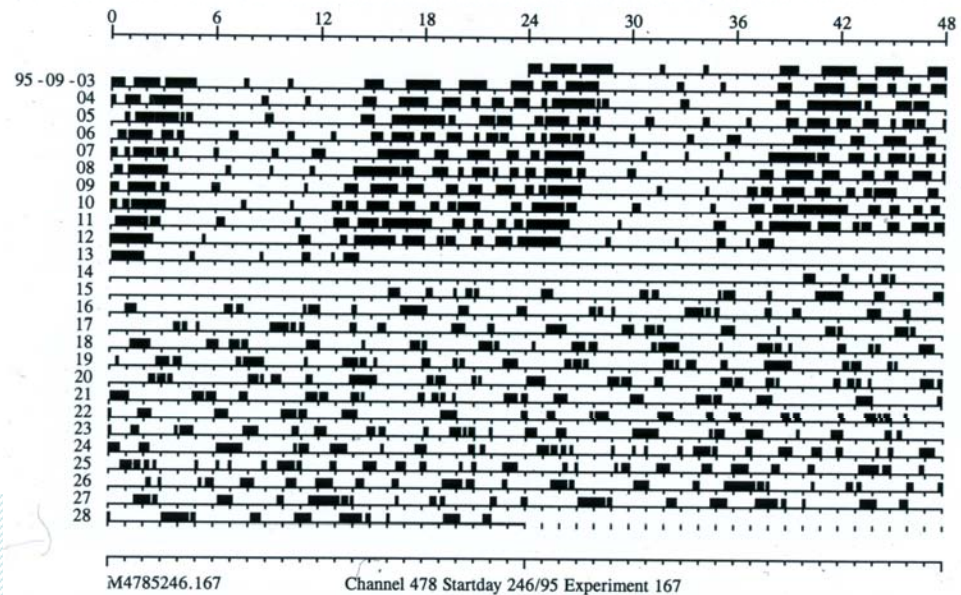
SPARROW *Passer domesticus*



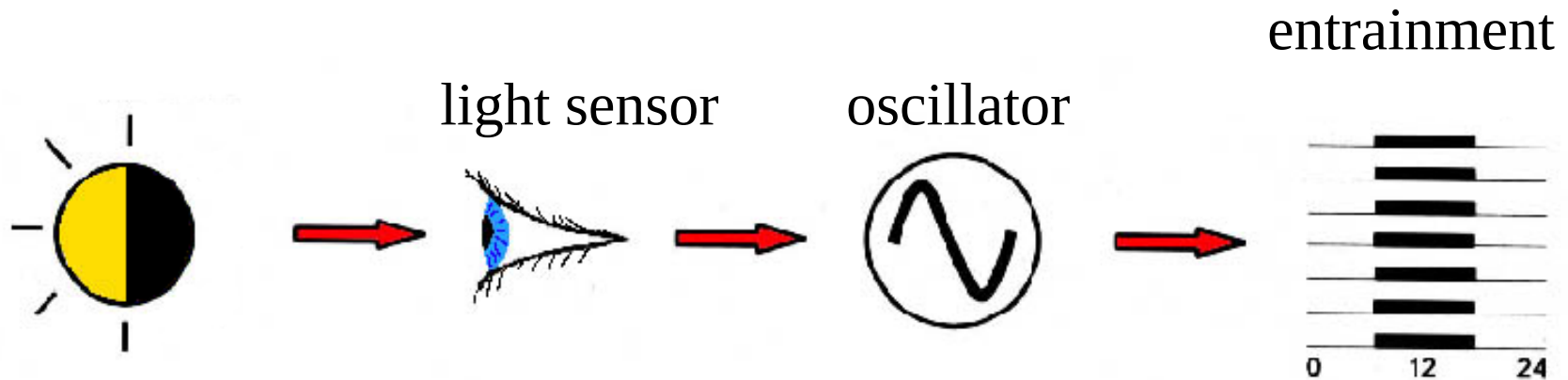
RAT *Rattus norvegicus*



