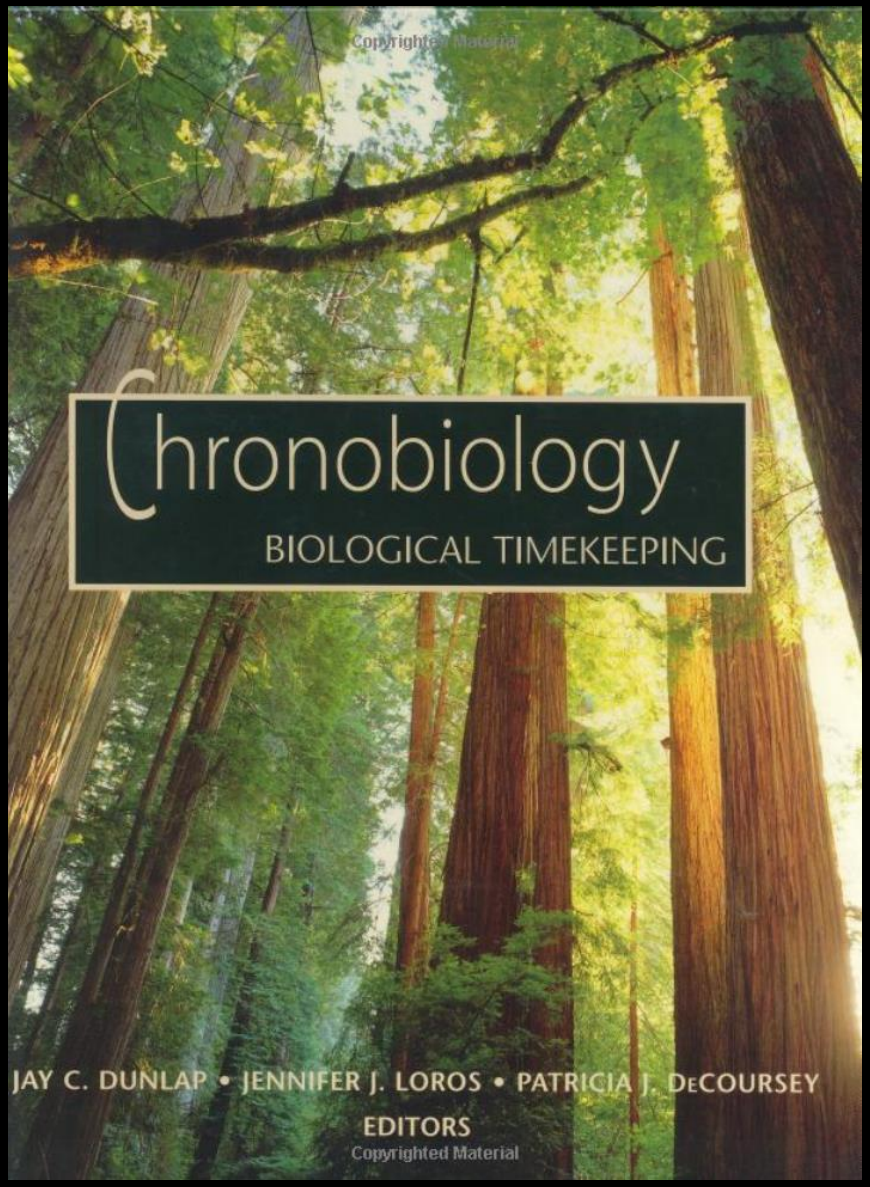

My paws are freezing!
Buddy, you think you've got problems!

Chronobiology -- daily rhythms and seasonality in animals

david.dolezel@entu.cas.cz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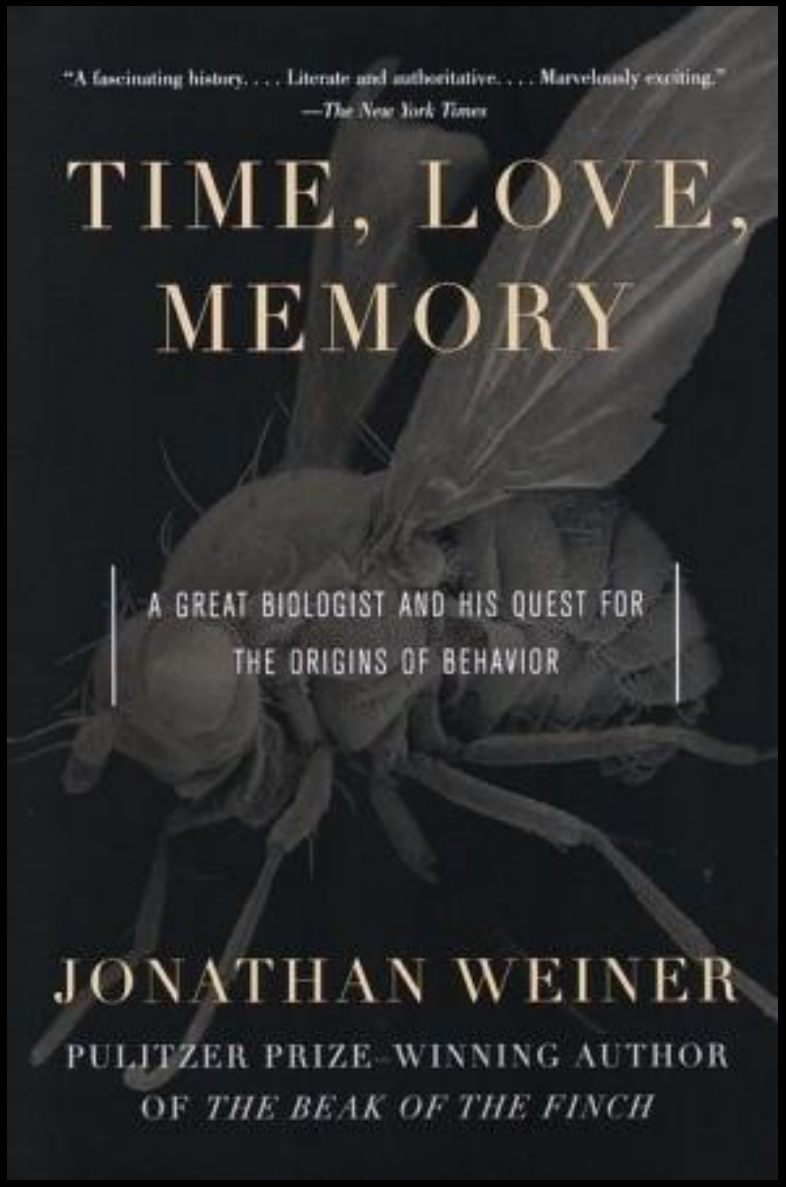
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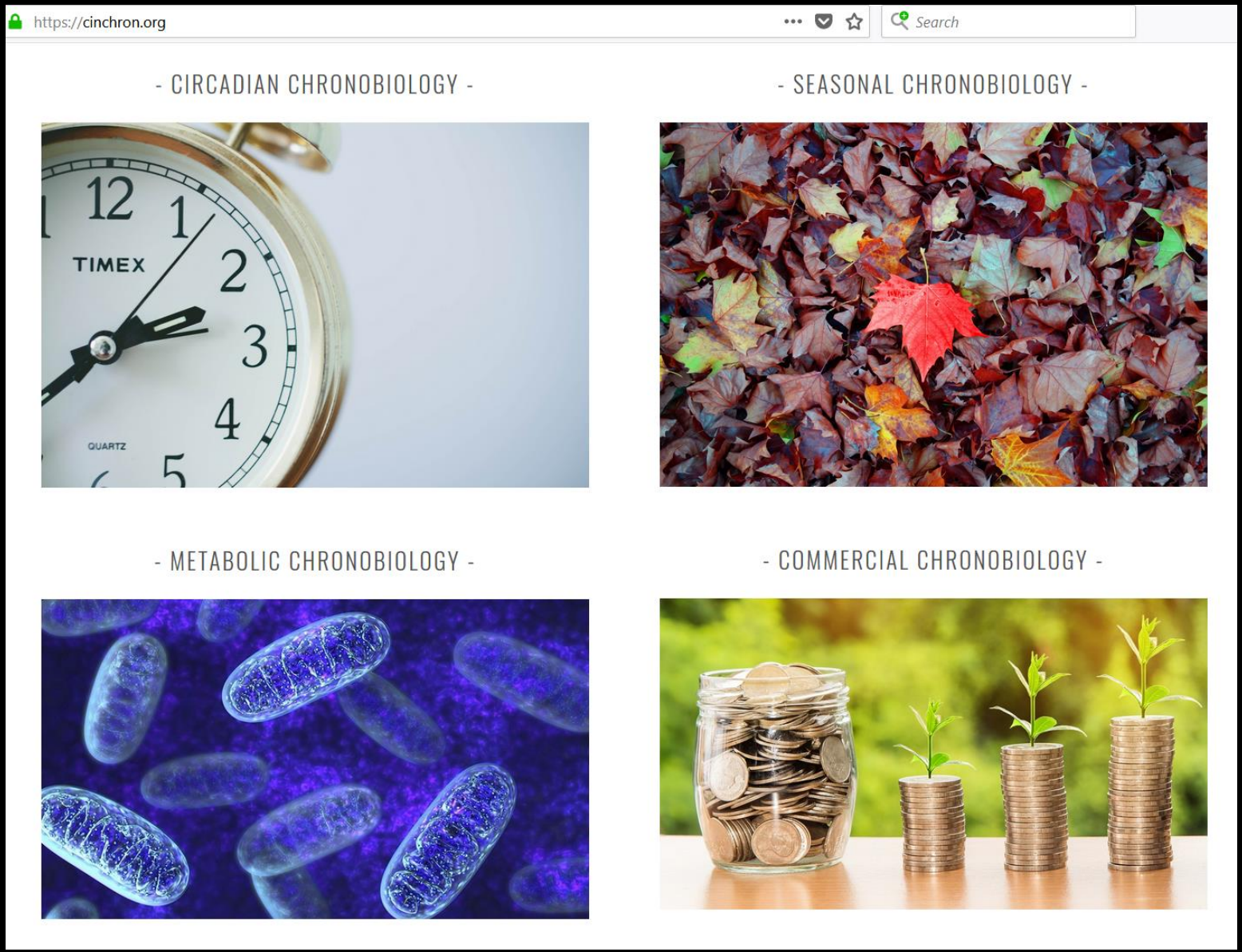
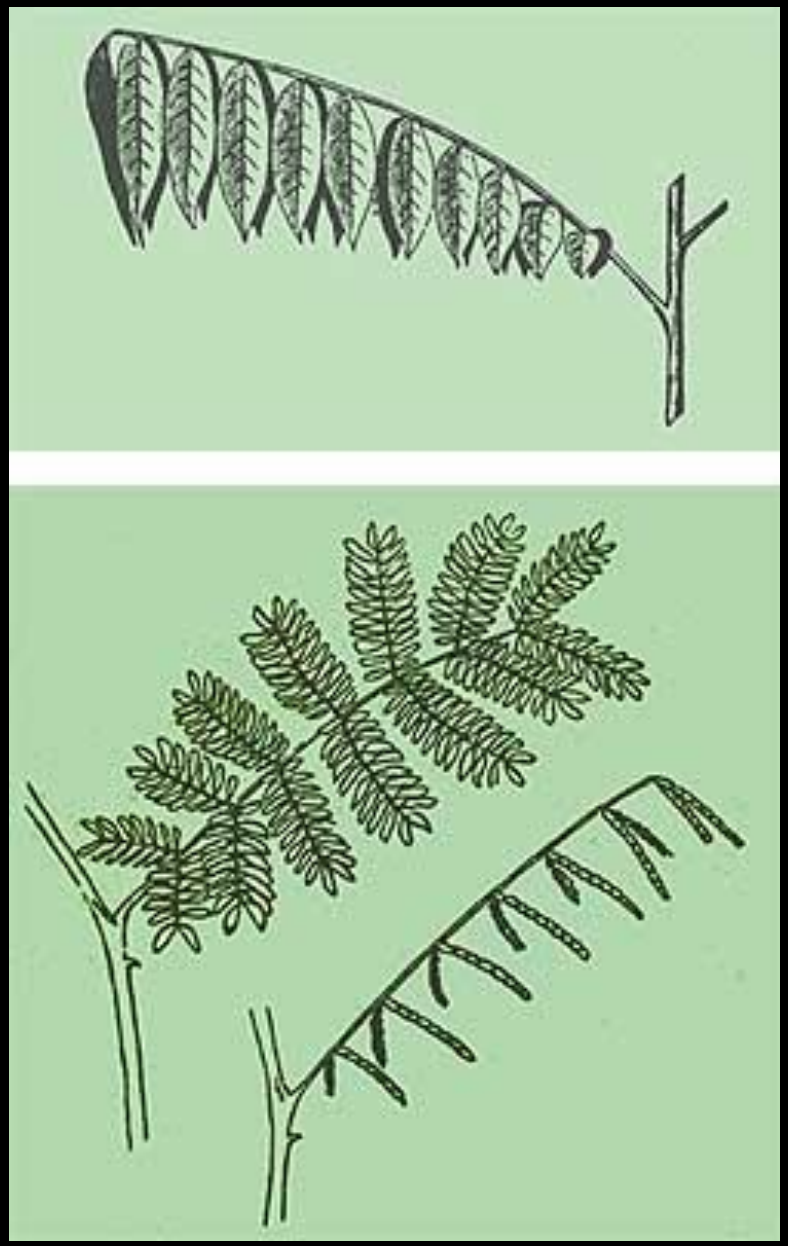


Insect Photoperiodic Timer

CRISPR/CAS9 gene editing
Population genetics
Insect neuropeptides

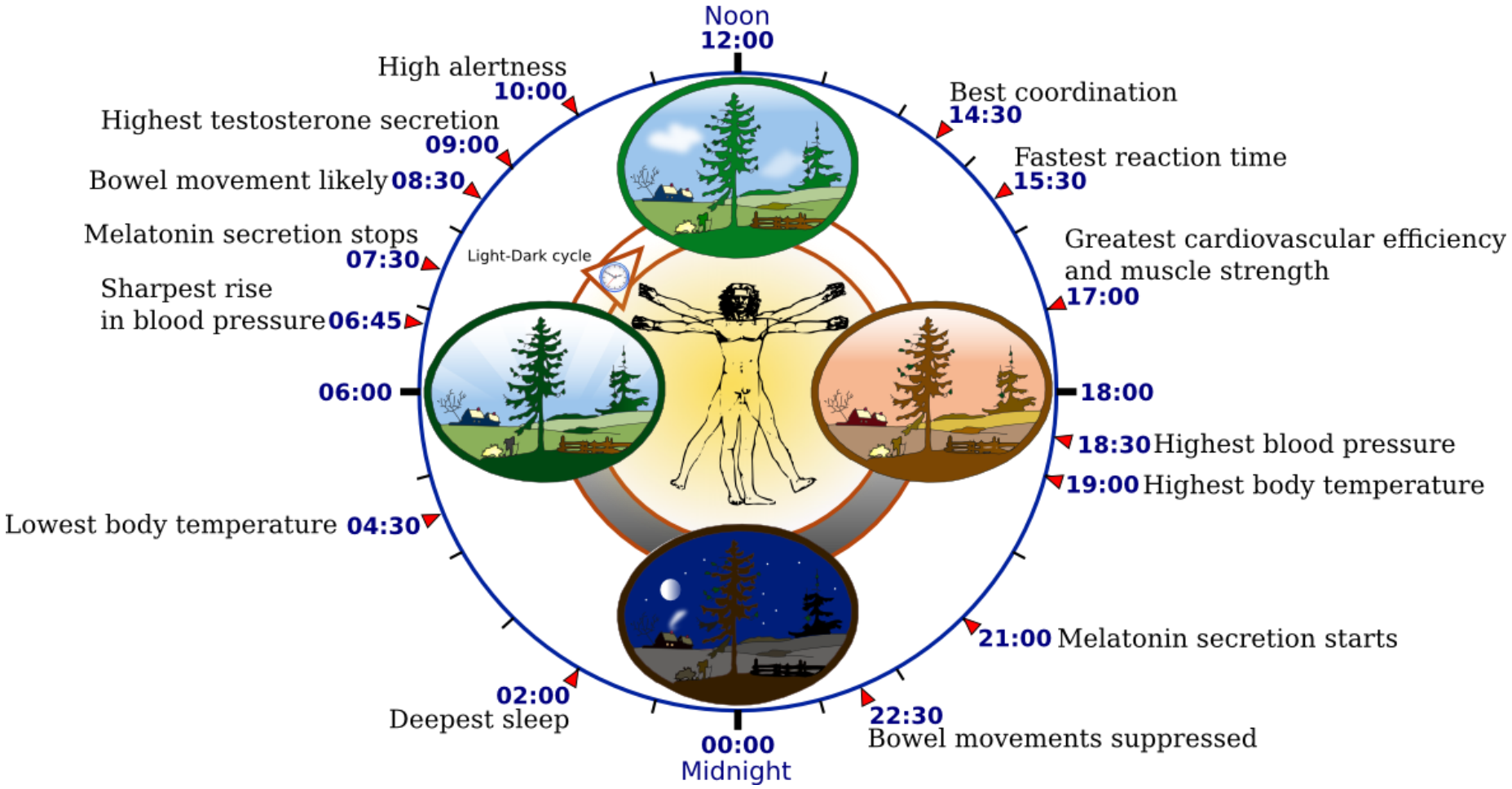
david.dolezel@entu.cas.cz

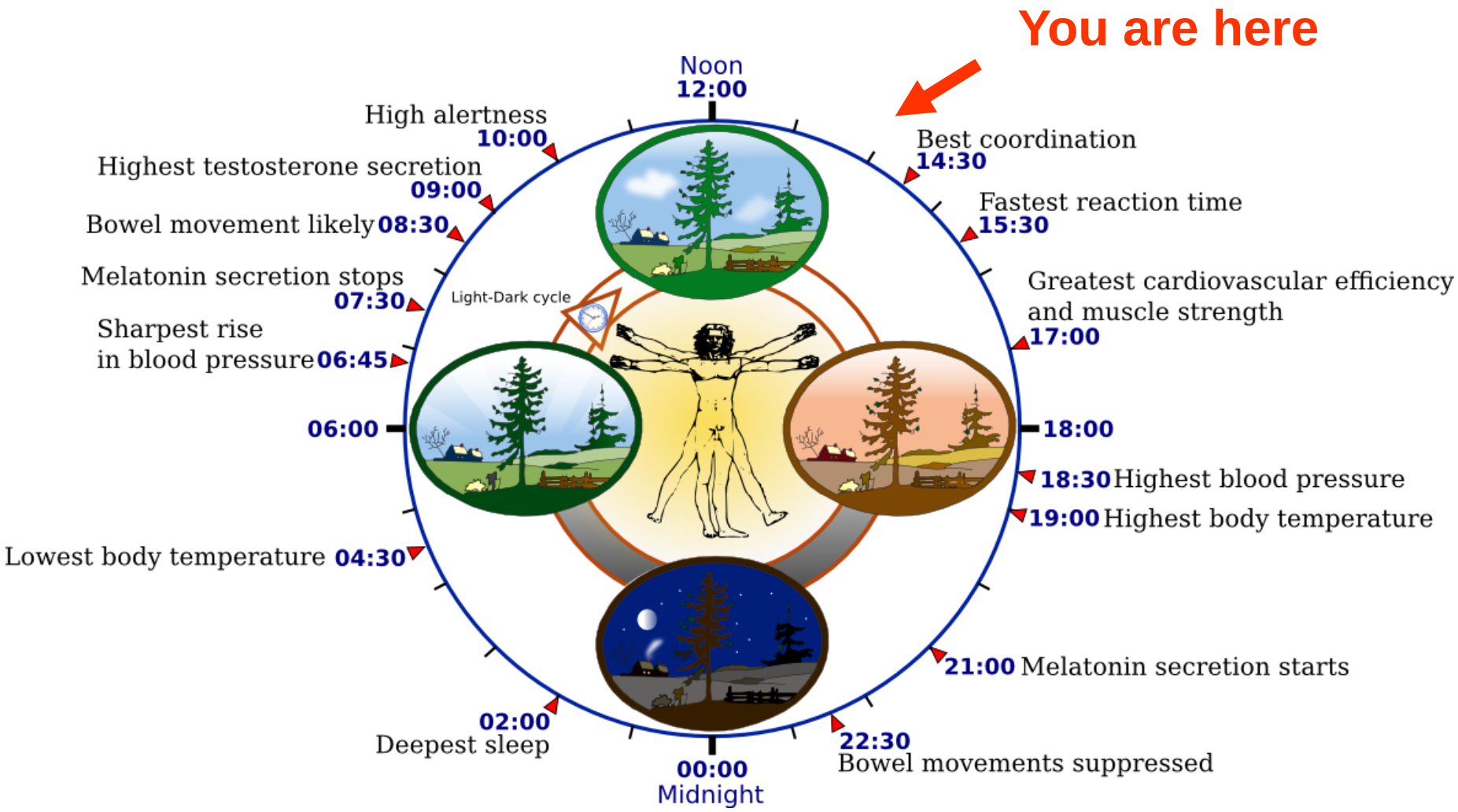
CIRCADIAN RHYTHM



Jean-Jacques d'Ortous de Mairan, 1729

CIRCADIAN RHYTHM


Noon
12:00
High alertness
10:00
Best coordination
14:30
Highest testosterone secretion
09:00
Fastest reaction time
15:30
Bowel movement likely
08:30
Melatonin secretion stops
07:30
Light-Dark cycle
Greatest cardiovascular efficiency
and muscle strength
17:00
Sharpest rise
in blood pressure
06:45
06:00
18:00
18:30
Highest blood pressure
19:00
Highest body temperature
Lowest body temperature
04:30
21:00
Melatonin secretion starts
02:00
Deepest sleep
22:30
Bowel movements suppressed
00:00
Midnight


You are here
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Highest blood pressure
18:00
Greatest cardiovascular efficiency
and muscle strength
17:00
Fastest reaction time
15:30
Best coordination
14:30
Light-Dark cycle


