

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
- the week
- the month
- the year
- precession

24 h 7 days 29.53 days 365.25 days ~23,000 years

Suslik = European ground squirrel

MCTQ - Munich ChronoType Questionnaire

On workdays (don't fill out if you are retired)		
l get up at …	<u>7:00</u> o'clock	
I need	min to w ake 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	_22:55o'clock	
and it then takes me	5min 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	e afterwards	



Roenneberg, Wirz-Justice & Merrow, 2002, J. Biol. Rhythms

timing of sleep: variation in the population

Midsleep time MCTQ Groningen 2003



Zavada et al (2004)

humans follow the sun, not social time



Roenneberg et al. Curr.Biol. 17 (2007)

"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?





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



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



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

sleep EEG Slow Wave Activity (SWA)



sleep has intensity ! more sleep need > deeper sleep

Achermann et al 1993

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).

Tononi and Cirelli 2006



day:

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



- "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

Main points

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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?

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



Breeding seasons



Seasonality in humans



Main points

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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





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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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