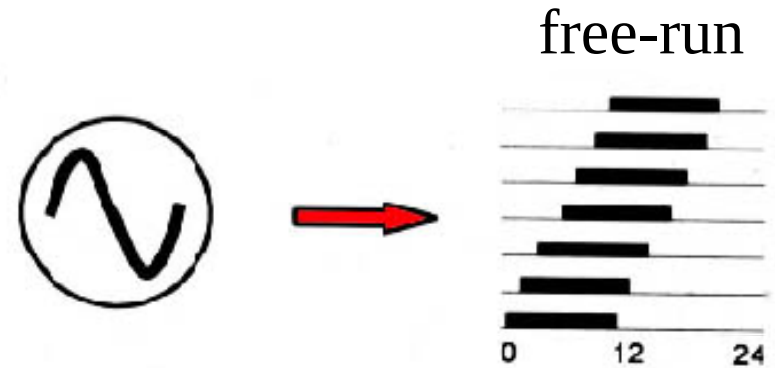
SCN



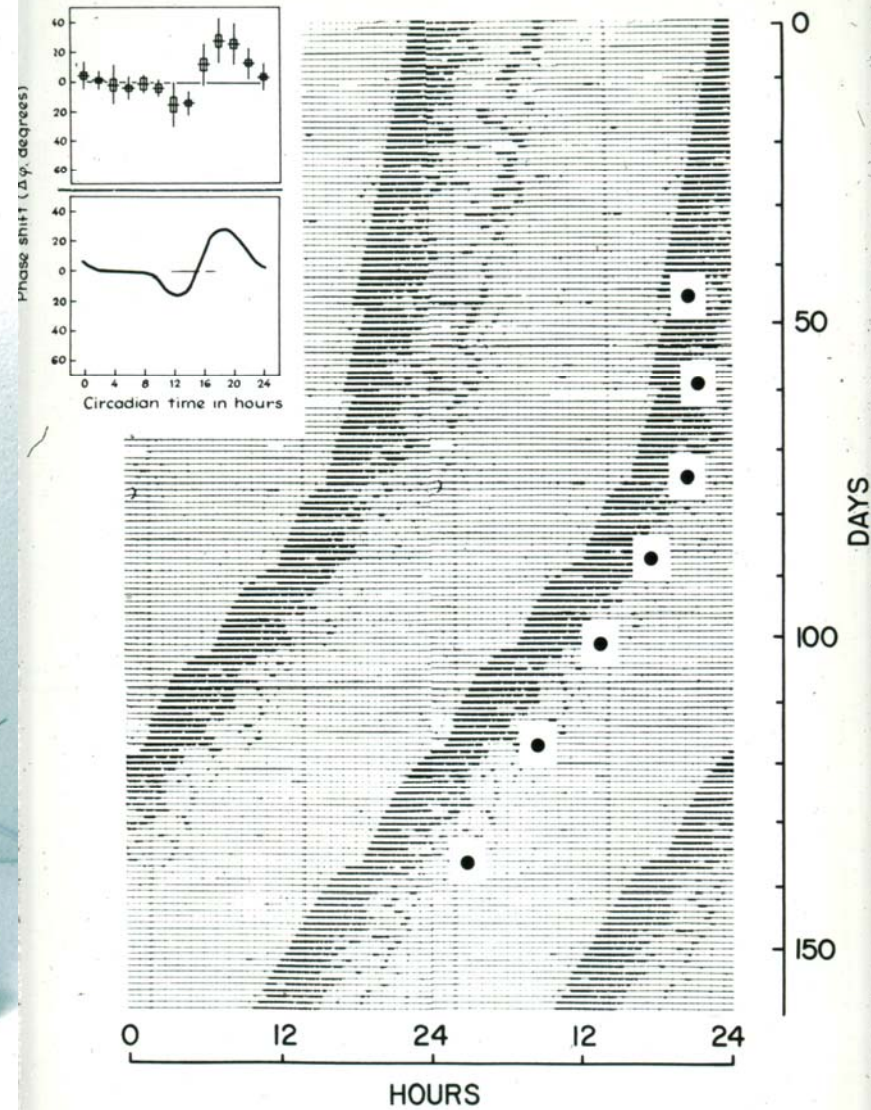
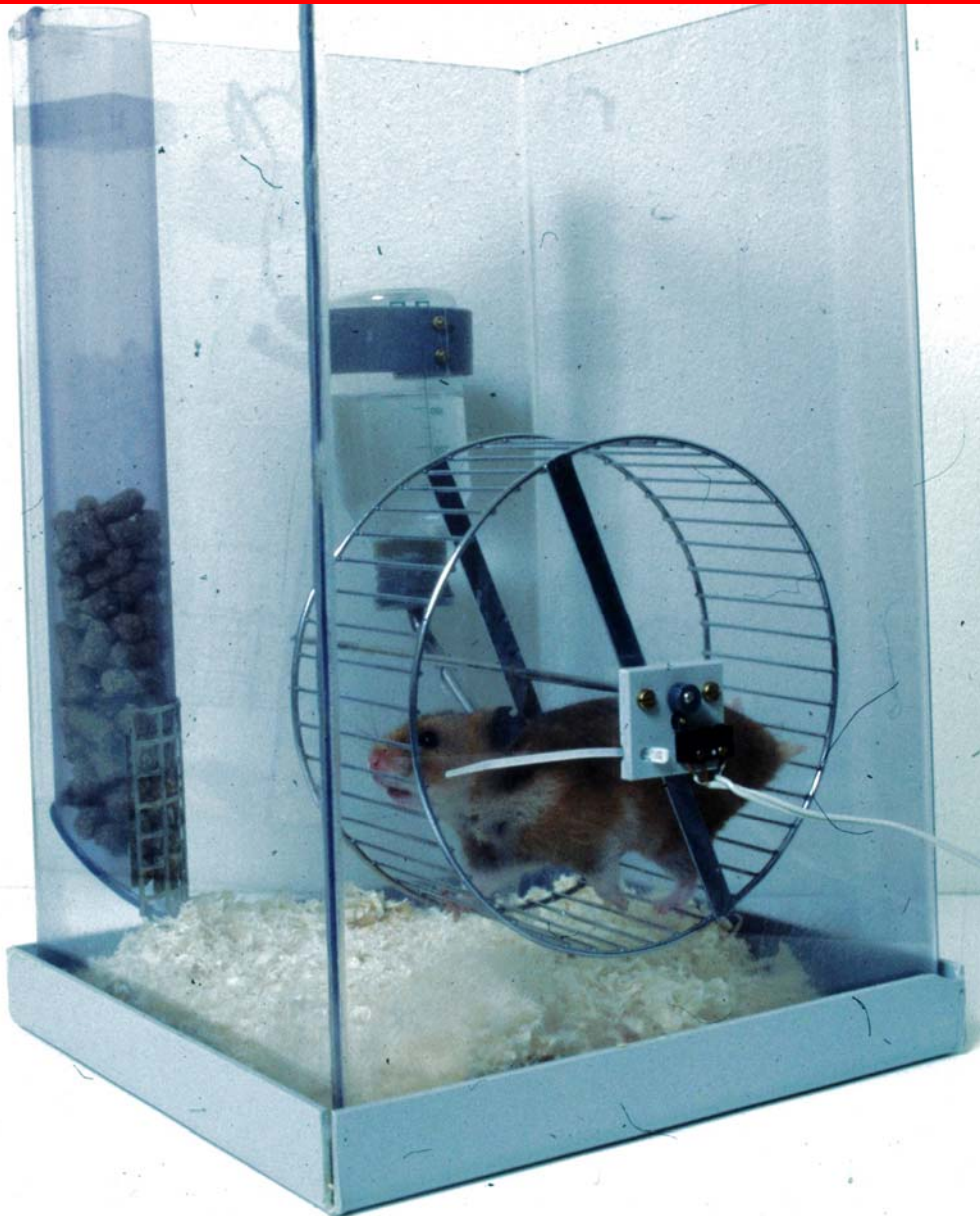
a biological oscillator, synchronized by light