UNITED STATES
CANADA
1. MAINE
2. NEW HAMPSHIRE
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4. MASSACHUSETTS
5. RHODE ISLAND
6. CONNECTICUT
7. NEW JERSEY
8. DELAWARE
9. MARYLAND
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Olympic National Park
Olympia
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VIRGINIA
WEST VIRGINIA
PENNSYLVANIA
NEW YORK
WASHINGTON DC
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Yellow Stone National Park
Dinosaur National Monument
Mt. Elbert 4401 m
Yosemite National Park
Mt. Whitney 4421 m
Golden Gate Bridge
Zion N.P.
The Hoover Dam
Death Valley National Park
Copper Canyon
Houston space centre
Disney World
Kennedy Space Center Visitor Complex
Everglades National Park
Statue of Liberty
White House
NASA Headquarters
Niagara Falls
PACIFIC OCEAN
ATLANTIC OCEAN
Gulf of Mexico
MEXICO
THE BAHAMAS
CUBA
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HAWAII
Honolulu
Hilo
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State Boundary
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River
Major City
Sea Port
Country Capital
Airport
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30°N
40°N
50°N


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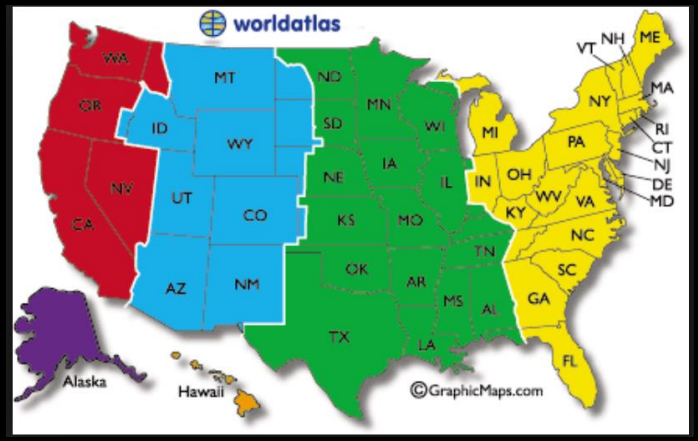


scientific correspondence

Nature 377, 583 (19 October 2002); doi:10.1038/377583a0

Baseball teams beaten by jet lag

LAWRENCE D. RECHT*, ROBERT A. LEW† & WILLIAM J. SCHWARTZ*

*Department of Neurology, University of Massachusetts Medical School, Worcester, Massachusetts 01655, USA
†Multipurpose Arthritis & Musculoskeletal Diseases Center, Department of Rheumatology and Immunology, Brigham and Women's Hospital, Boston, Massachusetts 02115, USA

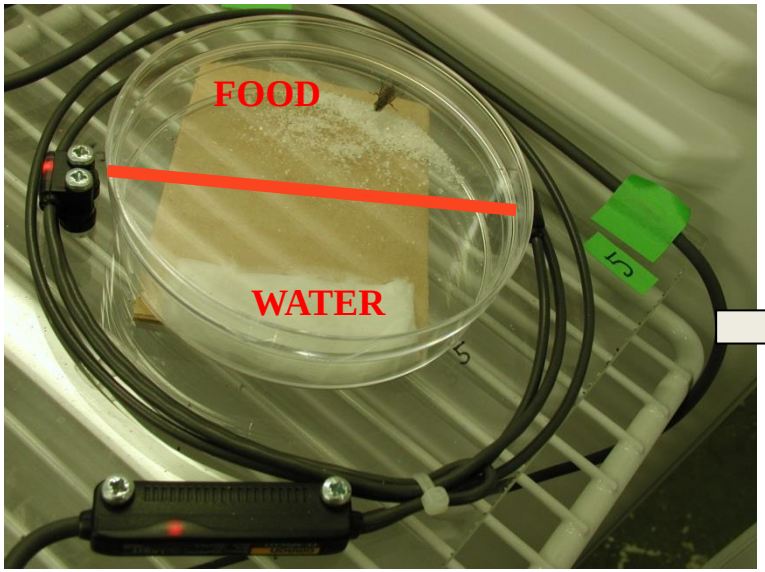
Out of the Zone: Jet-Lagged Baseball Teams Suffer Disadvantage

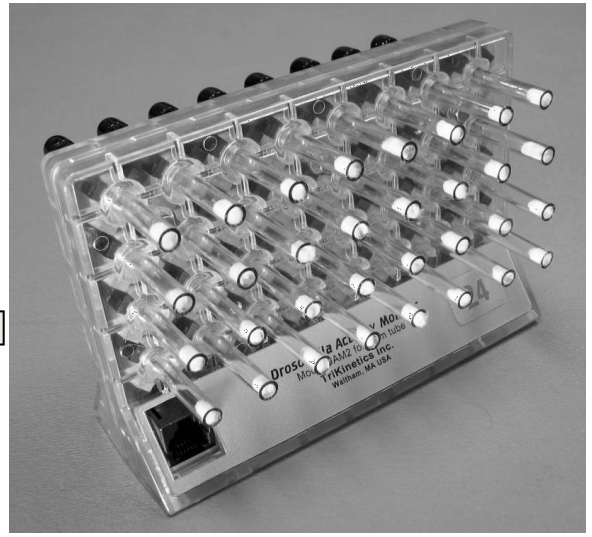
New research shows that long commutes affect a team's chances of winning

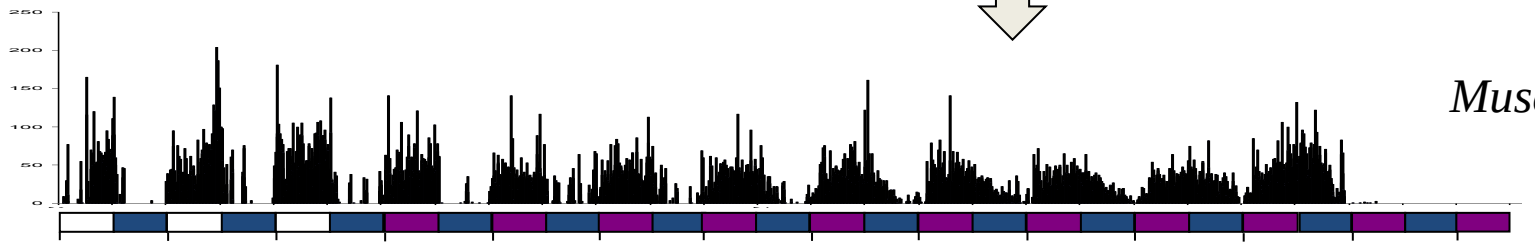
By Nikhil Swaminathan | June 10, 2008 | 0

The Science of Baseball
As Opening Day nears, we take a look at green stadiums, the physics of baseball, and other scientific underpinnings of the U.S. national pastime »
April 5, 2009

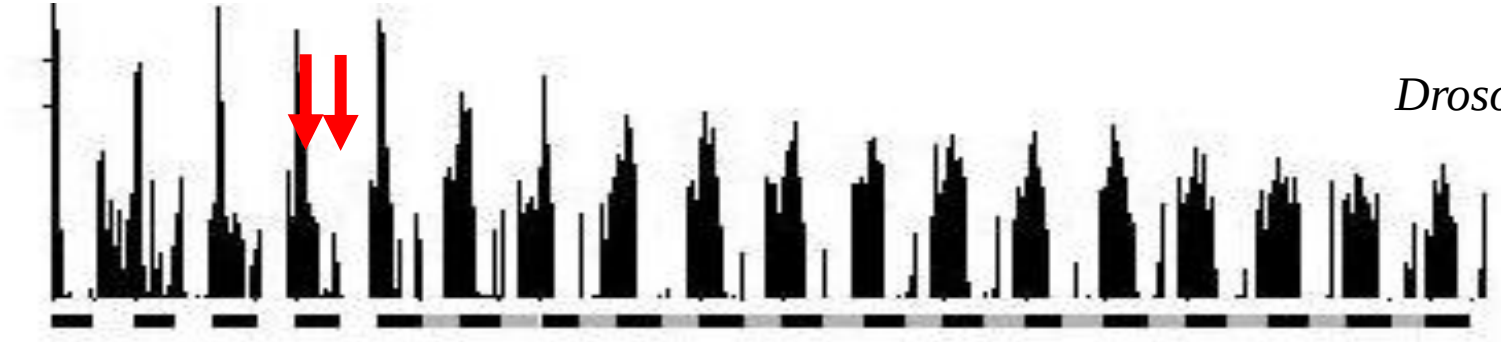
Betting on your favorite Major League Baseball team? You might want to reconsider if it has to cross three time zones to play. A new study shows that MLB teams that travel such distances to play a game could have up to a 60 percent chance of losing.







Musca



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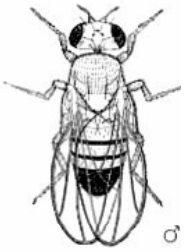

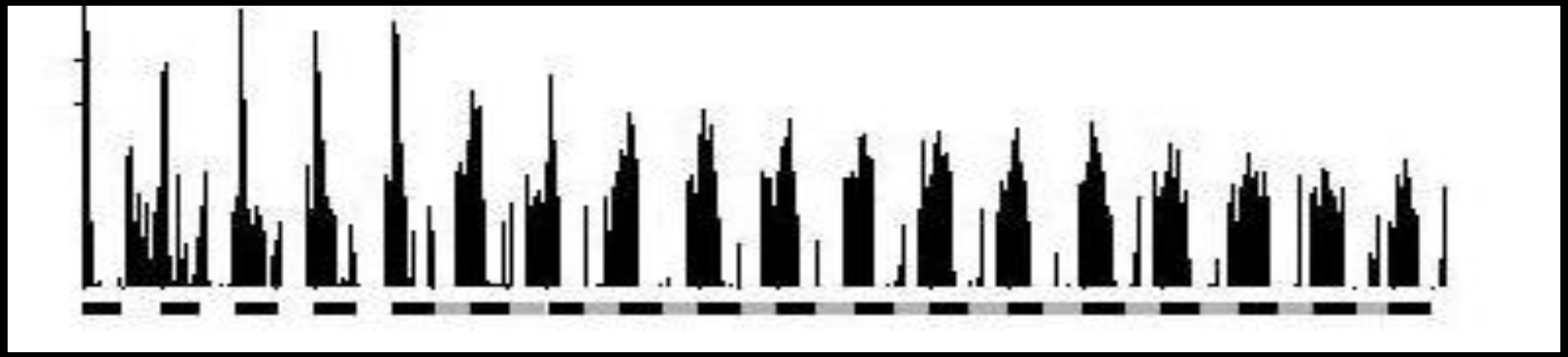

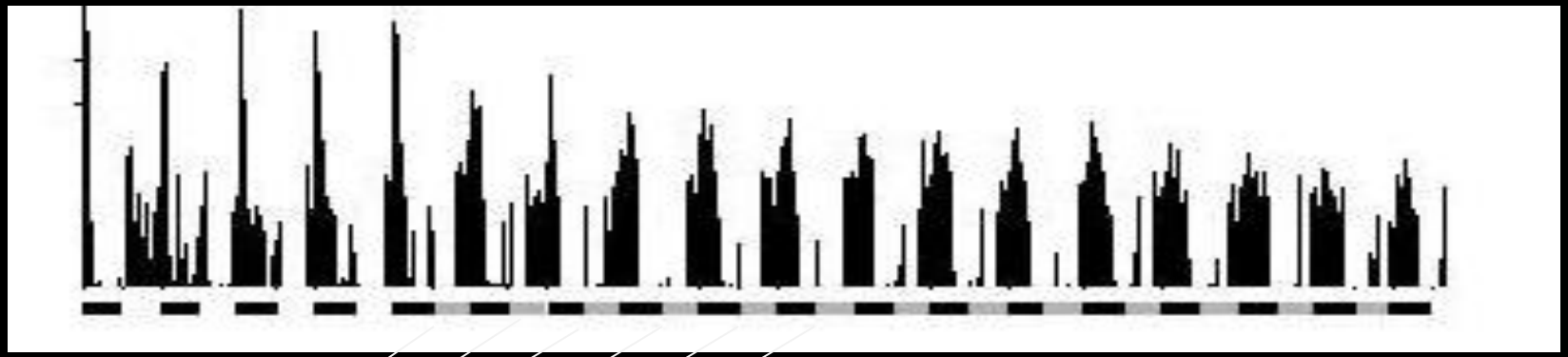

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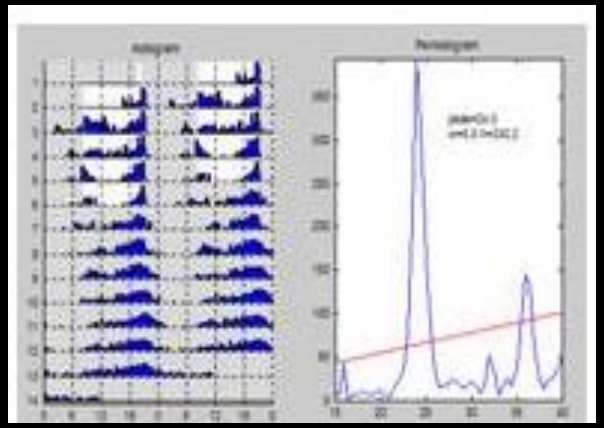

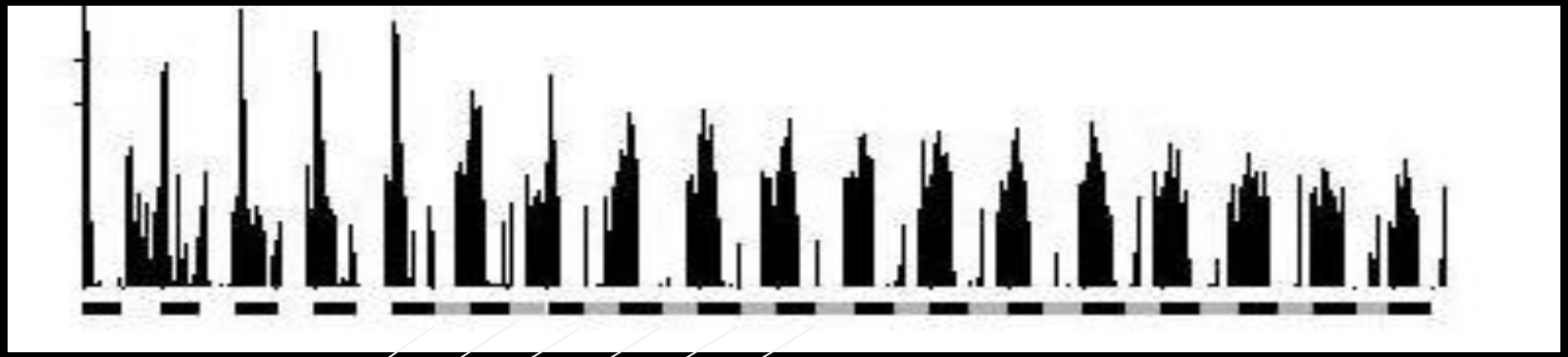

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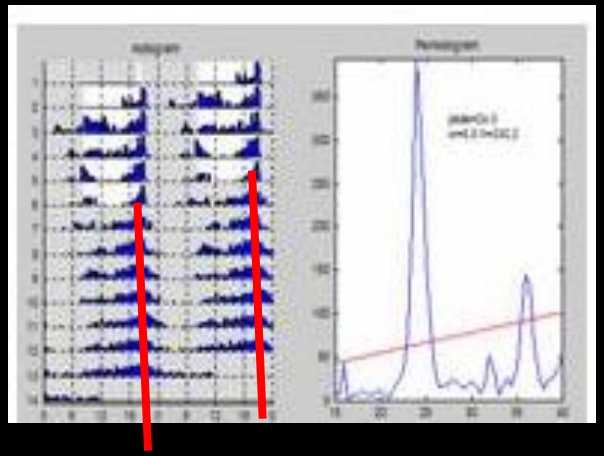

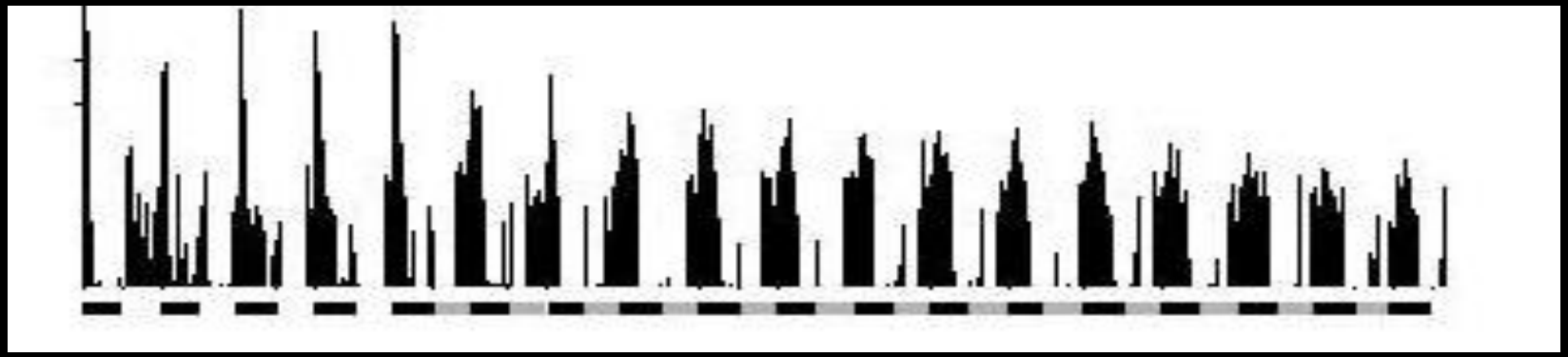

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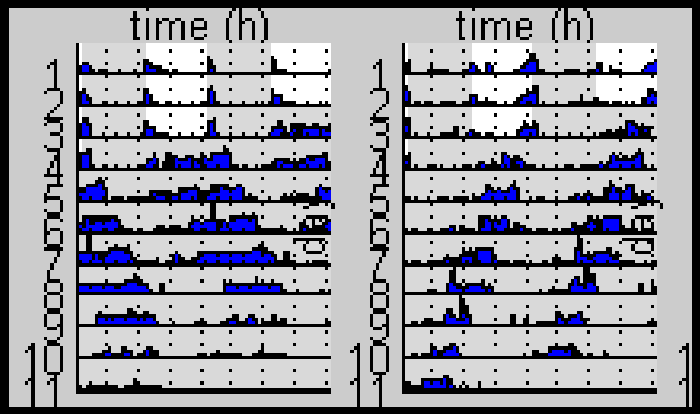

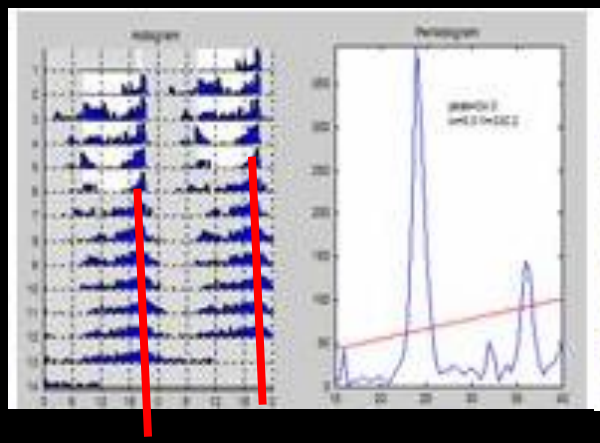

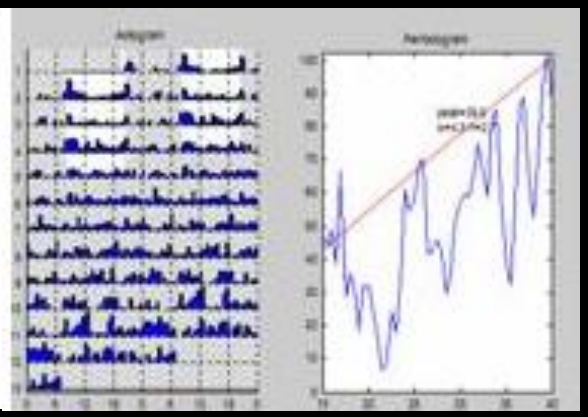

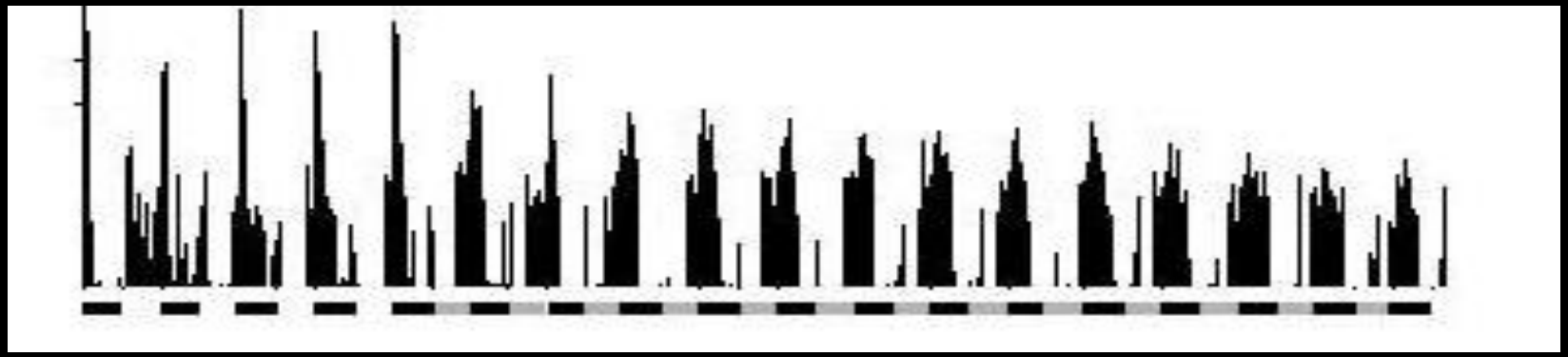

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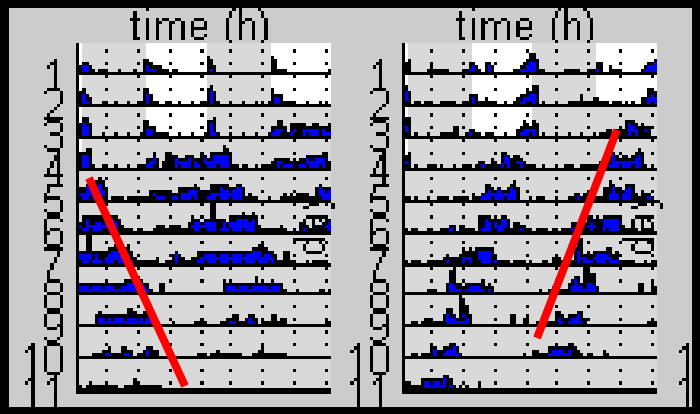
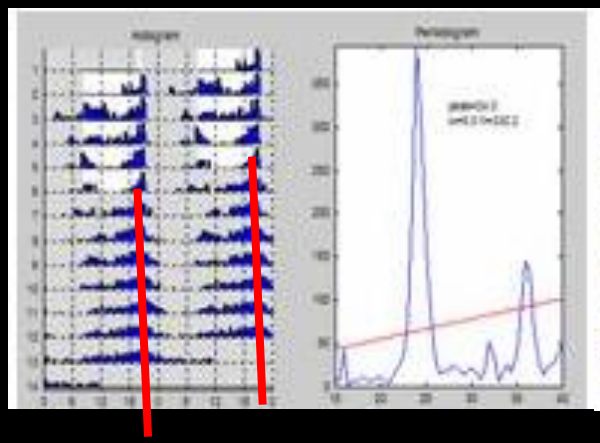
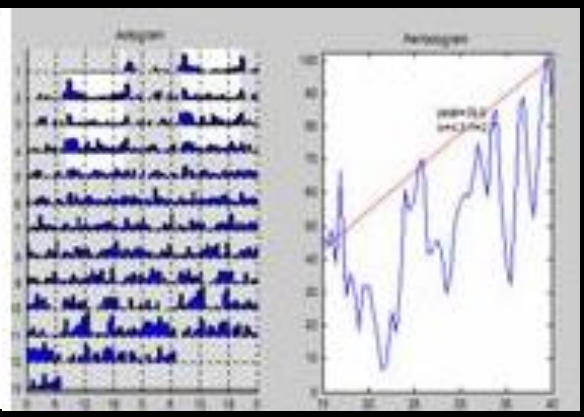