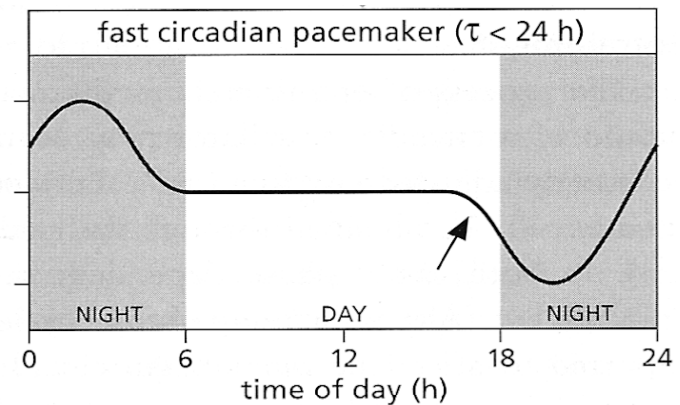
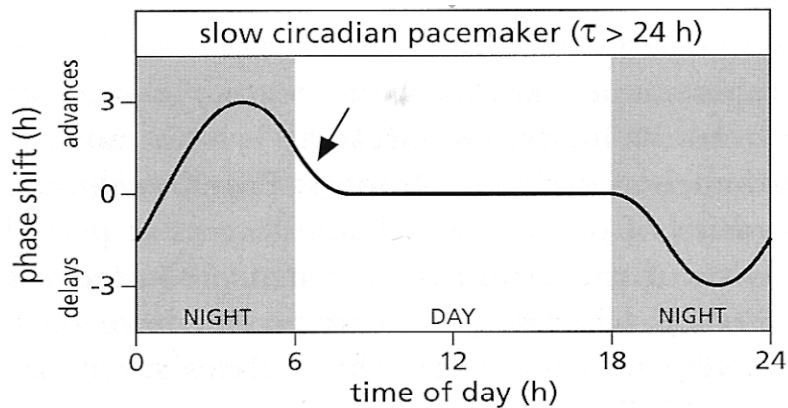
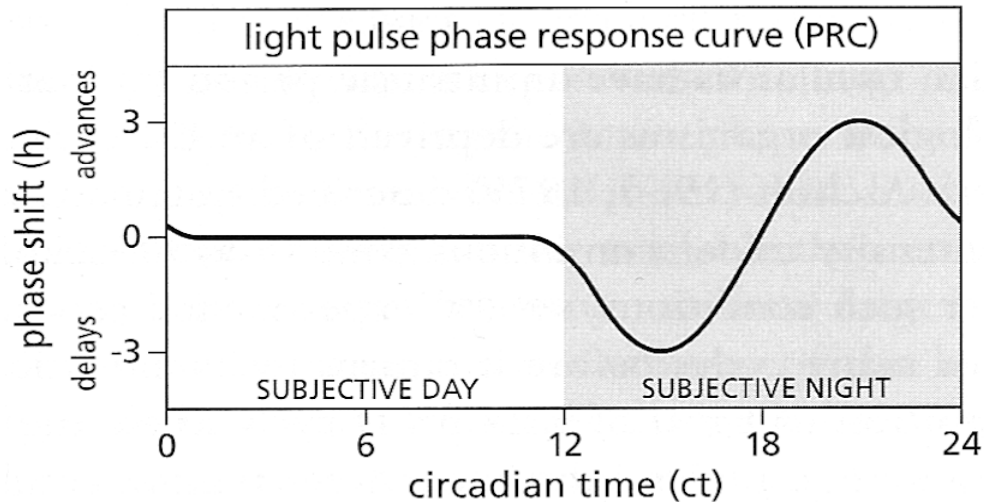
circa - dian:



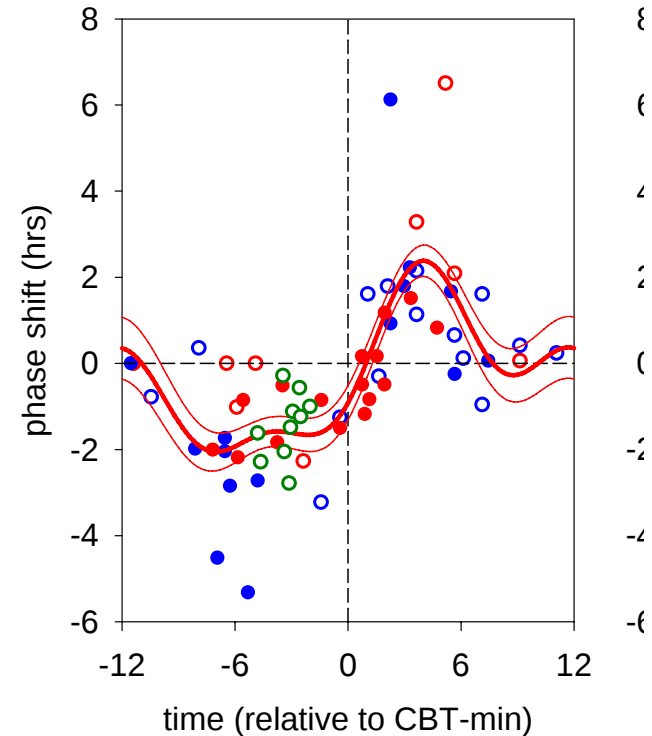
synchronization by light: PRC



phase response curve: self-correction



the first human phase response curve for light



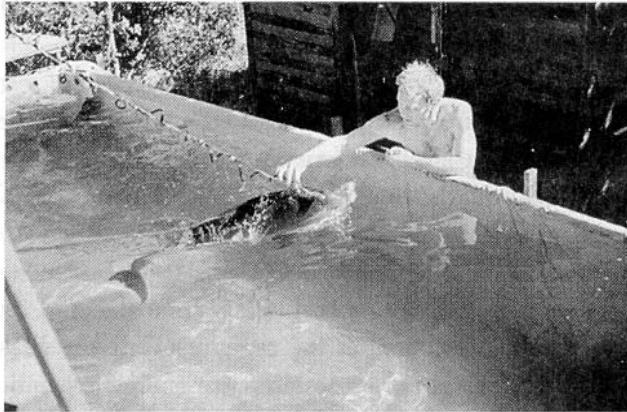
- Honma and Honma 1988, n = 9
- Minors et al 1991, n = 15
- Dawson et al 1993, n = 16
- Van Cauter et al 1994, n = 15
- Rüger et al 2003, n = 10

mammals and birds: two different sleep states

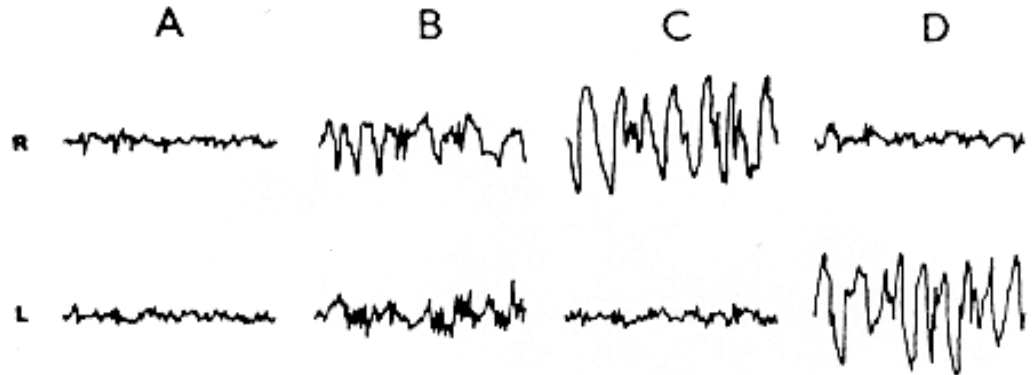
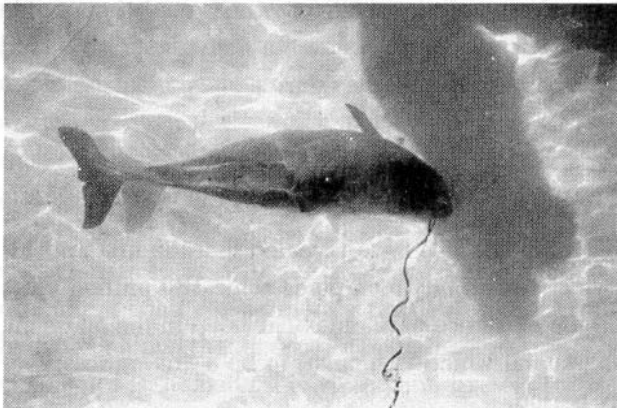