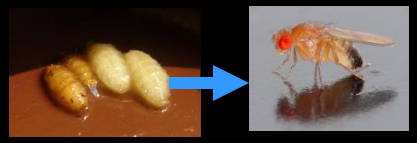


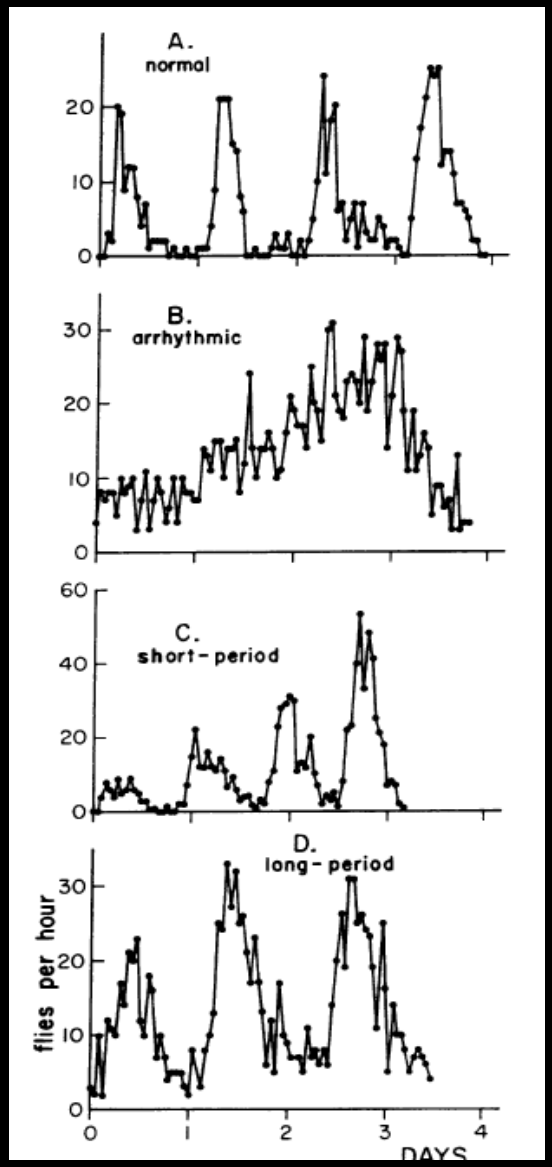


Circadian “mantra“

Circadian clocks are:

- Free running (e.g. in constant conditions)
- Entrainable (such as by light, among others)
- Temperature-compensated
- Genetically determined





Proc. Nat. Acad. Sci. USA
Vol. 68, No. 9, pp. 2112–2116, September 1971

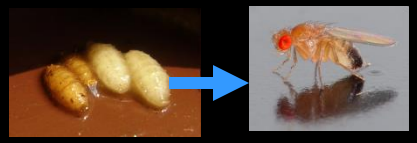
Clock Mutants of *Drosophila melanogaster*

(eclosion/circadian/rhythms/X chromosome)

RONALD J. KONOPKA AND SEYMOUR BENZER

Division of Biology, California Institute of Technology, Pasadena, Calif. 91109

Contributed by Seymour Benzer, July 2, 1971



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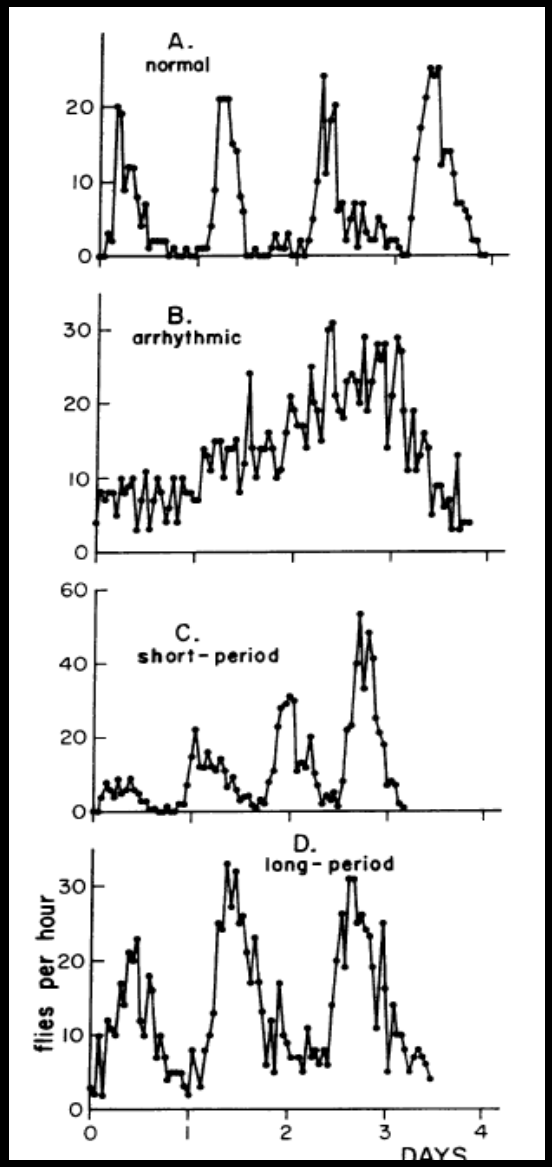

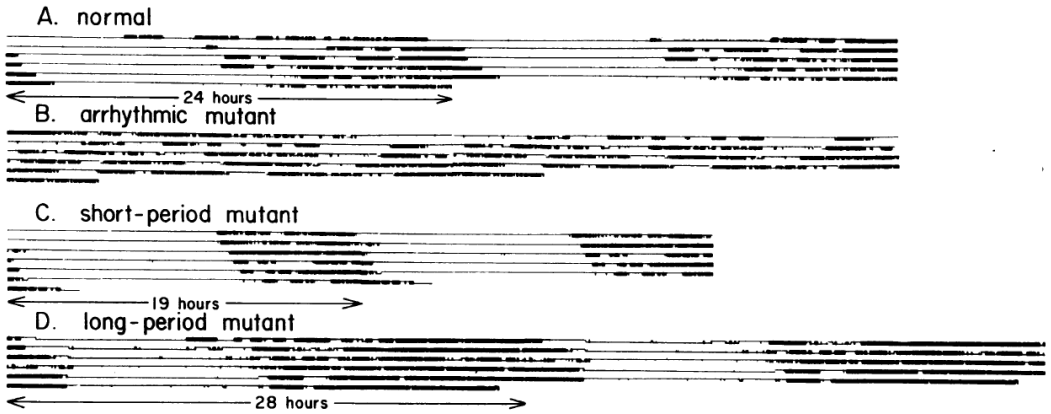

here

yellow period white

here

yellow

period

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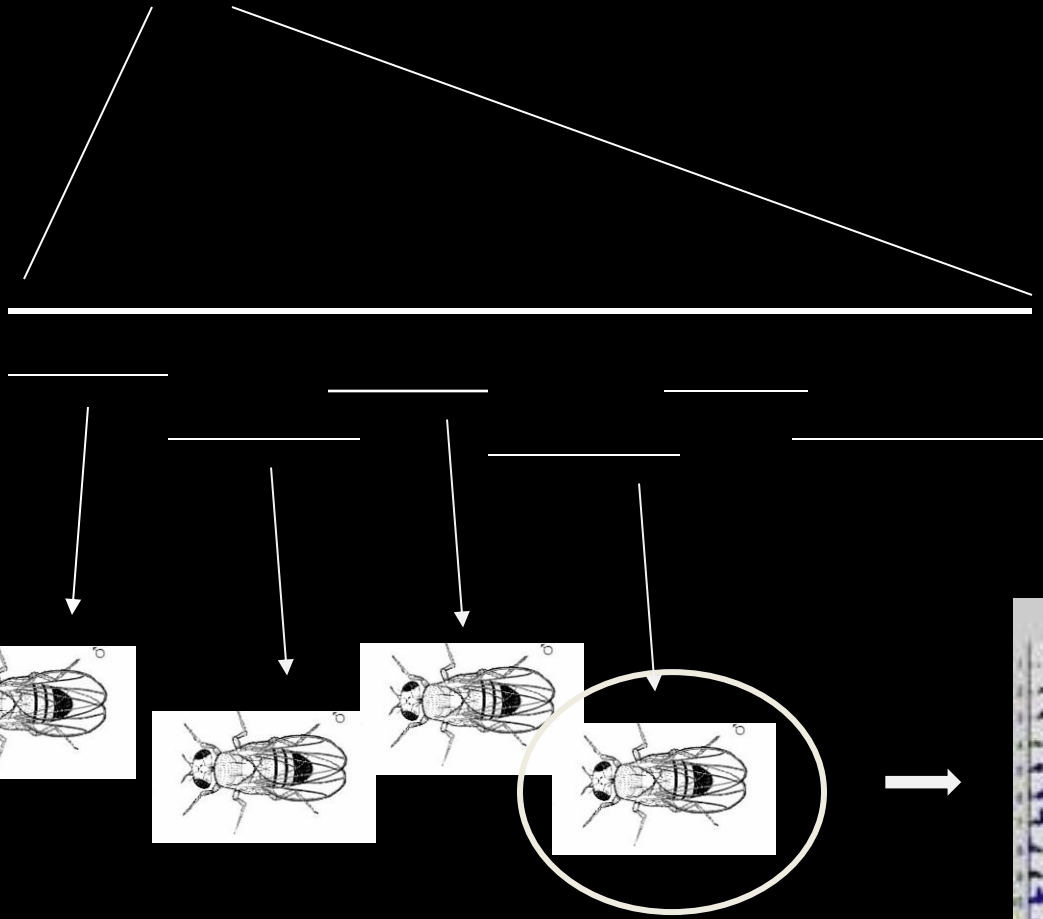

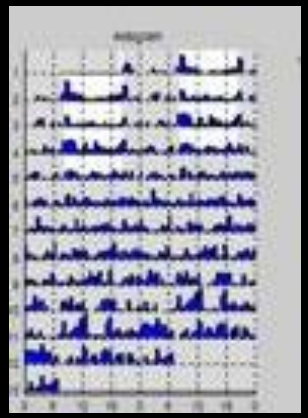

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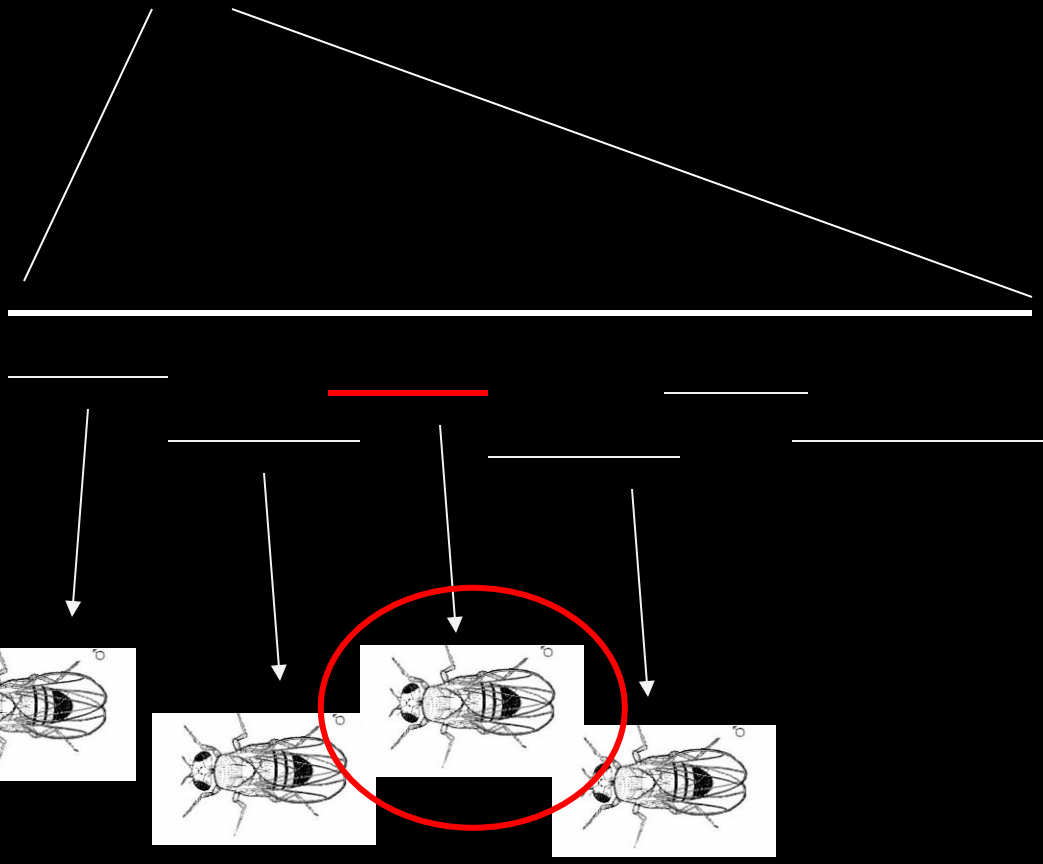

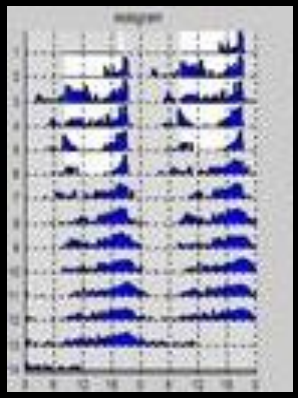


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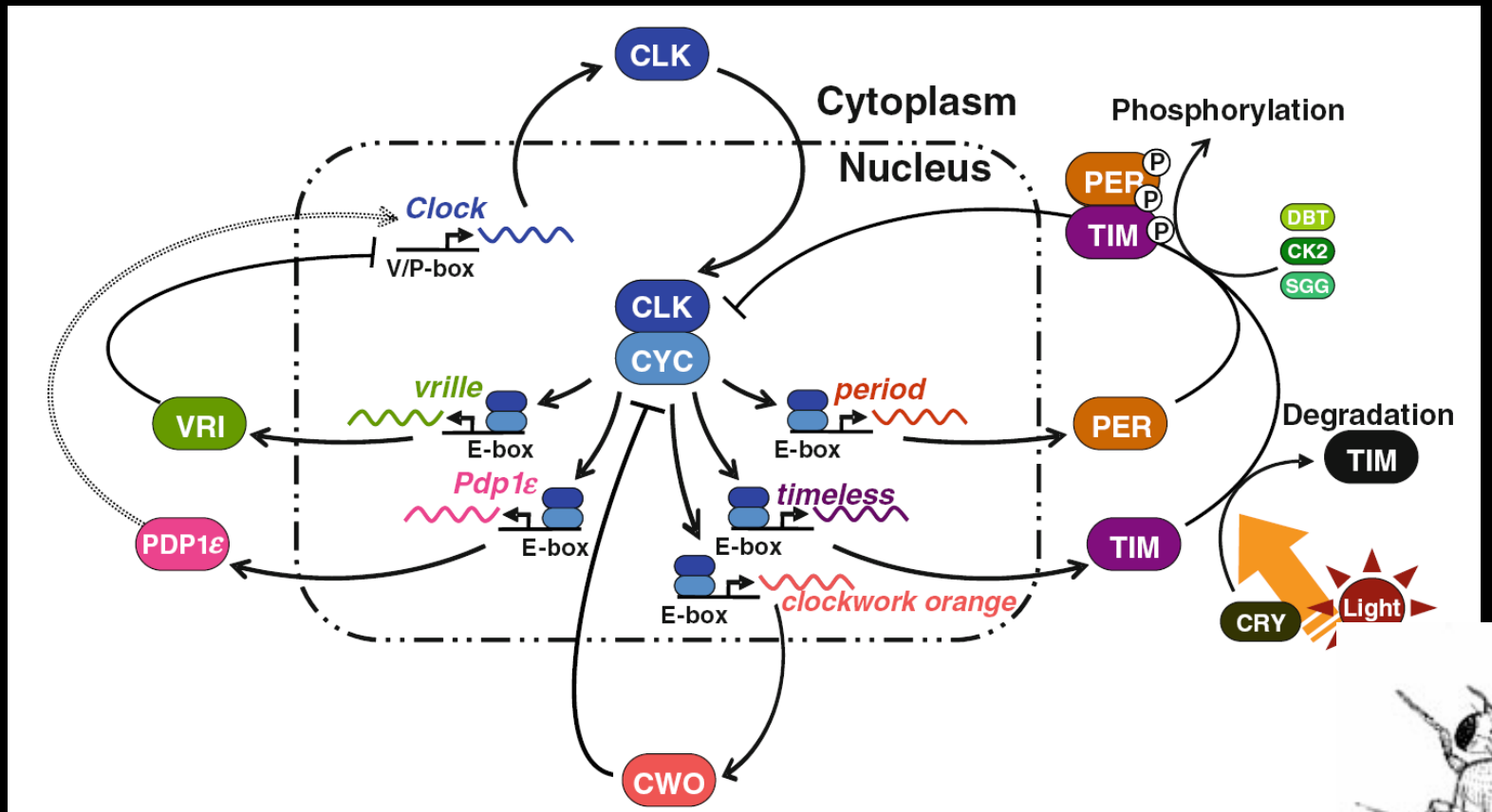
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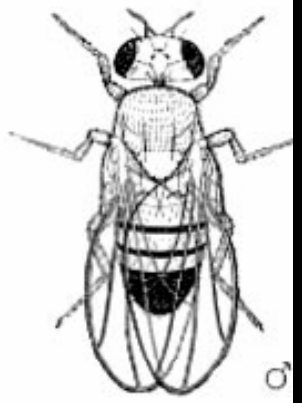

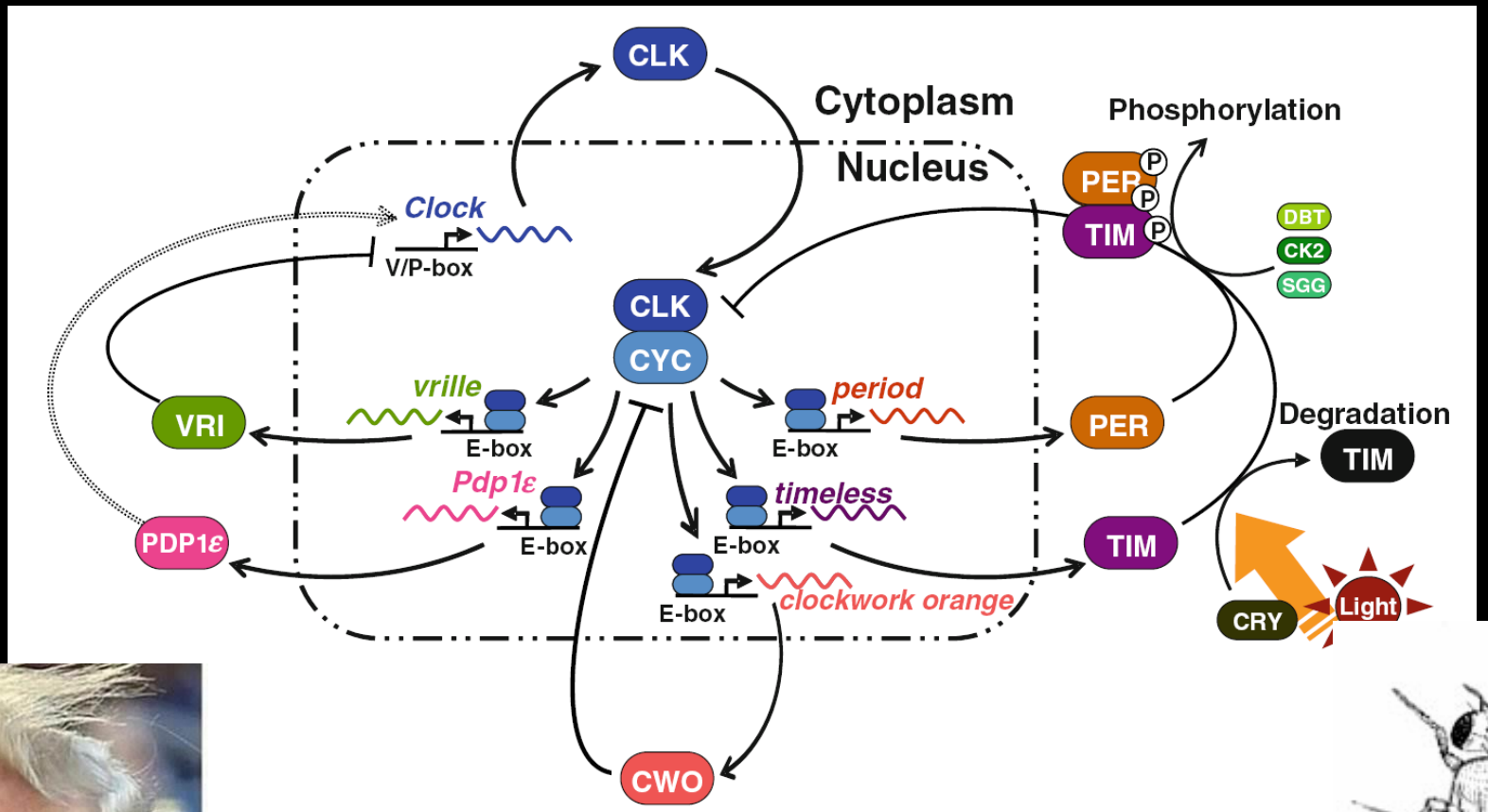
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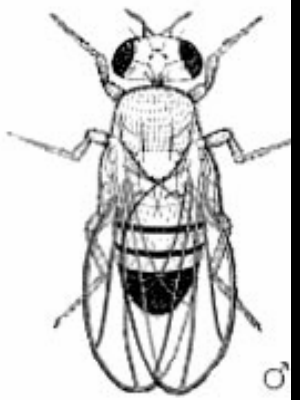