- non rapid-eye-movement (NREM) sleep:
slow-wave sleep
- rapid-eye-movement (REM) sleep

dolphins: brain halves alternate sleep



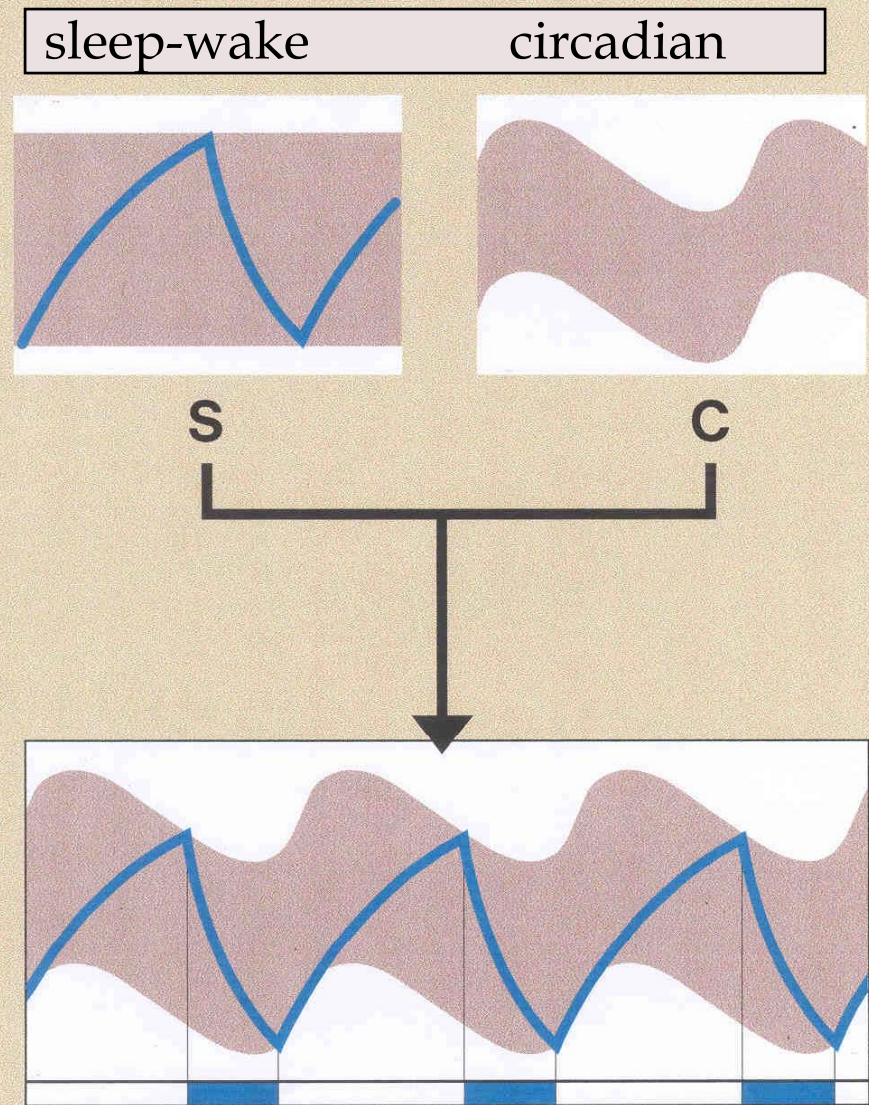
DOLPHIN



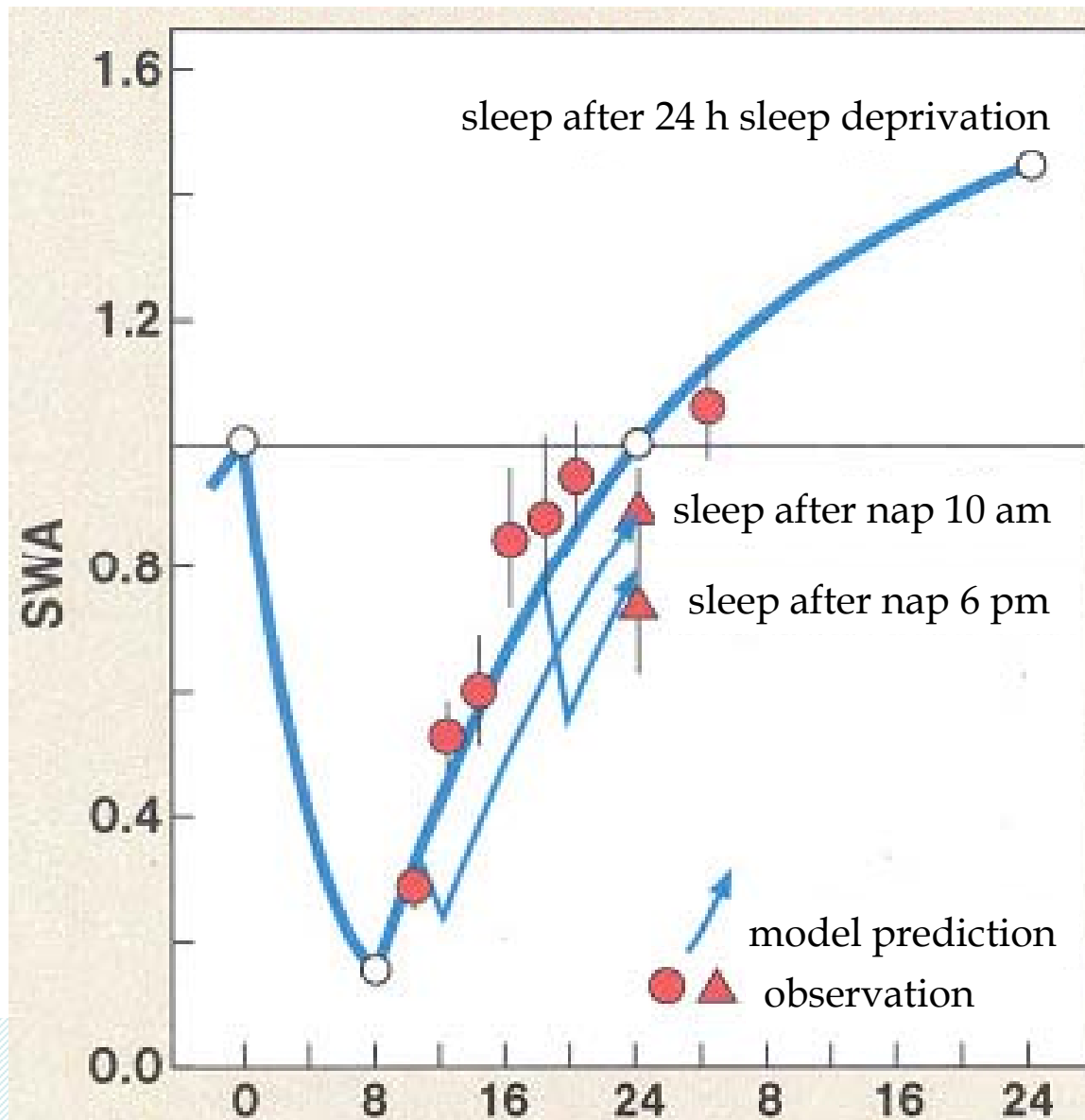
sleep lost by one half of the brain can not be compensated by the other !

the 2 process model

a need buildup – need reduction
process, synchronized by the
circadian pacemaker



one of many model tests



function of slow wave activity ?

glycogen buildup ? synaptic downscaling ? memory ?

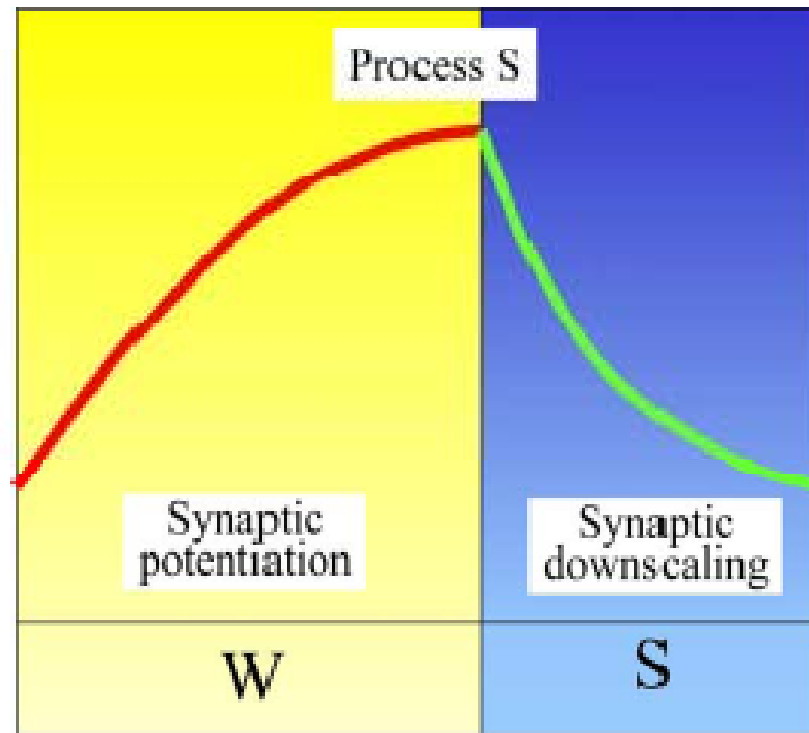


Fig. 1 The two-process model involving the circadian component (process C) and the homeostatic component (process S).

Main points

day:
endogenous circadian clocks, synchronized by light, gently controlling activity and maintenance processes such as sleep, essential for survival and reproduction

week ?

a weekly rhythm in weather ?

“Daily precipitation records for 219 surface observing stations in the United States for the 42- year period 1951-1992 are investigated for weekly cycles in precipitation.

Results indicate that neither the occurrence nor amount of precipitation significantly depends upon the day of the week.”

the week

is not a cosmic but a cultural cycle

Week of 7 days imposed on Christianity by Emperor
Constantin

In other cultures weeks of other lengths:

e.g.,	Maya	20 days
	Roman empire	8 days
	Christian Lithuania	9 days

claims of biological ‘**circaseptan**’ rhythms rarely substantiated

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week:

not a cosmic cycle, but a cultural, behavioural cycle, possibly originally associated with market synchrony, and now massively affecting life and perhaps environment

month ?

the month





exploiting the moon: grunion spawning

the moon and human behaviour ?