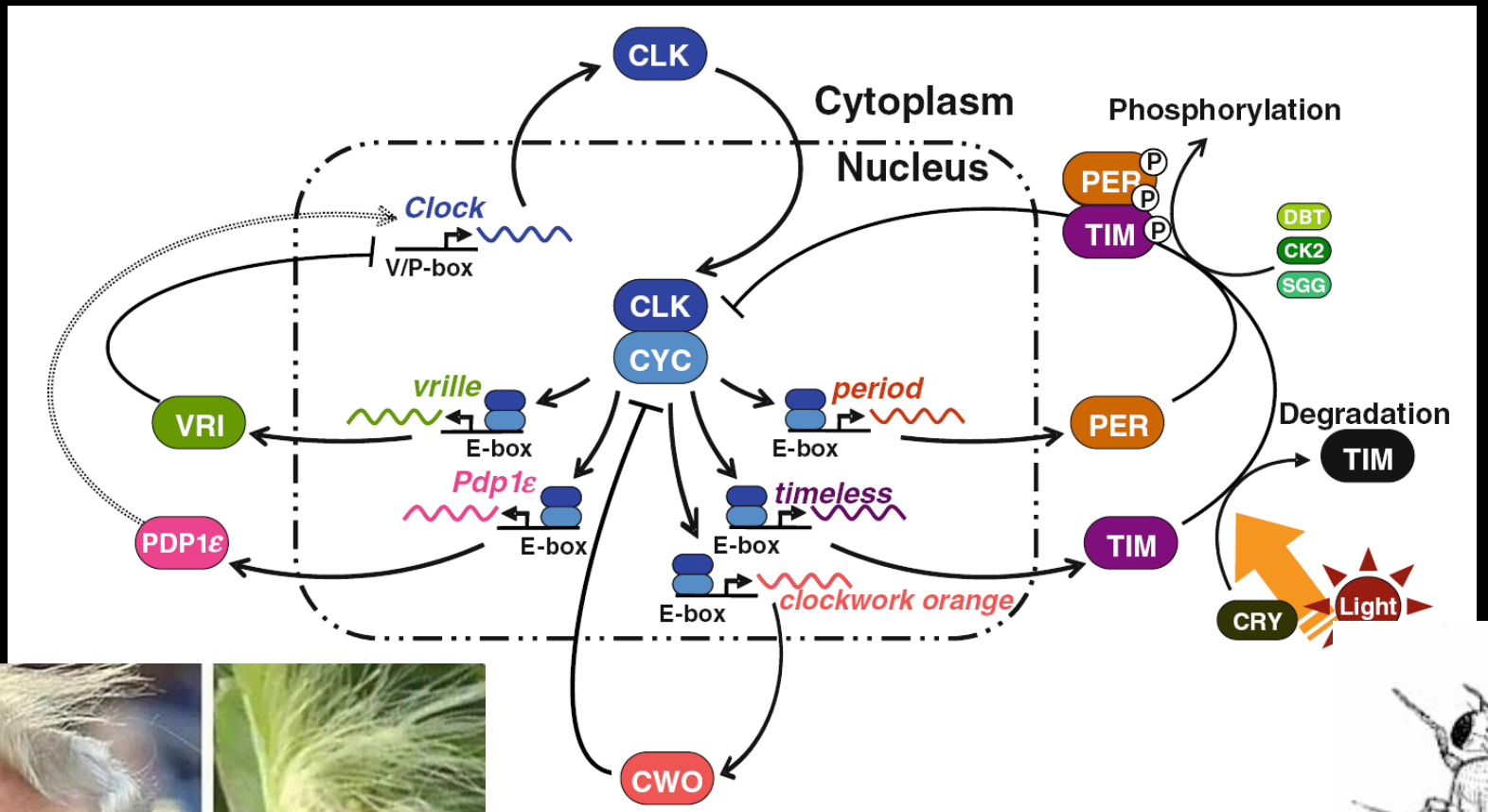
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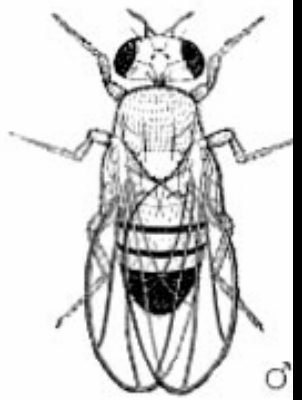

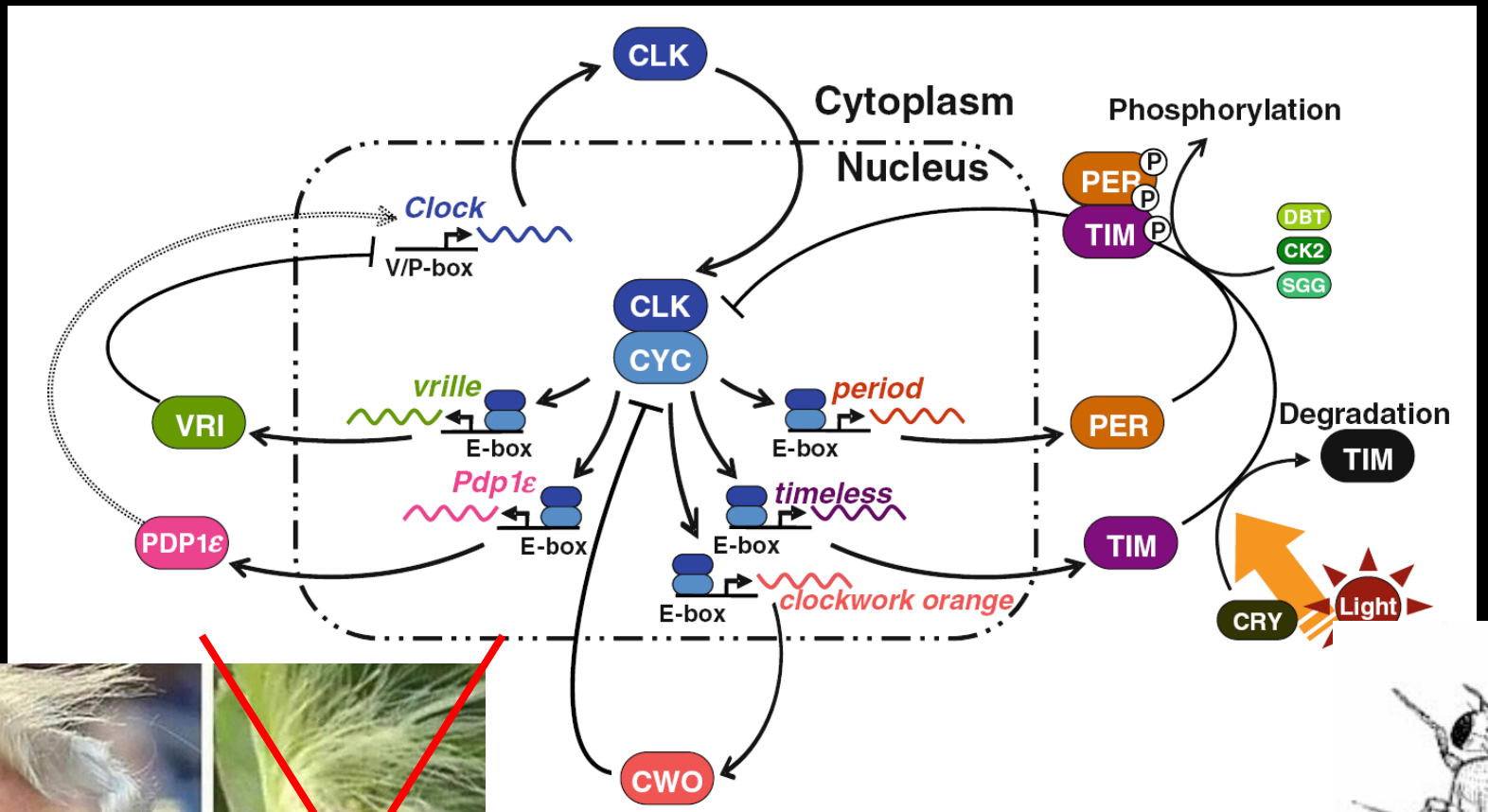
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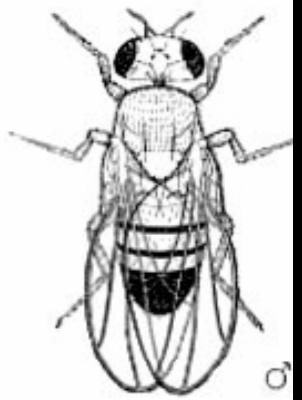
Light
CWO



Human FASP

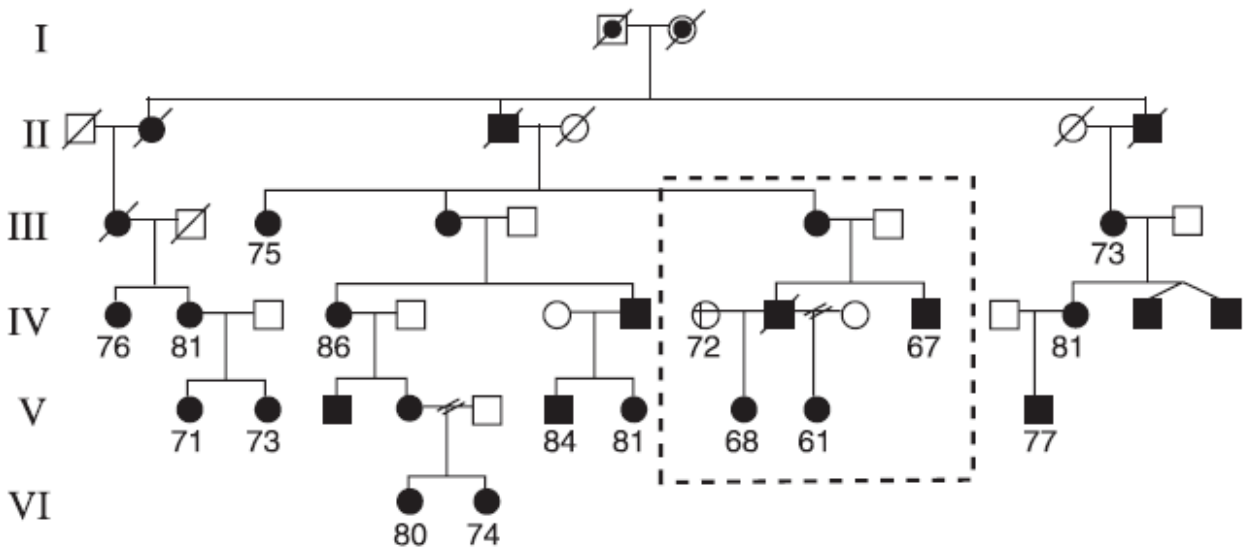


Fig. 1. ASPS kindred 2174. Horne-Östberg scores are shown below individuals. The dotted line marks a branch (branch 3) where the ASPS phenotype does not cosegregate with the mutation. Circles, women; squares, men; filled circles and squares, affected individuals; empty circles and squares, unaffected individuals. Unknown individuals (not meeting strict criteria for being "affected" or "unaffected") were eliminated from this pedigree for the sake of simplicity.

Human FASP

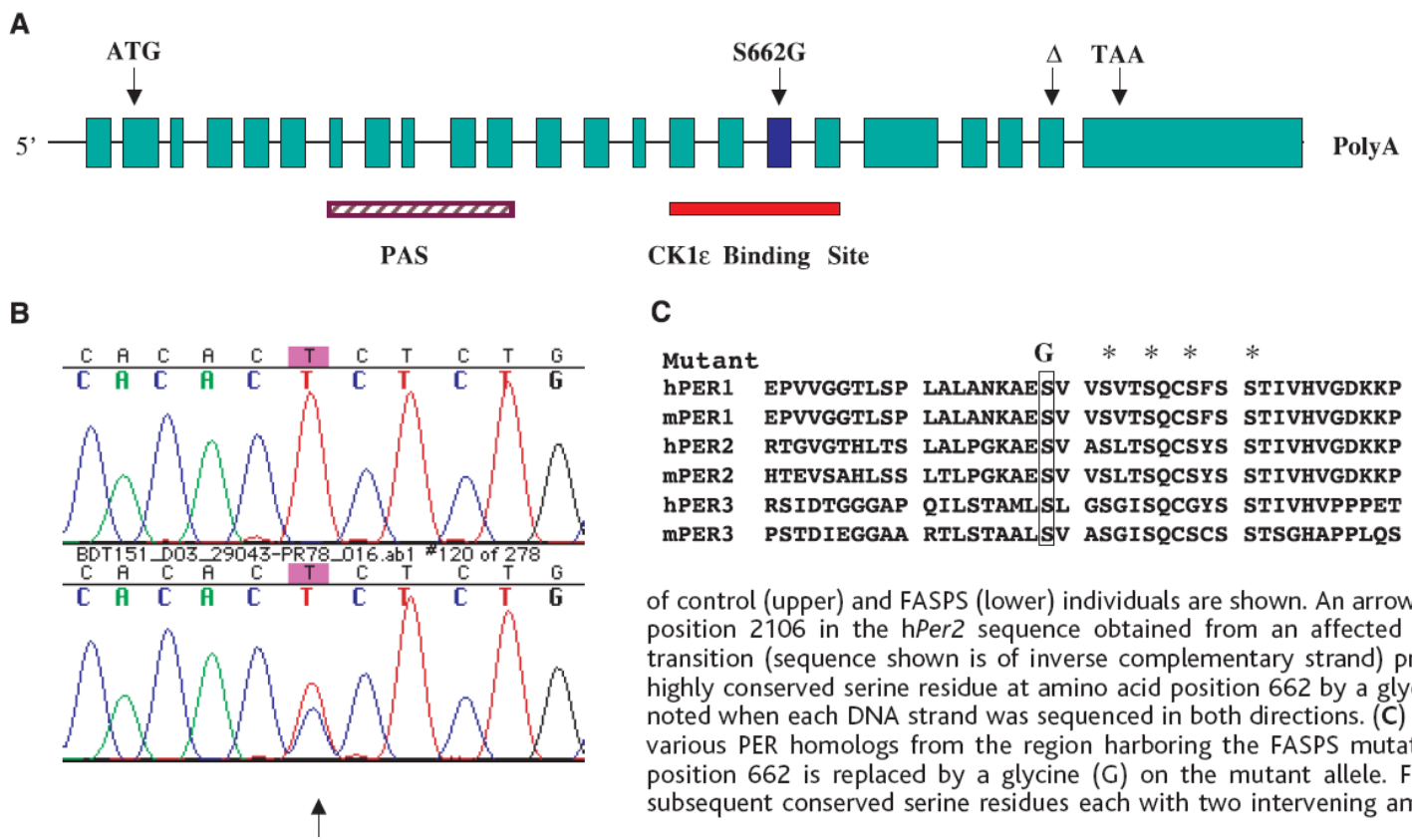
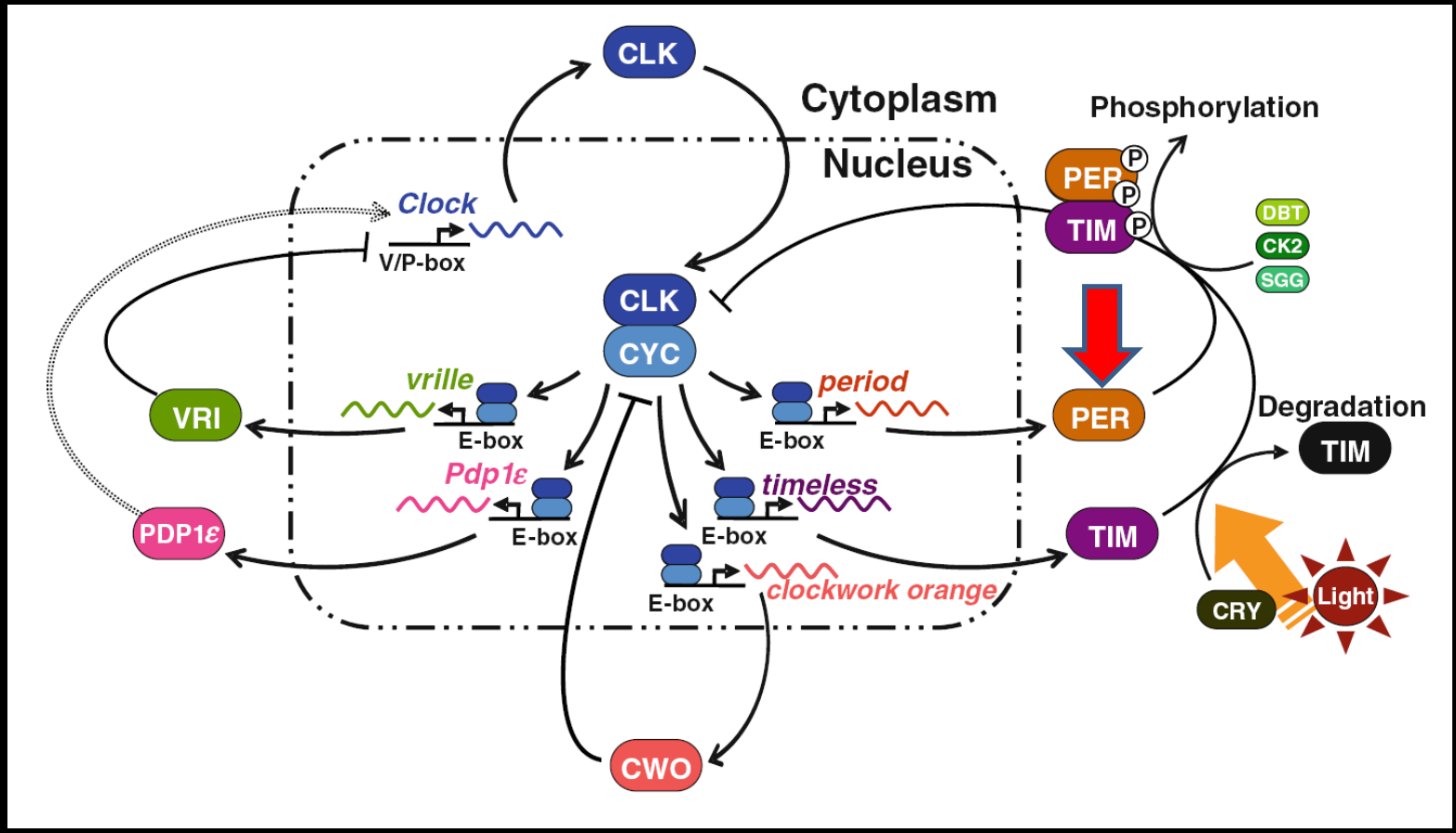
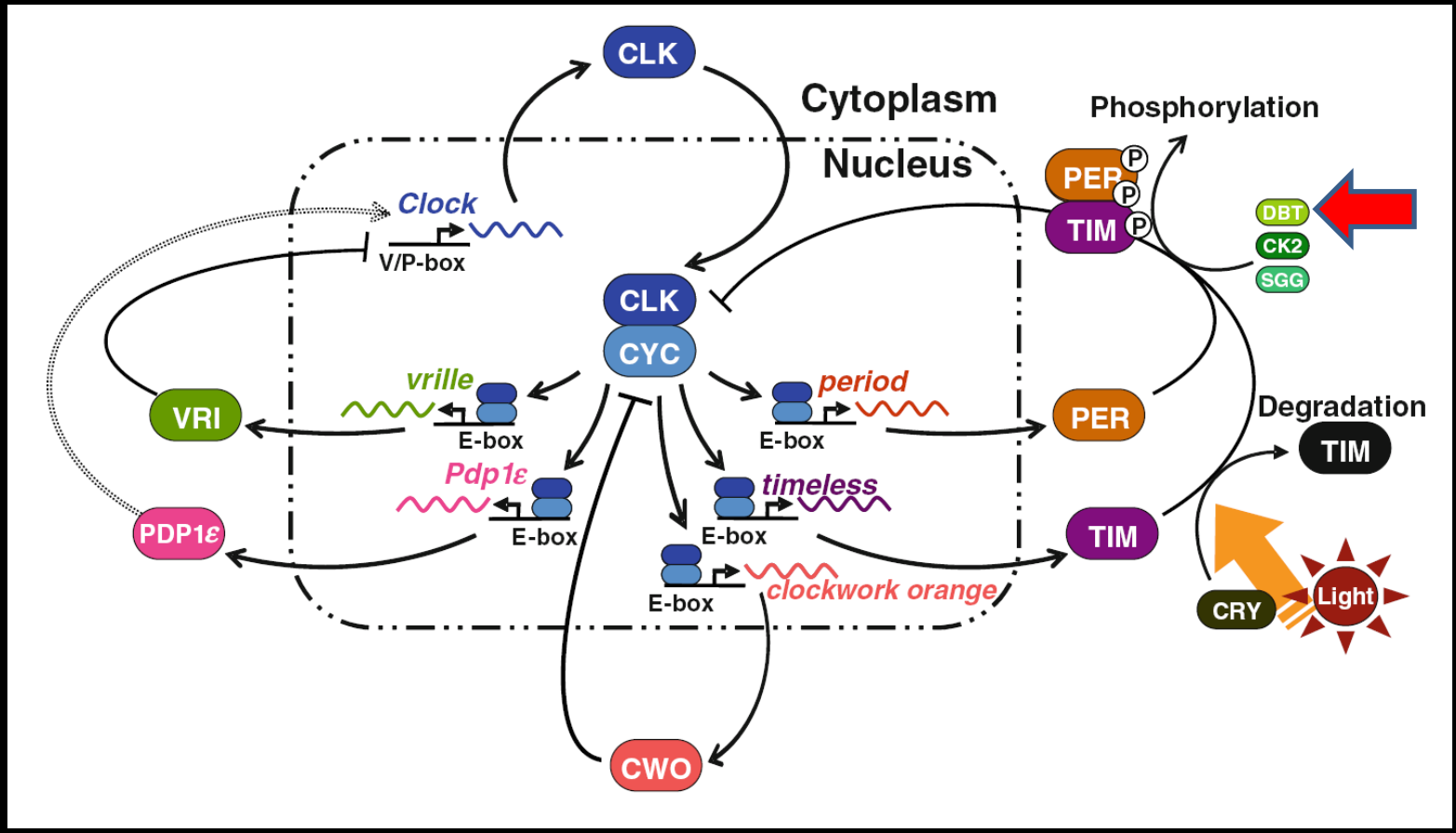


Fig. 2. (**A**) Genomic structure of h*Per2*. The h*Per2* gene contains 23 exons (colored rectangles). The intervening introns are not drawn to scale. The mutation in kindred 2174 (S662G) occurs in exon 17. The "Δ" above exon 22 shows the location of the sequence error (a 1 base pair deletion) in the h*Per2* cDNA GenBank sequence. (**B**) The h*Per2* mutation in kindred 2174. DNA sequences from the h*Per2* gene of control (upper) and FASPS (lower) individuals are shown. An arrow marks a double peak at position 2106 in the h*Per2* sequence obtained from an affected individual. This A to G transition (sequence shown is of inverse complementary strand) predicts substitution of a highly conserved serine residue at amino acid position 662 by a glycine. A double peak was noted when each DNA strand was sequenced in both directions. (**C**) Amino acid sequence of various PER homologs from the region harboring the FASPS mutation (*37*). The serine at position 662 is replaced by a glycine (G) on the mutant allele. Four asterisks mark four subsequent conserved serine residues each with two intervening amino acids.