- popular belief that the moon cycle influences human physiology, behaviour and health.
- an influence of the moon was presumed in alchemy, mythology and astrology.
- The word '**lunatic**' has been around since the 13th century to describe a recurring insanity dependent on the phases of the moon.
- “Many investigations relating lunar phase to admissions to psychiatric hospitals, general practice consultation rates, spontaneous deliveries, attempted suicides, crisis calls, or epileptic seizures failed to show an association.”

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not a cosmic cycle, but a cultural, behavioural cycle, possibly originally associated with market synchrony, and now massively affecting life and perhaps environment

month:

exploited by some animals for reproductive synchronization; by humans for ritual synchrony; virtually no biological influence

year ?

Breeding seasons

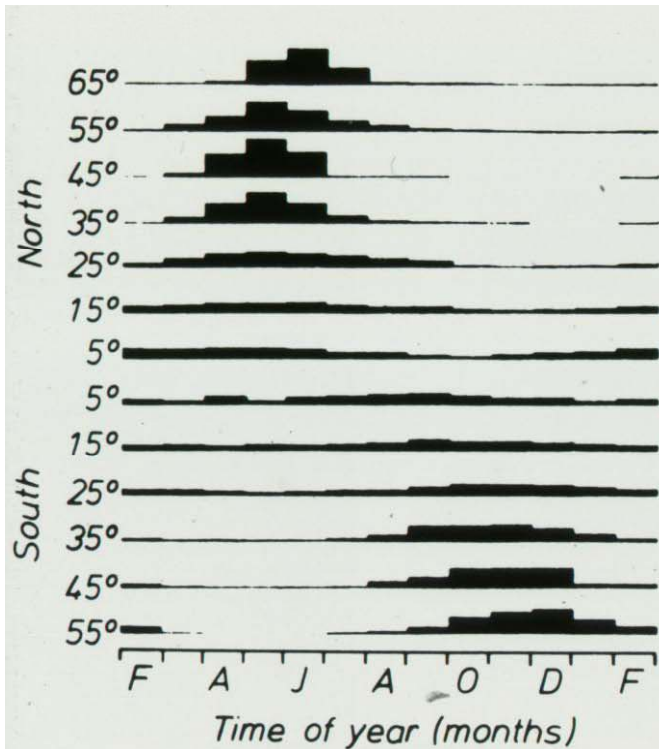
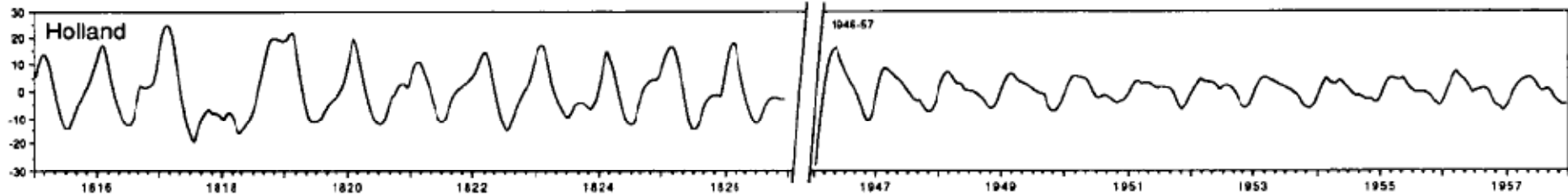


Fig. 1. Distribution of avian breeding seasons as a function of latitude. Diagrams show the relative numbers of times that fresh or incubated eggs have been found in each 10° of latitude, the means of which are given in the left-hand margin. (After Baker, 1938b.)

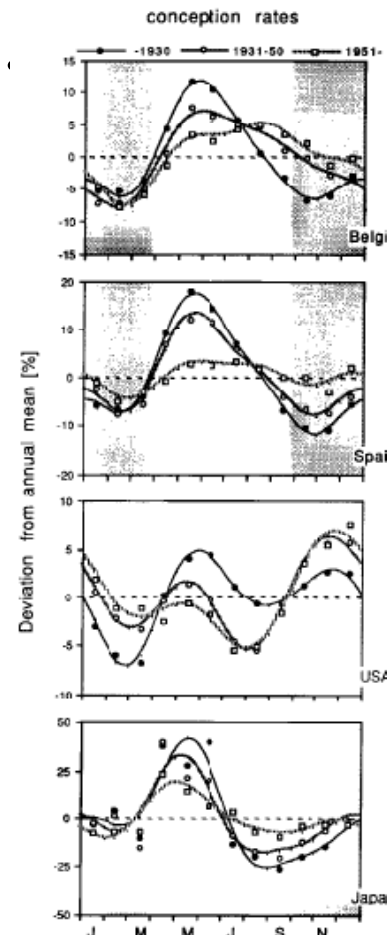
Seasonality in humans



1816.....1826

1947....

.....1957



Belgium

Spain

USA

Japan

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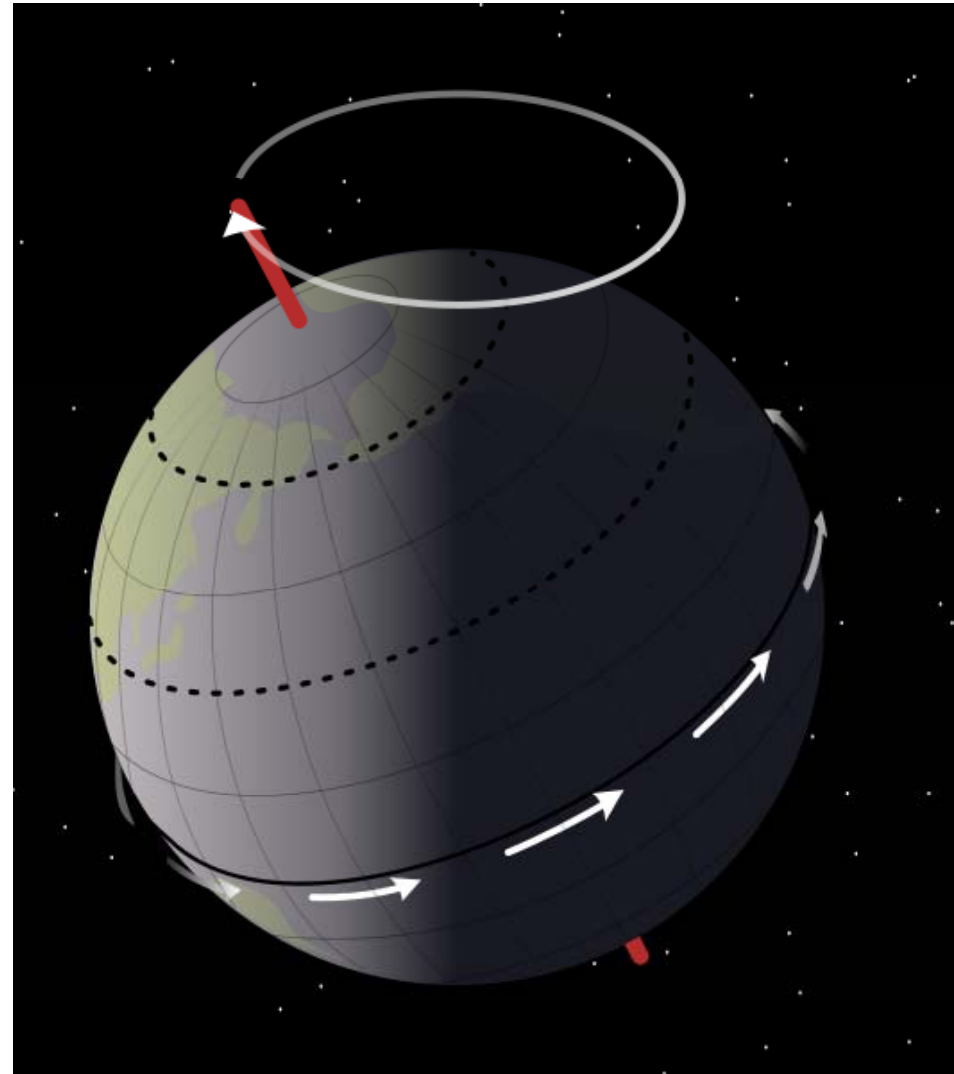
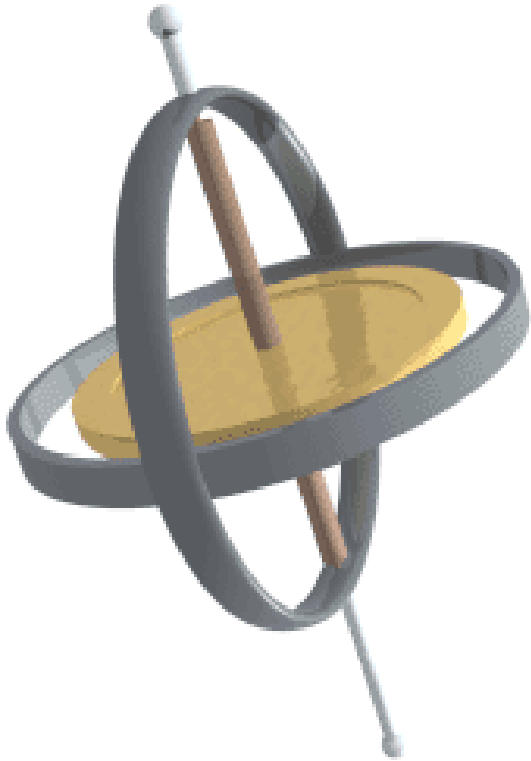
exploited by some animals for reproductive synchronization; by humans for ritual synchrony

year:

of vast importance for periodic reproduction, migration, hibernation, *etcetera*;
also in humans, although we gradually have escaped from the annual environmental periodicity

precession ?

precession



Main points

day:

endogenous circadian clocks, synchronized by light, gently controlling activity and maintenance processes such as sleep, essential for survival and reproduction

week:

not a cosmic cycle, but a cultural, behavioural cycle, possibly originally associated with market synchrony, and now massively affecting life and perhaps environment

month:

exploited by some animals for reproductive synchronization; by humans for ritual synchrony

year:

of vast importance for periodic reproduction, migration, hibernation, *etcetera*; also in humans, although we gradually have escaped from the annual environmental periodicity

precession and other long-term cycles:

- massive but slow periodicities in climate, including glaciations, with occasional severe effects (such as the demise of Maya culture by drought in the 9th century)
- current global change in climate much faster and likely to be locally lethal, but globally less threatening than the exhaustion of energy and food reserves

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Hokkaido University

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