CLK
Cytoplasm
Nucleus
Phosphorylation
PER
P
P
TIM
P
DBT
CK2
SGG
Clock
V/P-box
CLK
CYC
vrille
E-box
VRI
period
E-box
PER
Degradation
TIM
Pdp1ε
E-box
timeless
E-box
PDP1ε
TIM
E-box
clockwork orange
CRY
Light
CWO


CLK
Cytoplasm
Nucleus
Phosphorylation
PER
P
P
TIM
P
DBT
CK2
SGG
Clock
V/P-box
CLK
CYC
vrille
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period
E-box
PER
Degradation
TIM
Pdp1ε
E-box
timeless
E-box
PDP1ε
TIM
E-box
clockwork orange
CRY
Light
CWO

Human FASP

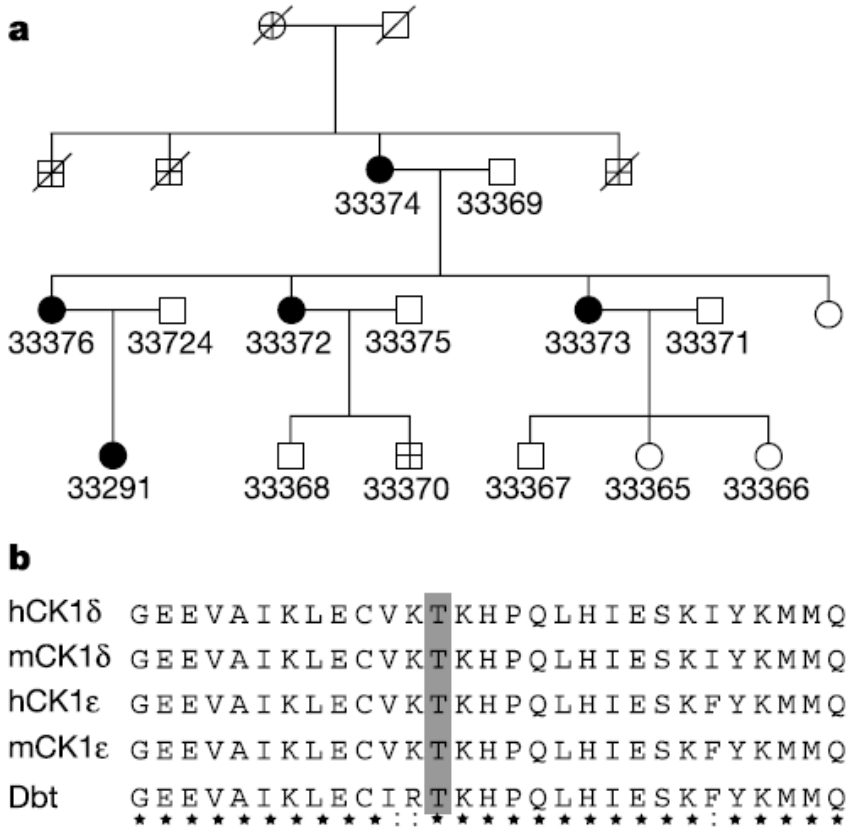
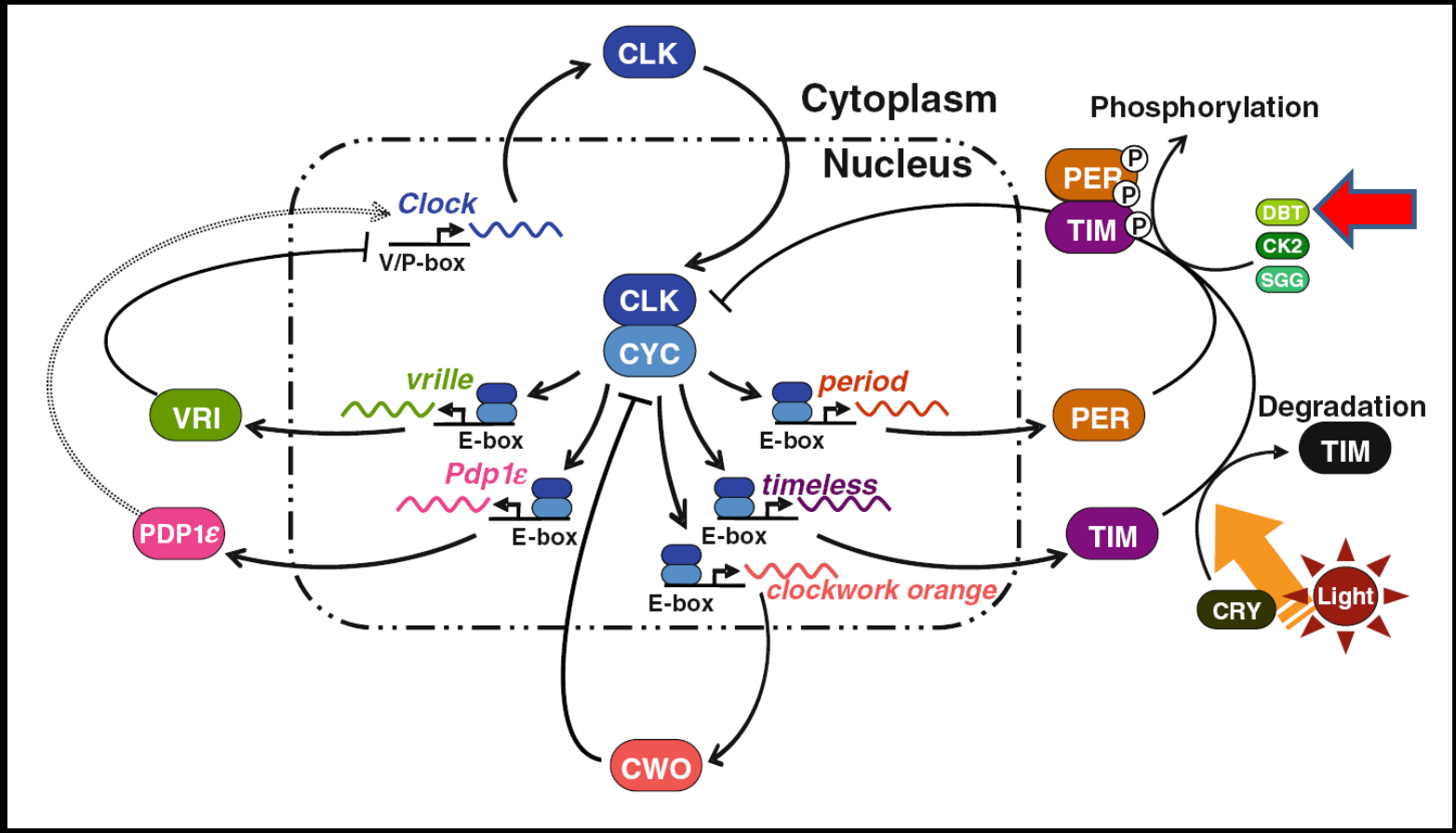


Figure 1 CKIδ-T44A FASPS pedigree and the amino acid alignment around the mutation. **a**, FASPS kindred 5231. Circles represent women, squares denote men, filled circles and squares show affected individuals; empty circles and squares show unaffected individuals. The individual marked with a cross is 'probably affected' but was conservatively classified as unknown. Diagonal lines across symbols indicate deceased individuals. **b**, Alignments for *Drosophila* Dbt and mouse (m) and human (h) CKIδ and CKIε proteins. The T44A mutation is highlighted.

Functional consequences of a *CKIδ* mutation causing familial advanced sleep phase syndrome

Ying Xu[1*], Quasar S. Padiath[1*], Robert E. Shapiro[2], Christopher R. Jones[3], Susan C. Wu[1], Noriko Saigoh[1], Kazumasa Saigoh[1†], Louis J. Ptáček[1,4] & Ying-Hui Fu[1]


CLK
Cytoplasm
Nucleus
Phosphorylation
PER
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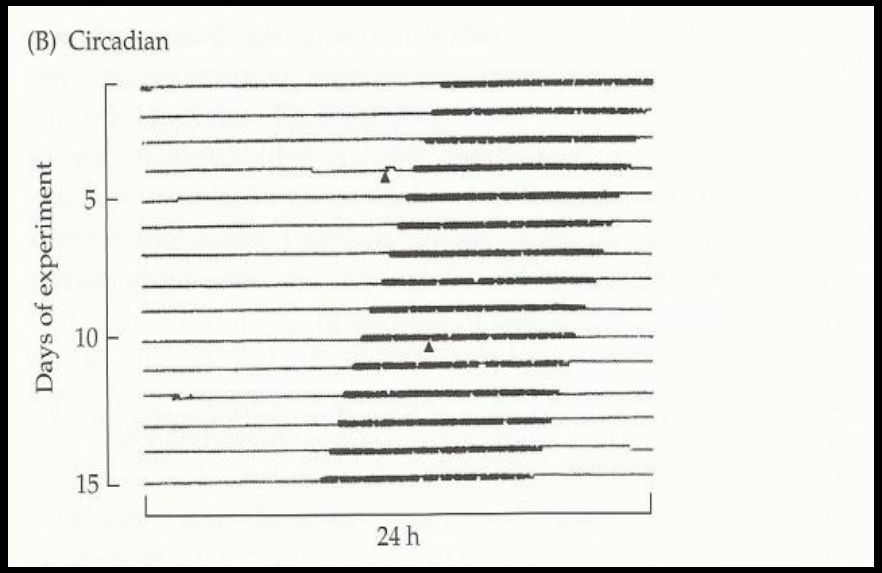
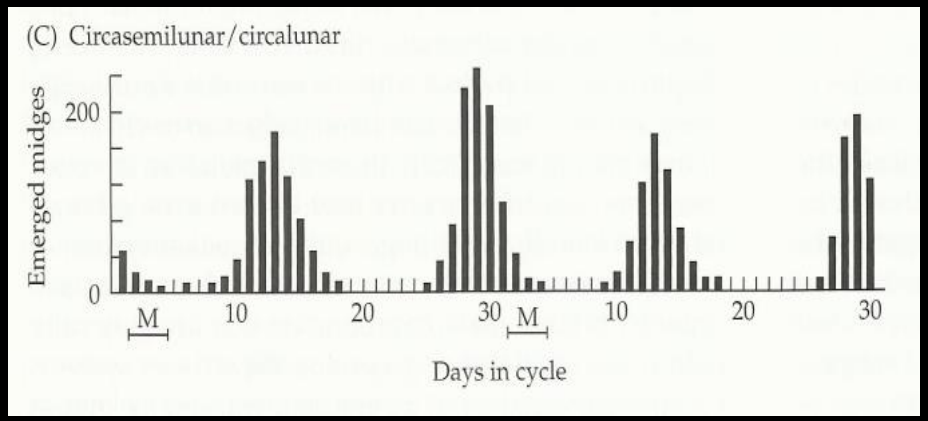
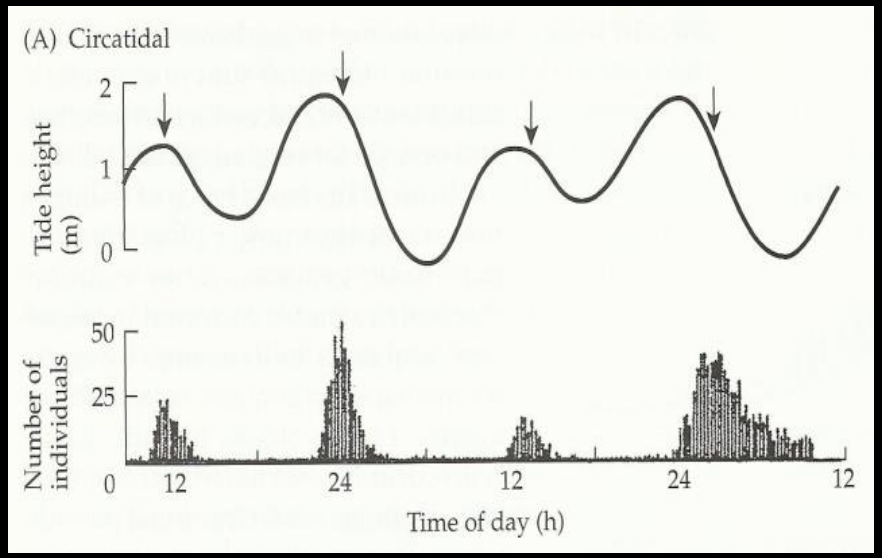
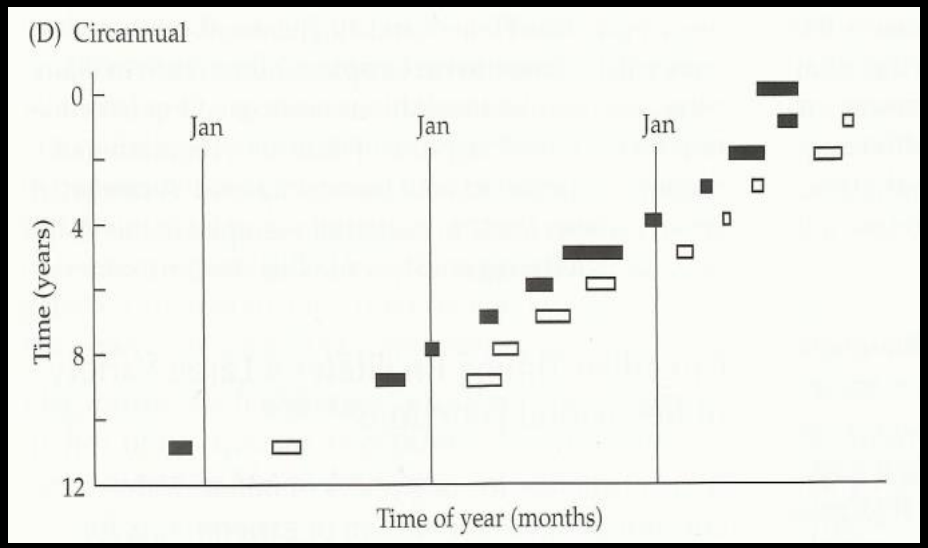
P
TIM
P
DBT
CK2
SGG
Clock
V/P-box
CLK
CYC
vrille
E-box
VRI
period
E-box
PER
Degradation
TIM
Pdp1ε
E-box
timeless
E-box
PDP1ε
TIM
E-box
clockwork orange
CRY
Light
CWO

NON-CIRCADIAN RHYTHMS





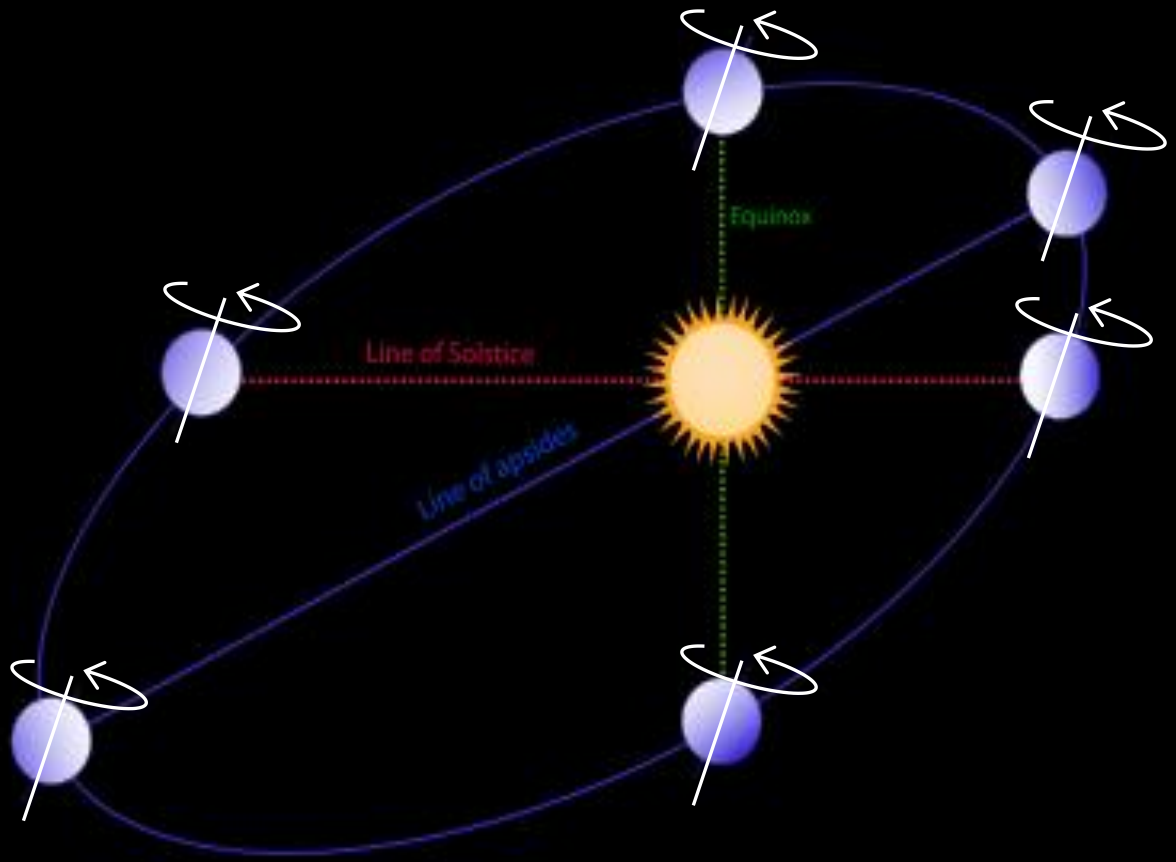




SEASONALITY:
THE PHOTOPERIODIC TIMER (CLOCK)

Northern spring/
Southern fall

Northern winter/
Southern summer



Northern summer/
Southern winter

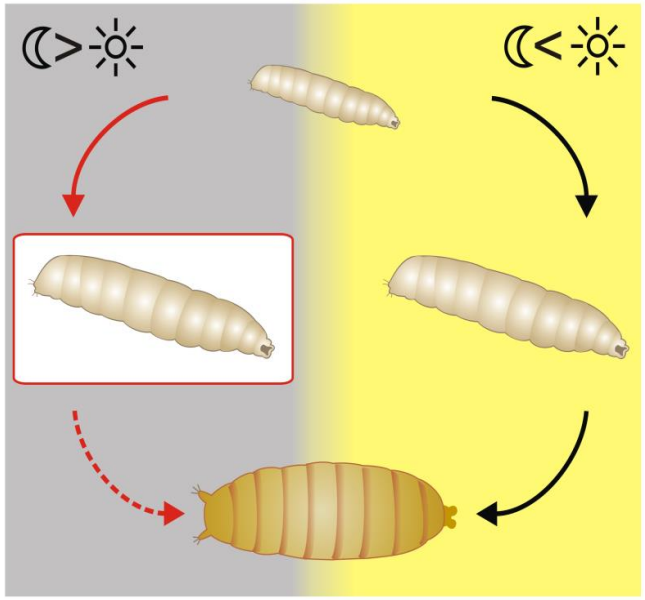
Northern fall/
Southern spring

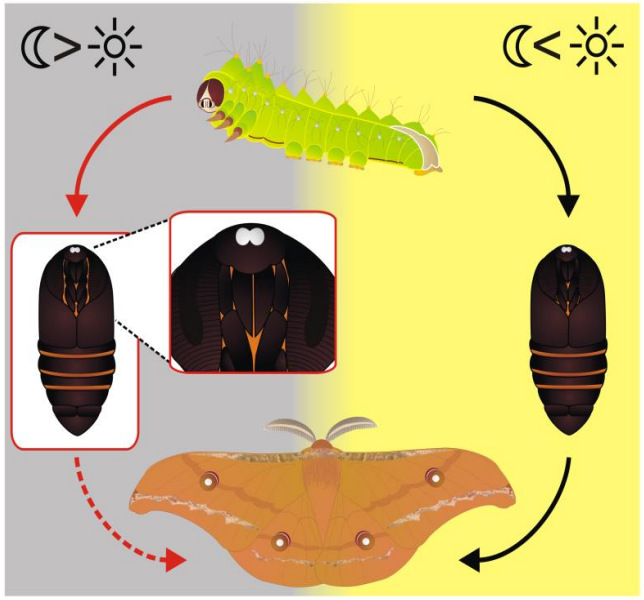
Insect diapause

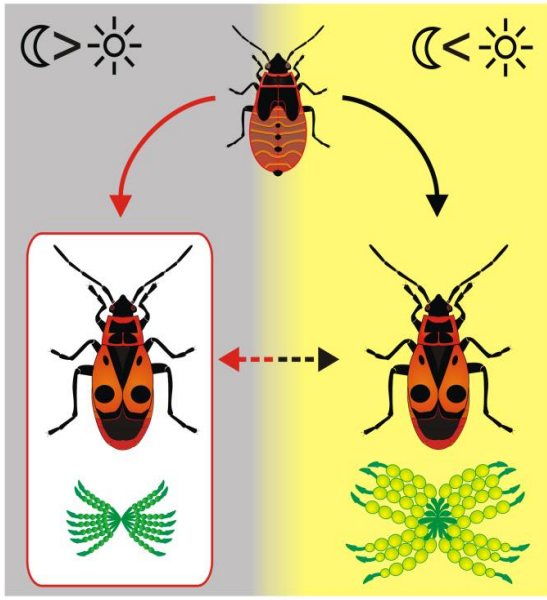
Larval diapause (*Chymomyza costata*)

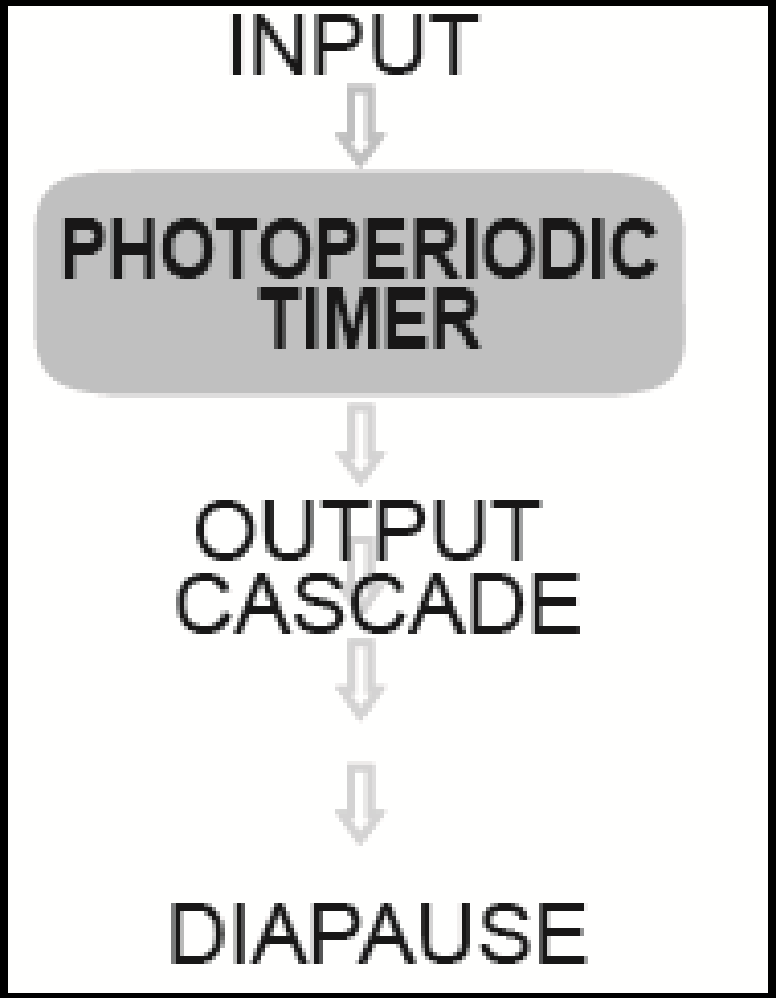
Pupal diapause (*Antheraea pernyi*)

Adult diapause (*Pyrrhocoris apterus*)



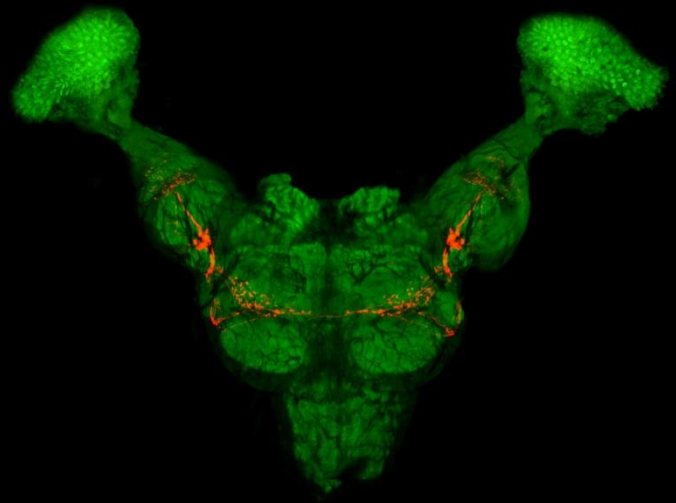




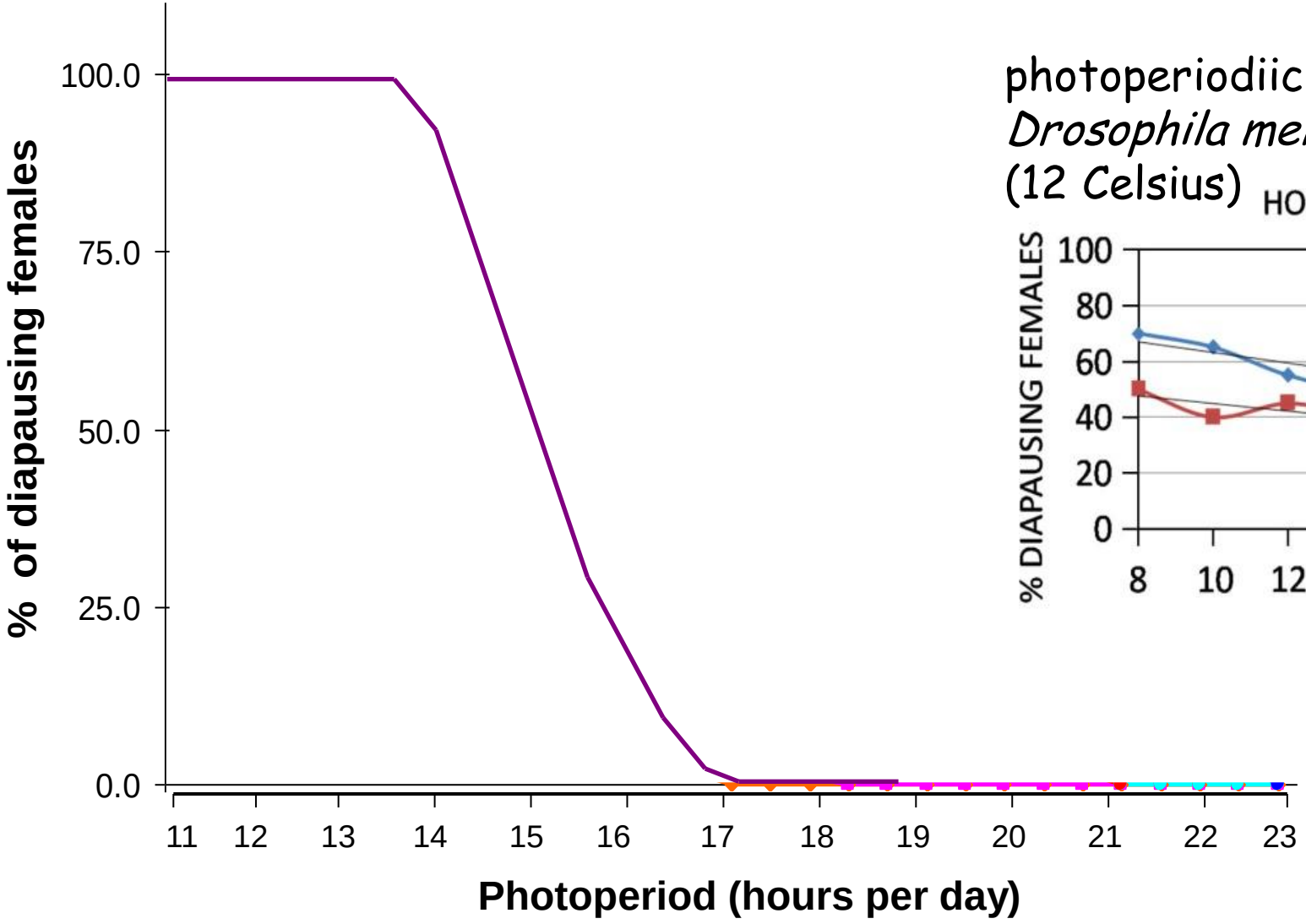


Diapause is an ultimate physiological output far downstream of the photoperiodic timer

Pyrrhocoris apterus



Photoperiodic response in *P. apterus* (25 Celsius)



photoperiodiic response
Drosophila melanogaster
(12 Celsius)

CIRCADIAN CLOCK

- Runs at constant conditions (DD)

PHOTOPERIODIC TIMER (photoperiodic clock)

- Measures photoperiod or night-length (day-length)

CIRCADIAN CLOCK

- Runs at constant conditions (DD)
- Free running period close to 24hrs

PHOTOPERIODIC TIMER (photoperiodic clock)

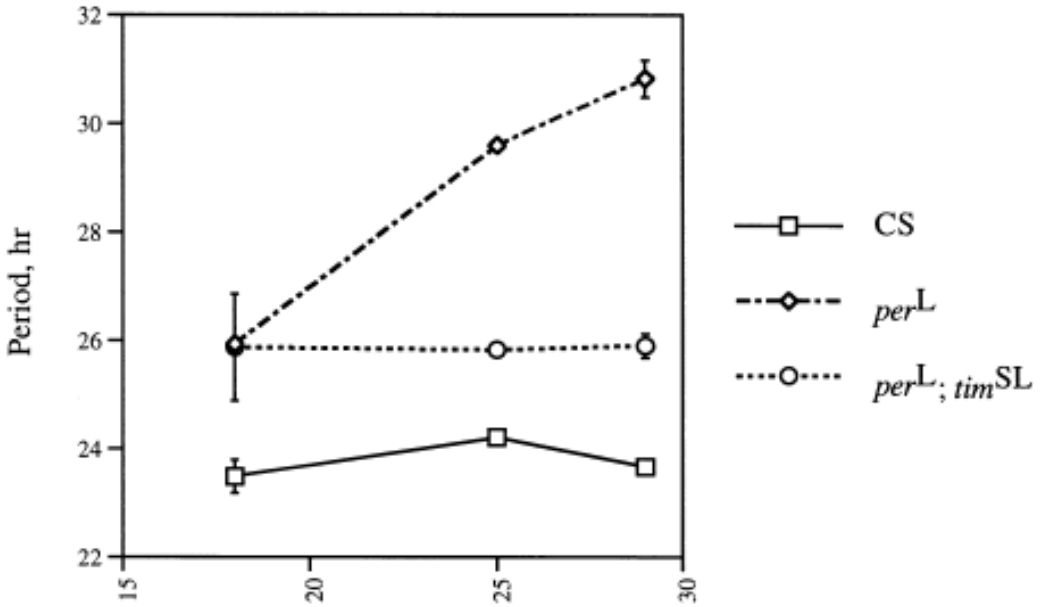
- Measures photoperiod or night-length (day-length)
- No free running period

CIRCADIAN CLOCK

- Runs at constant conditions (DD)
- Free running period close to 24hrs
- Temperature compensated

PHOTOPERIODIC TIMER (photoperiodic clock)

- Measures photoperiod or night-length (day-length)
- No free running period

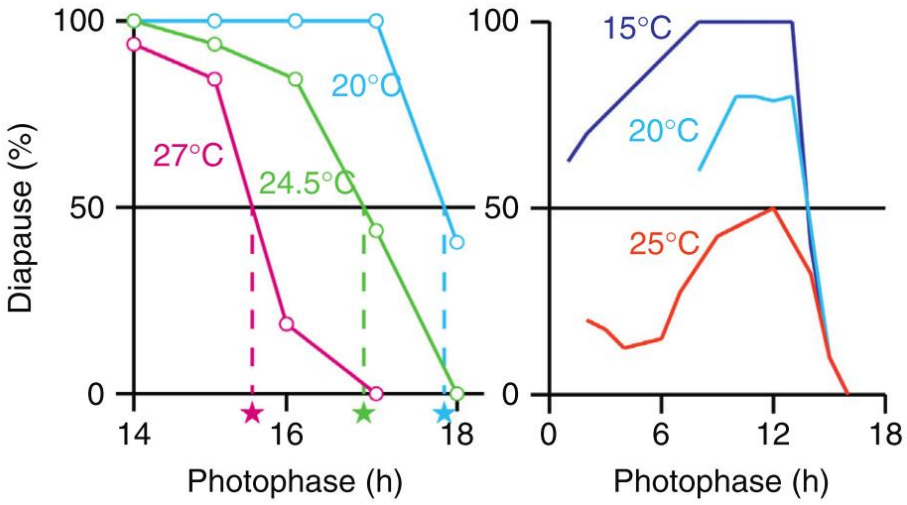


CIRCADIAN CLOCK

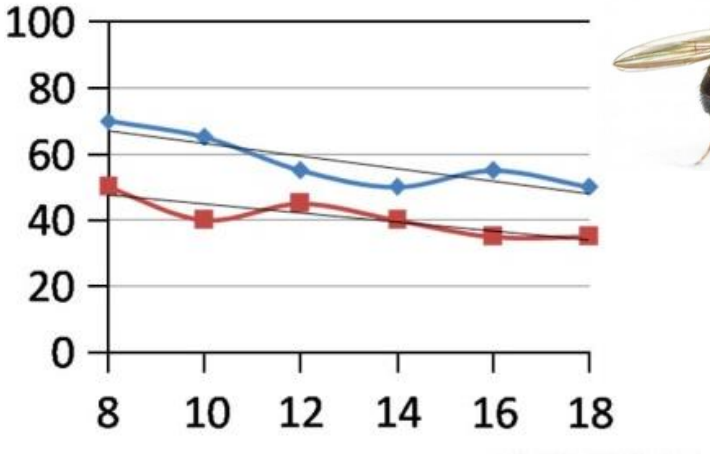
- Runs at constant conditions (DD)
- Free running period close to 24hrs
- Temperature compensated

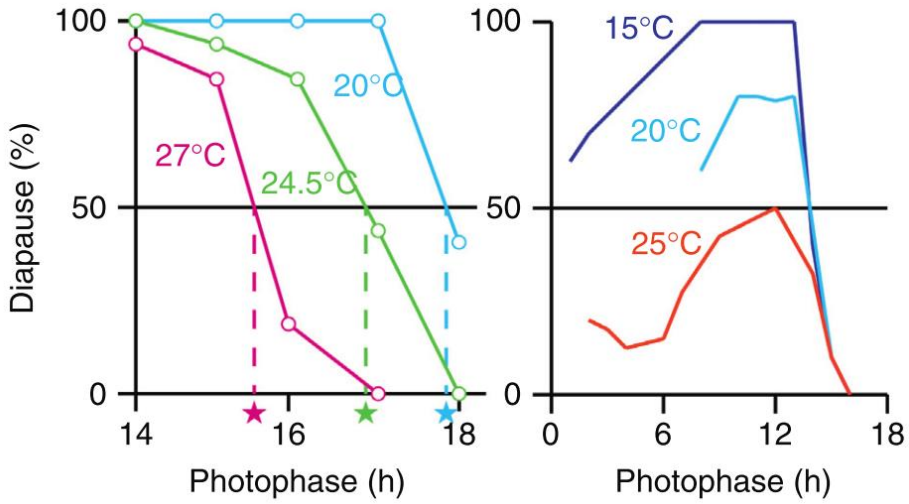
PHOTOPERIODIC TIMER (photoperiodic clock)

- Measures photoperiod or night-length (day-length)
- No free running period
- Temperature is important factor influencing photoperiodic response curve

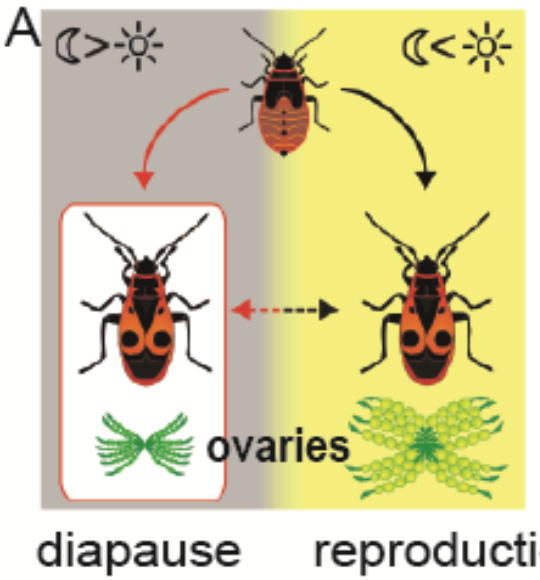


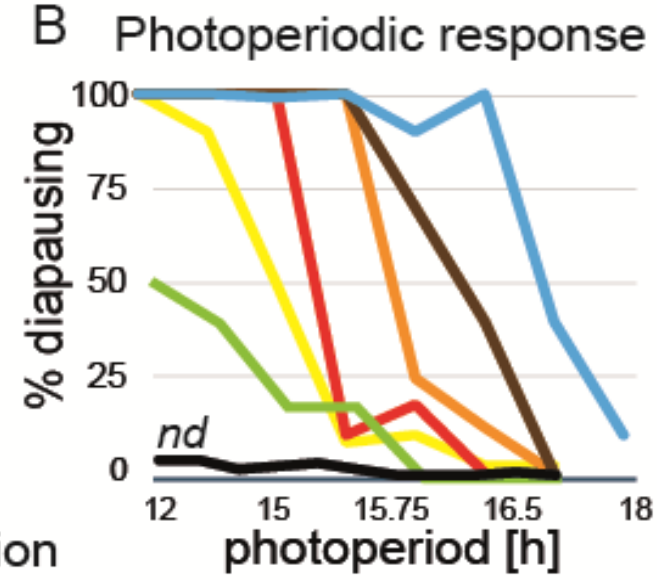
PHOTOPERIODIC TIMER (photoperiodic clock)

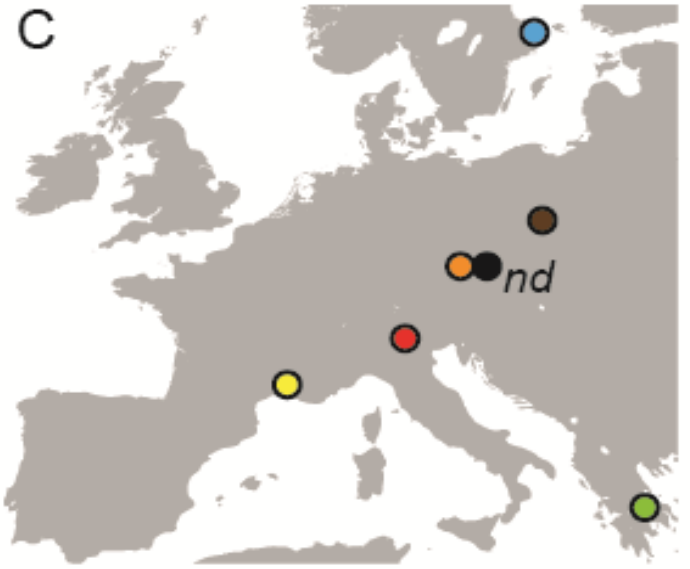


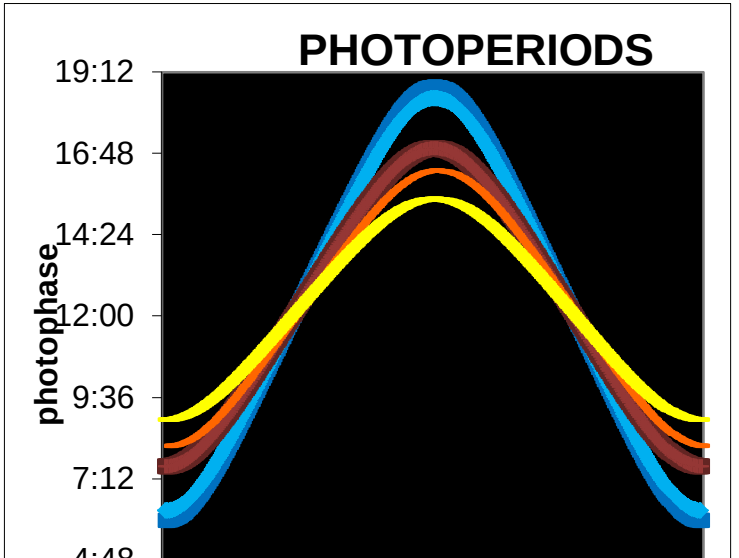


A big experiment in Nature: geographic variability



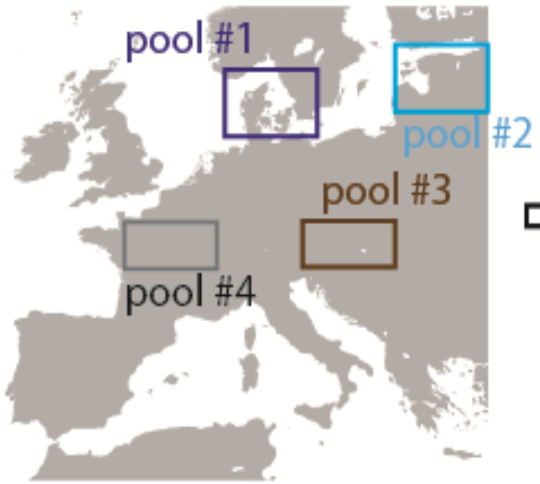




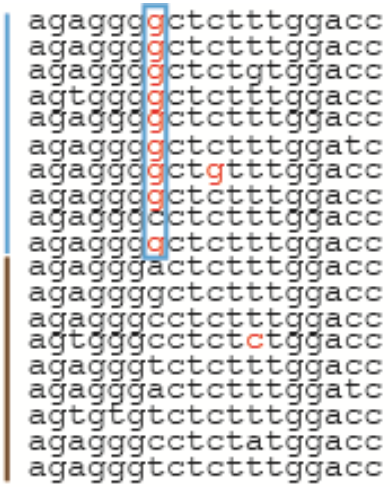


How to study natural adaptations? – distinguish important changes from unimportant variability

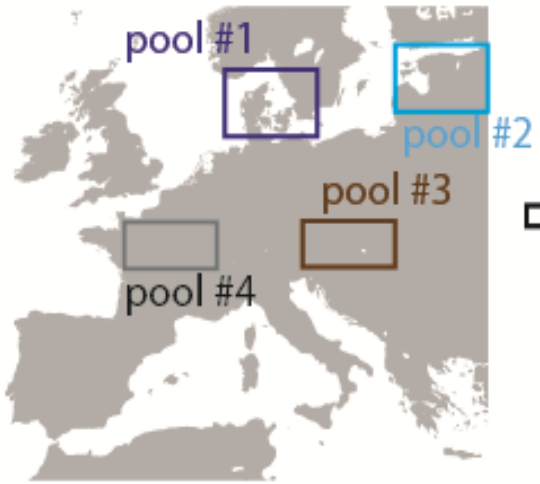
- Genetic variability behind the biology you are studding
- Genetic variability behind something else
  (important & interesting, but for someone else)
- Random variability, bottleneck, founder effect
- Technical artifacts & various limitations



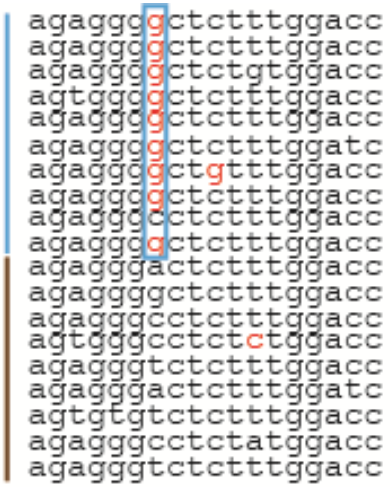
Pool-seq andividuals
(with known CPP)



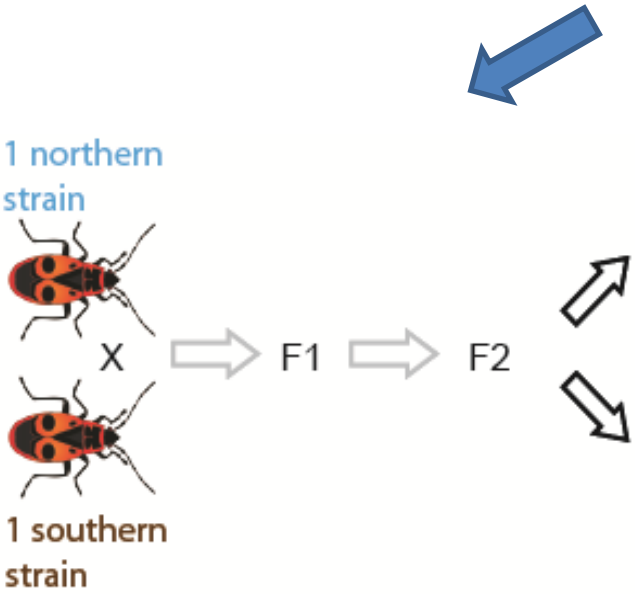
identify candidate
pool-specific SNPs



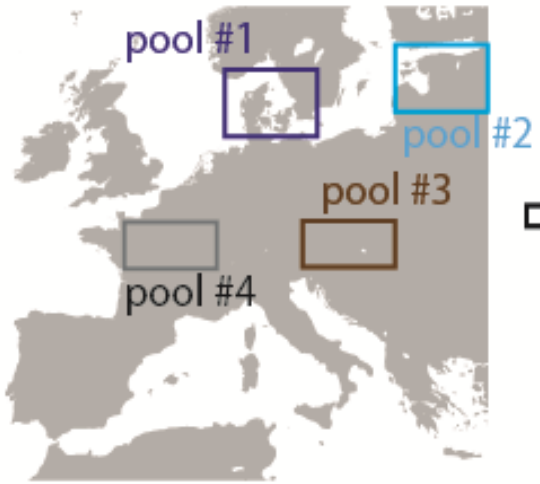
Pool-seq andividuals
(with known CPP)



identify candidate
pool-specific SNPs



phenotype & genotype
F1 and F2 bugs



Pool-seq andividuals
(with known CPP)

identify candidate
pool-specific SNPs

1 northern strain

X

1 southern strain

F1 F2

phenotype & genotype
F1 and F2 bugs

- too many candidates?
- Novel genes?

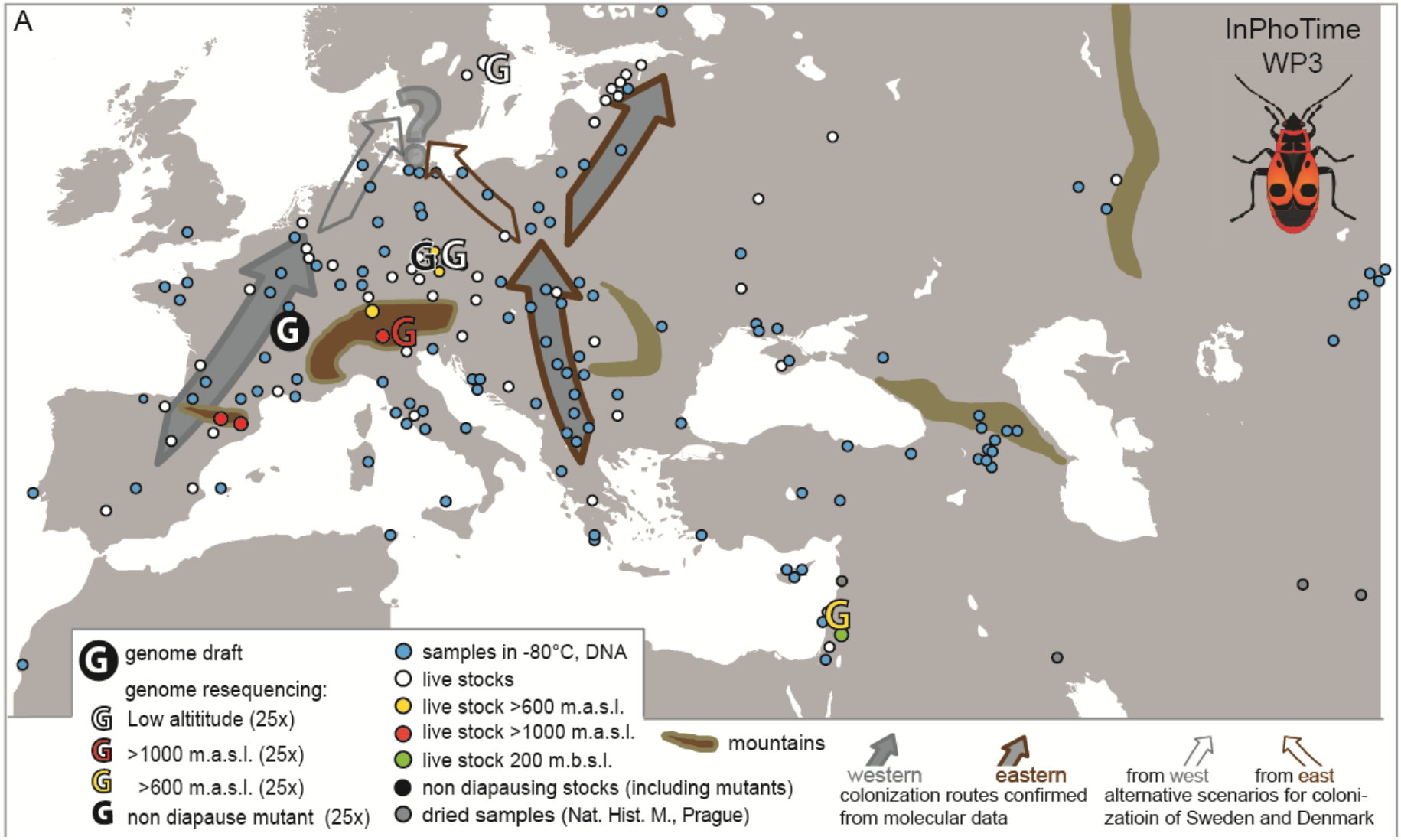
RNAi

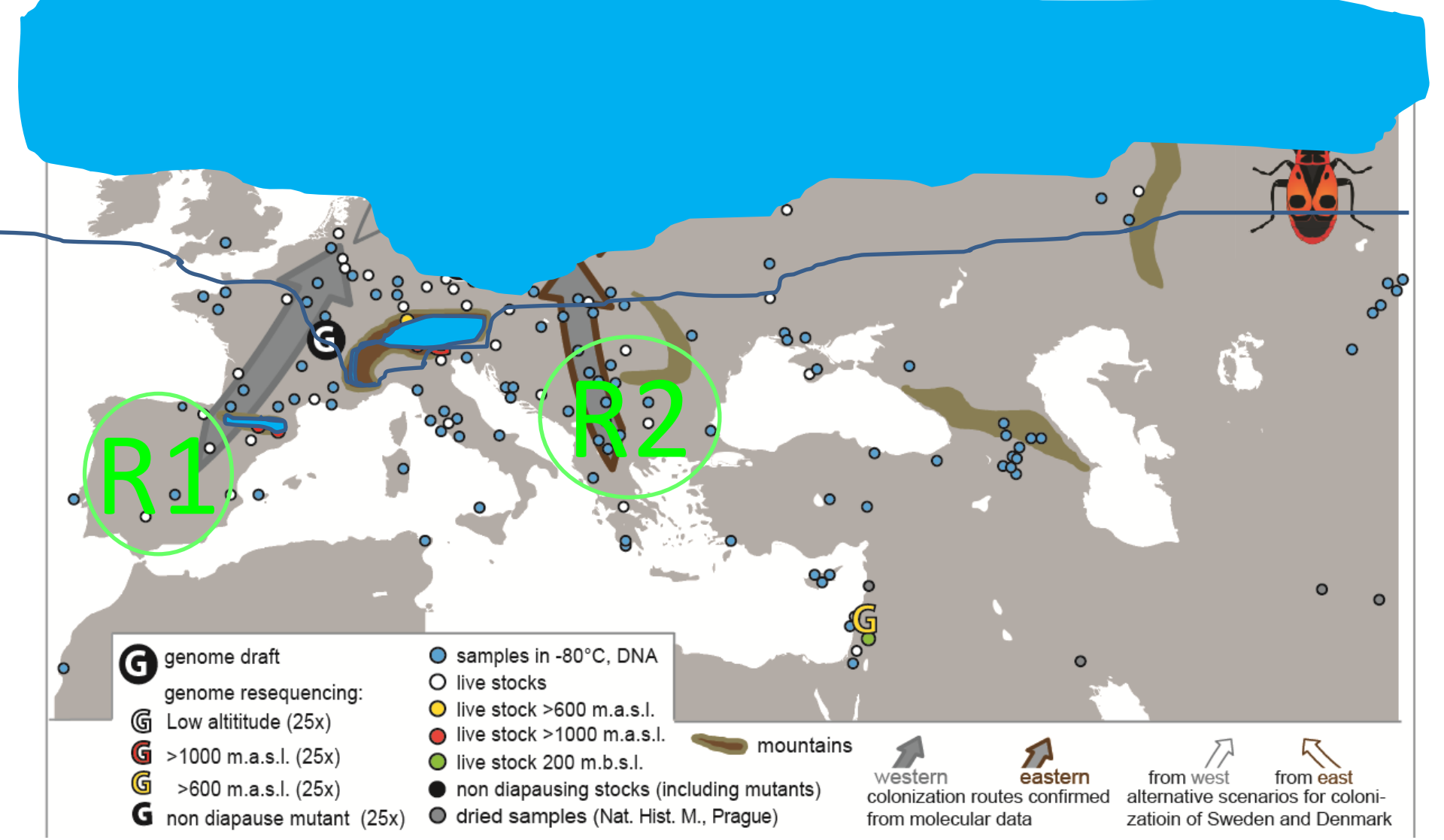
- a few clear candidates
- cis-regulatory regions
- allelic variants
  - AA change

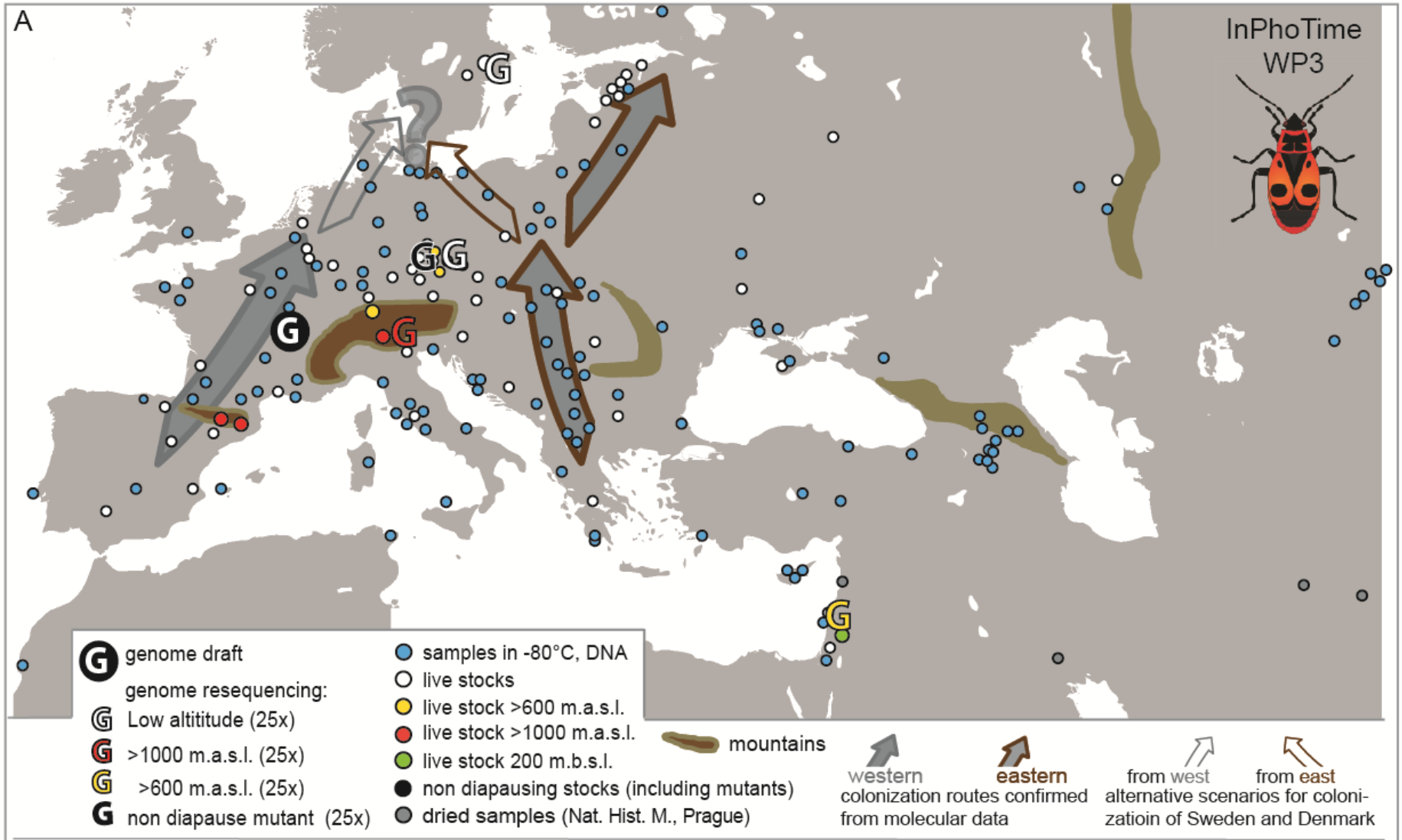
genome editing

variants associating
with CPP

test function by
reverse genetics


A
InPhoTime
WP3
genome draft
genome resequencing:
Low altititude (25x)
>1000 m.a.s.l. (25x)
>600 m.a.s.l. (25x)
non diapause mutant (25x)
samples in -80°C, DNA
live stocks
live stock >600 m.a.s.l.
live stock >1000 m.a.s.l.
live stock 200 m.b.s.l.
non diapausing stocks (including mutants)
dried samples (Nat. Hist. M., Prague)
mountains
western
eastern
colonization routes confirmed from molecular data
from west
from east
alternative scenarios for colonizatioin of Sweden and Denmark

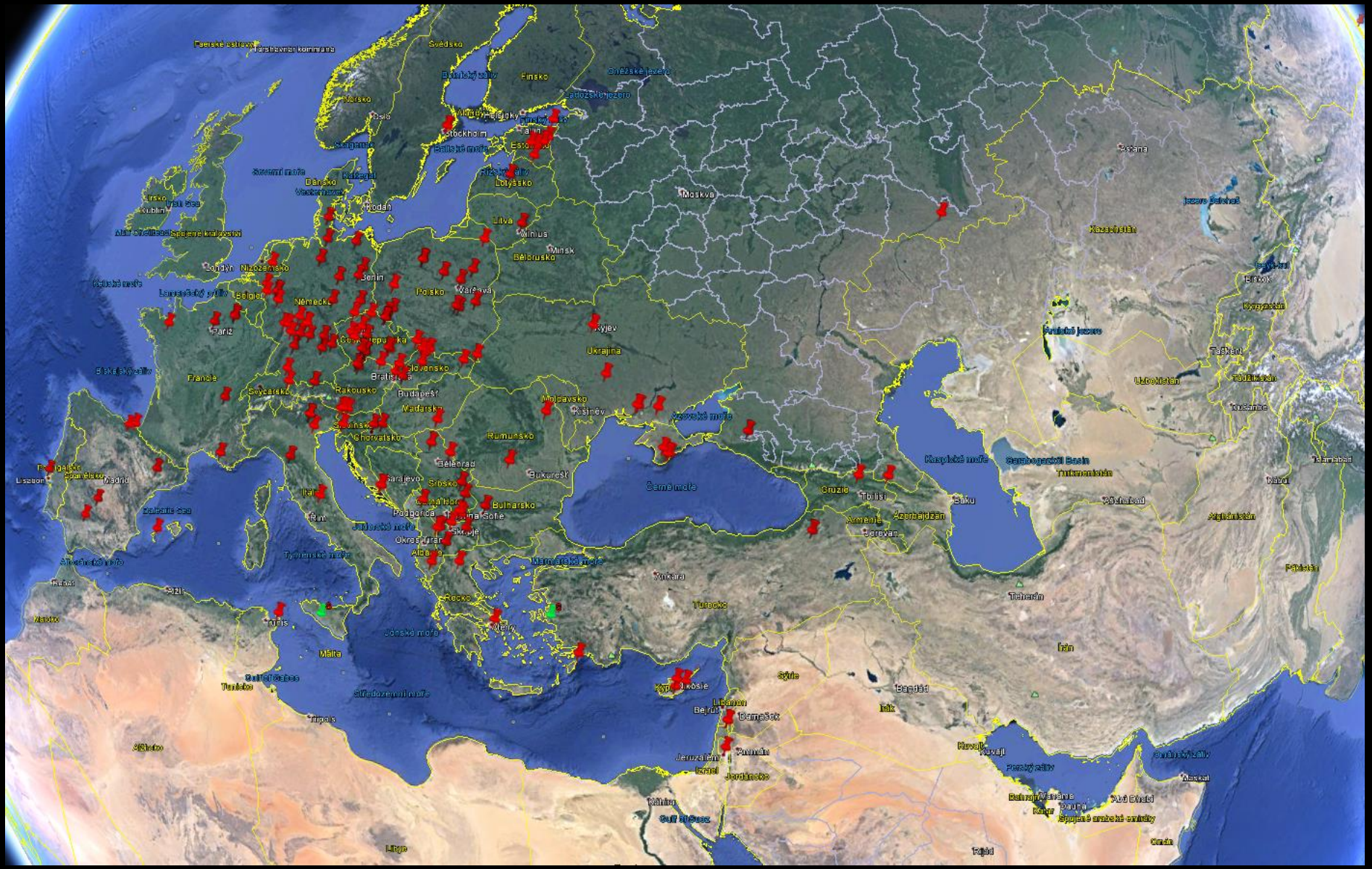

R1
R2
genome draft
genome resequencing:
Low altititude (25x)
>1000 m.a.s.l. (25x)
>600 m.a.s.l. (25x)
non diapause mutant (25x)
samples in -80°C, DNA
live stocks
live stock >600 m.a.s.l.
live stock >1000 m.a.s.l.
live stock 200 m.b.s.l.
non diapausing stocks (including mutants)
dried samples (Nat. Hist. M., Prague)
mountains
western
eastern
colonization routes confirmed from molecular data
from west
from east
alternative scenarios for colonizatioin of Sweden and Denmark



B

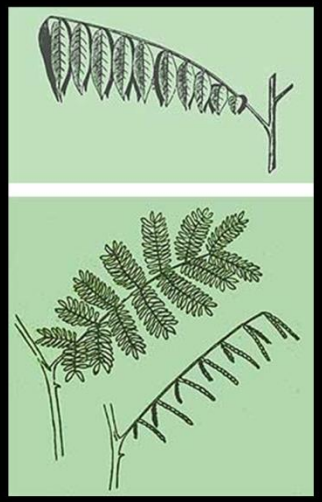
	CRYPTOCHROME2 (CRY2)	PERIOD (PER)
Sweden	TVQKASKCVIGTDYPLPM	NNDPVTPTIPNHETQ
Estonia	TVQKASKCVIGTDYPLPM	
Latvia	TVQKASKCVIGTDYPLPM	
Czech Rep.	TVQKASKCIIGTDYPLPM	NNDPVTPTIPNHETQ
Italy-mts.	TVQKASKCIIGTDYPLPM	NNDPVTPAIPNHETQ
Israel	TVQKASKCIIGTDYPLPM	NNDPVTPAIPNHETQ

Fig. 10 Preliminary data supporting WP3. (*A*) Western and **eastern** colonizations routes in Europe will serve as a uniques source for latitudinal and altitudinal genetic variants in the photoperiodic timer.
(*B*) Geographic variants of CRY2 and PER proteins


Švédsko
Finsko
Norsko
Stockholm
Estonsko
Lotyšsko
Litva
Vilnius
Moskva
Kazachstán
Bělorusko
Minsk
Polsko
Varšava
Německo
Berlín
Nizozemsko
Belgie
Lucembursko
Francie
Paříž
Švýcarsko
Rakousko
Maďarsko
Budapešť
Slovensko
Bratislava
Ukrajina
Kyjev
Moldavsko
Kišiněv
Rumunsko
Bukurešť
Srbsko
Bělehrad
Sarajevo
Bulharsko
Chorvatsko
Slovinsko
Itálie
Řím
Španělsko
Madrid
Portugalsko
Lisabon
Turecko
Ankara
Istanbul
Řecko
Athény
Kypr
Nikósie
Sýrie
Libanon
Bejrút
Damašek
Izrael
Jeruzalém
Jordánsko
Irák
Bagdád
Írán
Teherán
Arménie
Jerevan
Ázerbájdžán
Baku
Gruzie
Tbilisi
Turkmenistán
Aškhabad
Uzbekistán
Taškent
Kyrgyzstán
Biškek
Kazachstán
Malta
Tripolis
Libye
Tunisko
Alžírsko
Maroko
Černé moře
Kaspické moře
Egejské moře
Jónské moře
Tyrhénské moře
Jaderské moře
Středozemní moře
Saúdská Arábie
Kuvajt
Bahrajn
Katar
Spojené arabské emiráty
Omán
Jemen
Pákistán
Afghánistán

Faerské ostrovy
Švédsko
Finsko
Norsko
Oslo
Botnický záliv
Oněžské jezero
Ladožské jezero
Stockholm
Tallin
Estonsko
Baltské moře
Skagerrak
Kattegat
Severní moře
Dánsko
Kodaň
Rižský záliv
Lotyšsko
Litva
Vilnius
Minsk
Bělorusko
Moskva
Astana
Kazachstán
Irsko
Dublin
Spojené království
Londýn
Nizozemsko
Keltské moře
Belgie
Berlín
Německo
Polsko
Varšava
Paříž
Francie
Biskajský záliv
Švýcarsko
Rakousko
Slovensko
Bratislava
Budapešť
Maďarsko
Slovinsko
Chorvatsko
Kyjev
Ukrajina
Moldavsko
Kišiněv
Azovské moře
Rumunsko
Bukurešť
Bělehrad
Sarajevo
Srbsko
Bulharsko
Sofie
Podgorica
Skopje
Albánie
Madrid
Lisabon
Řím
Jaderské moře
Tyrhénské moře
Černé moře
Gruzie
Tbilisi
Arménie
Jerevan
Ázerbájdžán
Baku
Kaspické moře
Aralské jezero
Uzbekistán
Taškent
Tádžikistán
Kyrgyzstán
Turkmenistán
Ašchabad
Kábul
Afghánistán
Pákistán
Islamabad
Ankara
Turecko
Teherán
Írán
Řecko
Jónské moře
Malta
Tunis
Tunisko
Tripolis
Středozemní moře
Alžírsko
Maroko
Libye
Kypr
Nikósie
Sýrie
Libanon
Bejrút
Damašek
Bagdád
Irák
Jeruzalém
Izrael
Ammán
Jordánsko
Káhira
Kuvajt
Perský záliv
Bahrajn
Katar
Dauha
Abú Dhabí
Spojené arabské emiráty
Ománský záliv
Maskat
Omán
Rijád

Summary



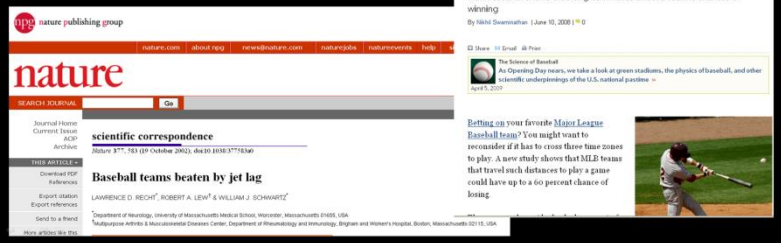
Jean-Jacques d'Ortous de Mairan, 1729

CIRCADIAN RHYTHM

Summary

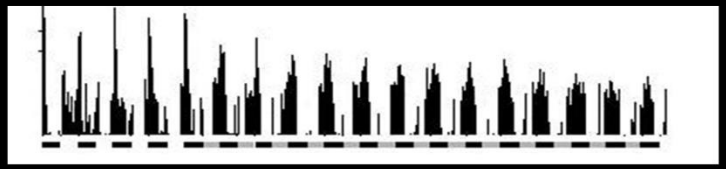

UNITED STATES
CANADA
MEXICO


worldatlas


nature publishing group
nature
scientific correspondence
Baseball teams beaten by jet lag

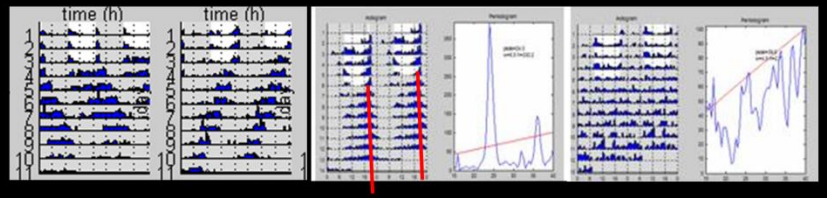
Out of the Zone: Jet-Lagged Baseball Teams Suffer Disadvantage
New research shows that long commutes affect a team's chances of winning

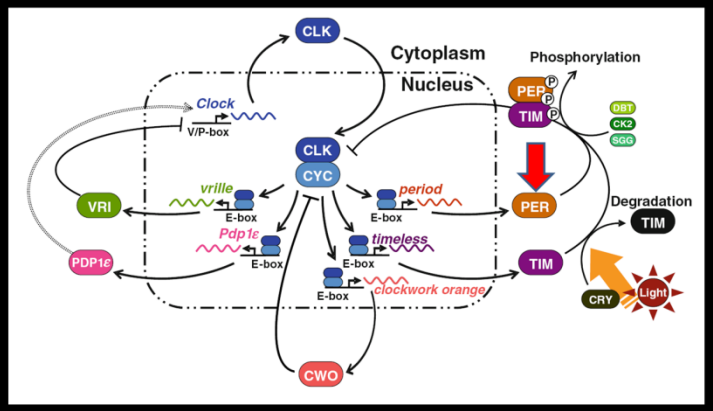
Summary



1	2
2	3
3	4
4	5
5	6
6	

~24 h





Human FASP

Summary

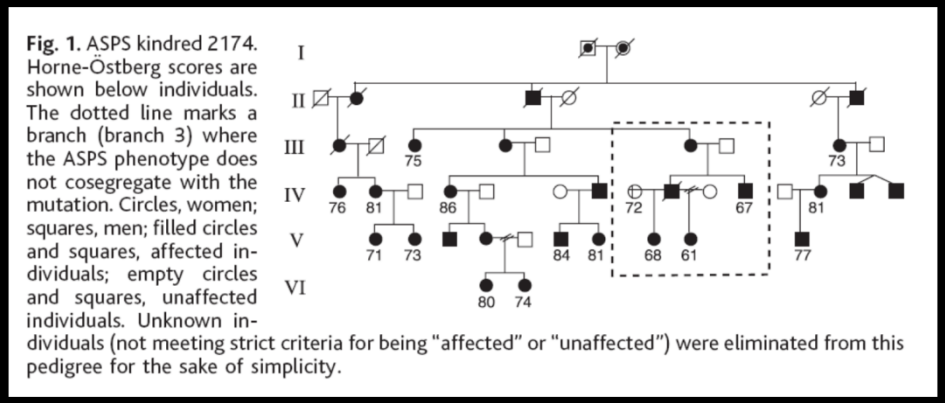
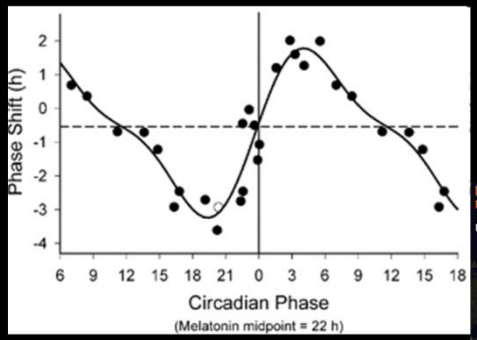


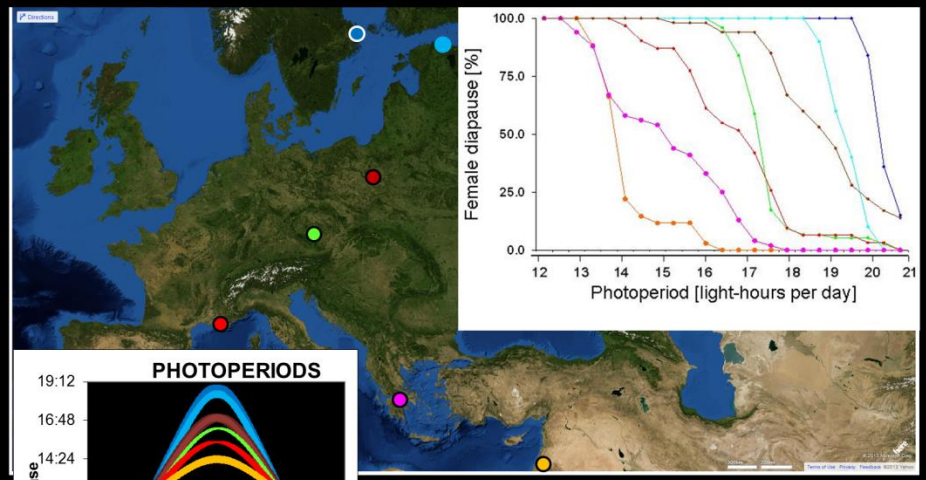
Fig. 1. ASPS kindred 2174. Horne-Östberg scores are shown below individuals. The dotted line marks a branch (branch 3) where the ASPS phenotype does not cosegregate with the mutation. Circles, women; squares, men; filled circles and squares, affected individuals; empty circles and squares, unaffected individuals. Unknown individuals (not meeting strict criteria for being "affected" or "unaffected") were eliminated from this pedigree for the sake of simplicity.

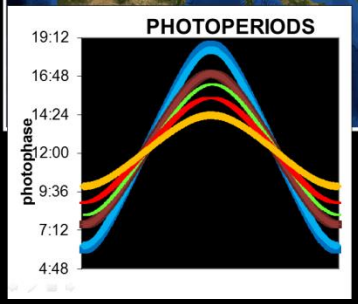
You leave SF in the afternoon (3 p.m.) arriving to London at 7a.m. (of London time), what do you do to entrain to the new regime? Time difference is 8 hrs.

a) Expose yourself to light (blue is better)
b) Hide from light



Summary





INsecTIME Marie Curie Initial Training Network on Insect Timing

https://cinchron.org/

https://cinchron.org

Search

- CIRCADIAN CHRONOBIOLOGY -

- SEASONAL CHRONOBIOLOGY -

- METABOLIC CHRONOBIOLOGY -

- COMMERCIAL CHRONOBIOLOGY -

Insect Photoperiodic Timer

CRISPR/CAS9 gene editing
Population genetics
Insect neuropeptides

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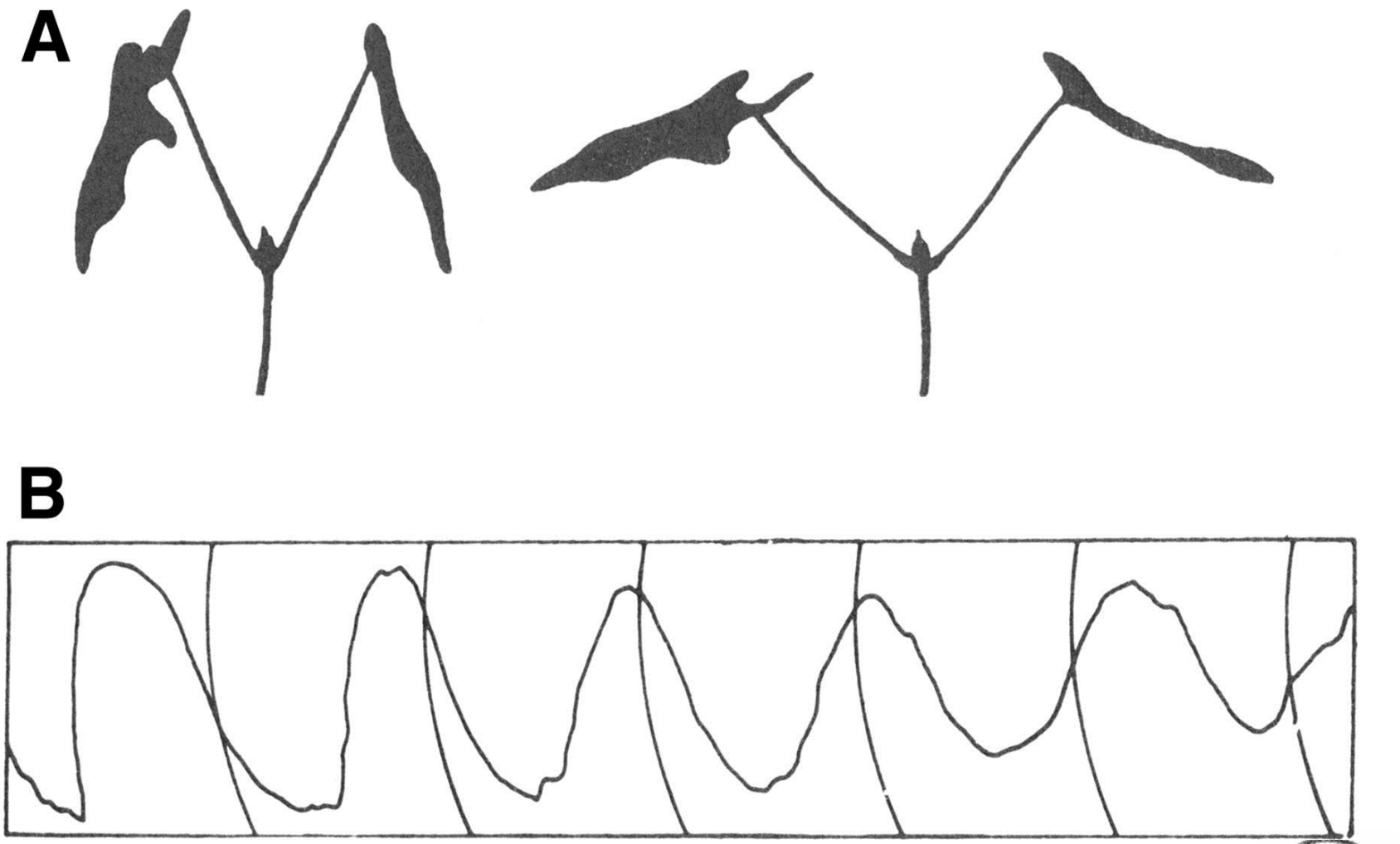
Hanka Vaneckova
Jan Martinek

EMBL Heidelberg
- Vladimír Beneš
- Jonathon Blake

Currently we have one or two PhD positions

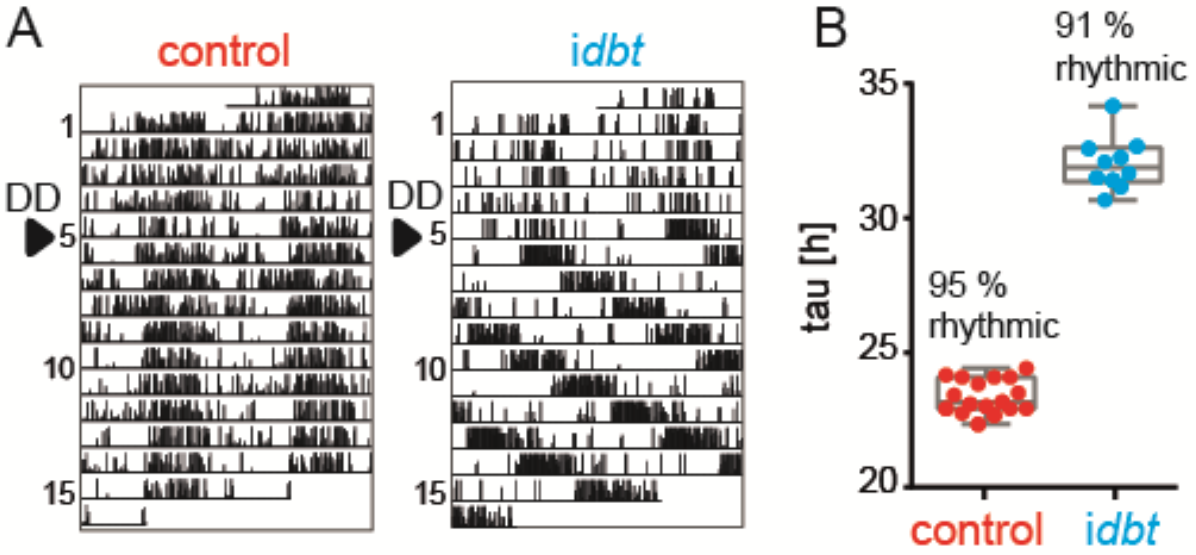
Leaf Movements of a Representative Species.(A) Sleep movements of Phaseolus coccineus.



C. Robertson McClung Plant Cell 2006;18:792-803

No circadian clock *versus* altered circadian clock

Circadian clock

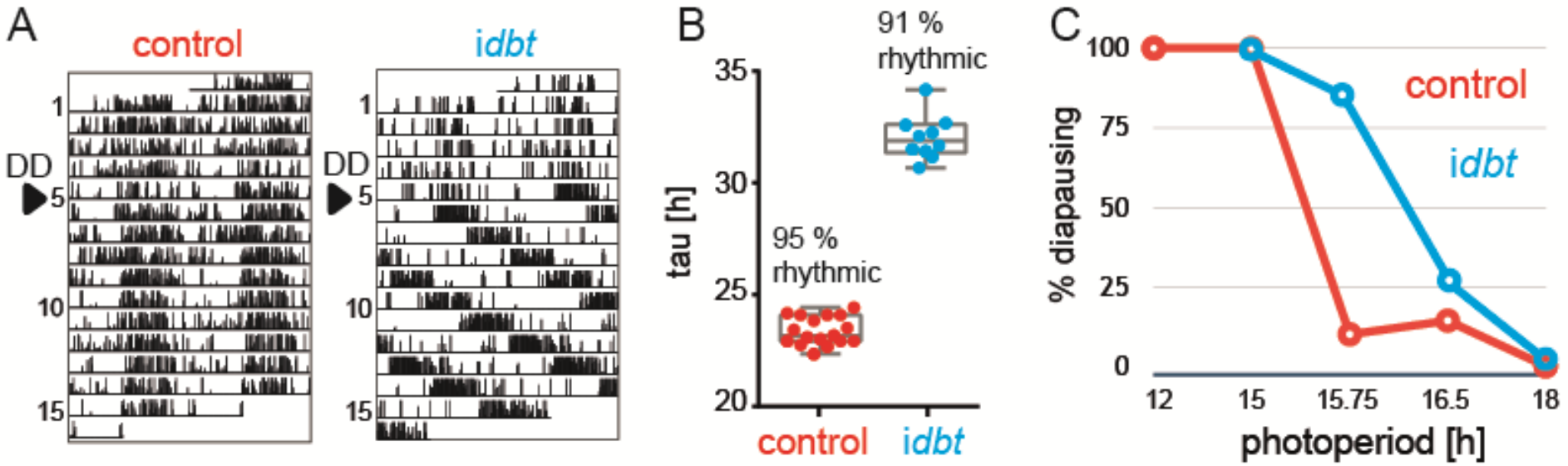


[Lenka Chodakova/Pivarciova et al., unpublished]

No circadian clock *versus* altered circadian clock

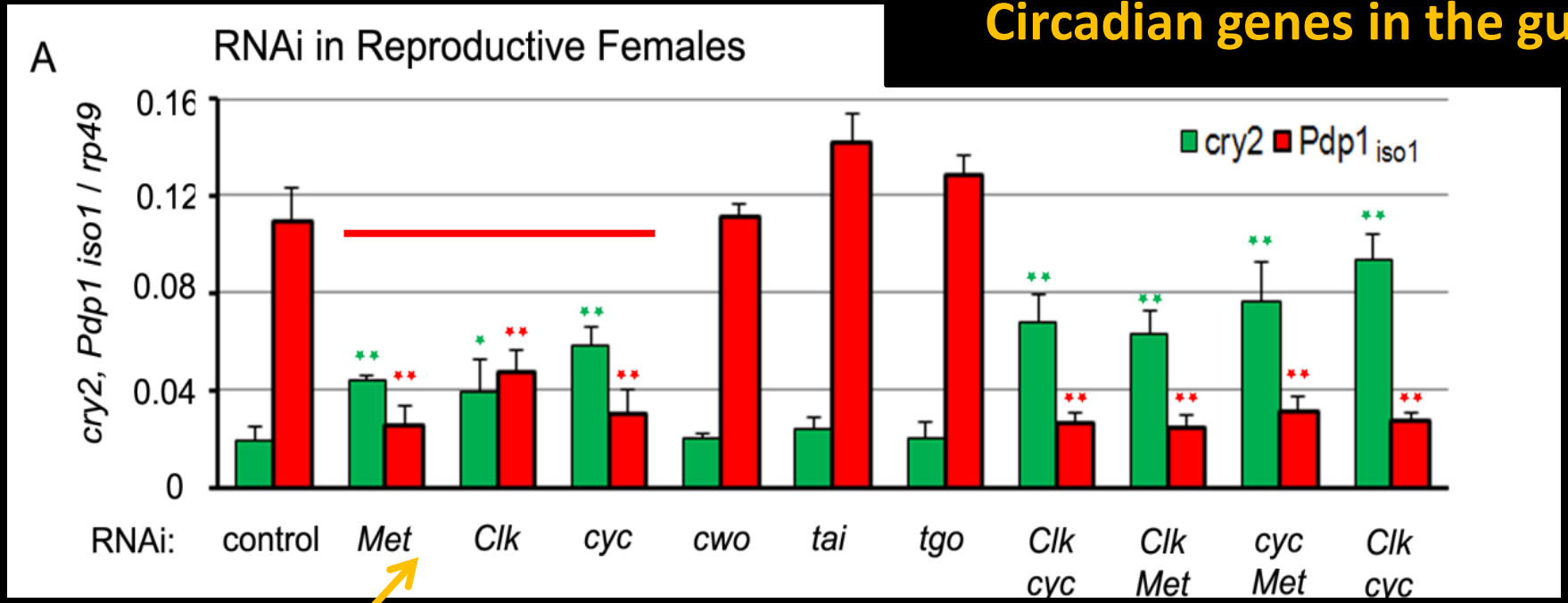
Circadian clock

Photoperiodic timer



[Lenka Chodakova/Pivarciova et al., unpublished and UNPUBLISHABLE]

Circadian genes in the gut



JH (juvenile hormone)