How to jetlag a mosquito

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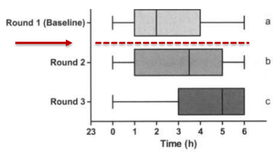
INTRODUCTION

Mosquitoes exhibit remarkable **behavioral plasticity**, enabling them to **adapt** rapidly to **changing environmental conditions**

Burmese python
Reeves et al. 2018

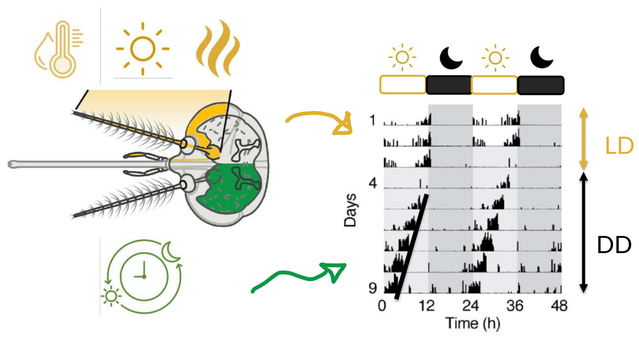
Celosia flower
Upshur et al. 2023

Distribution of insecticidal nets



Median biting time of *Anopheles funestus*
Moiroux et al. 2012

Aedes aegypti exhibit a **diurnal activity pattern** driven by **Zeitgebers**: **external cues** such as light and temperature cycles, but also by an **endogenous circadian clock**

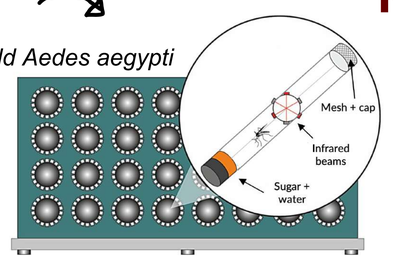


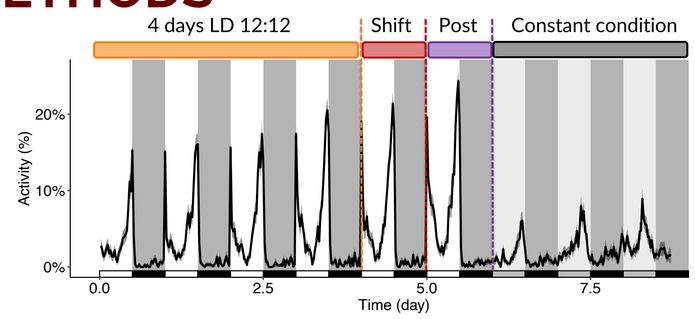
Knowledge gap

How mosquitoes' **circadian clocks** are **synchronized** by **light/dark** cycles changes

METHODS

2-days old Aedes aegypti





Shift modalities

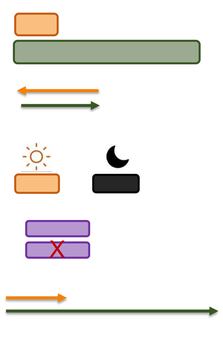
A) Synchronization Duration ?
Time to synchronize

B) Shift Direction ?
Advance or delay

C) Shift cycle ?
During day or Night

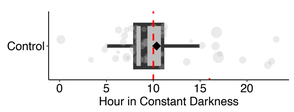
D) Post-shift recovery ?
Presence or absence

E) Shift Magnitude ?
Length of the shift

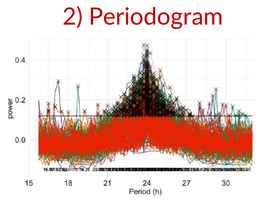


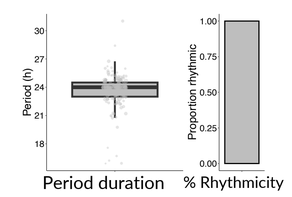
Metrics

1) Peak timing



2) Periodogram

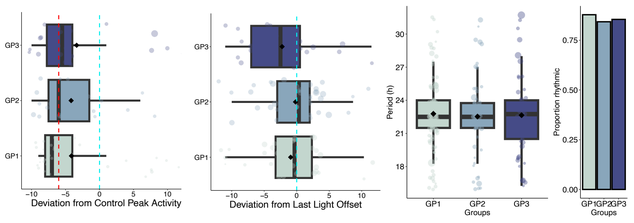




HOW DOES MOSQUITOES ADAPT TO NEW LIGHT/DARK CYCLES ?

A- Synchronization duration

Gp3: 1 day | 1 day | 1 day
Gp2: 1 day | 1 day | 4 days
Gp1: 4 days | 1 day | 1 day



- ❑ Only **1 day** is **sufficient** to **synchronize** the circadian clock
- ❑ **Synchronization duration** (1 vs. 4 days) has **no significant** effect

B- Shift direction ± 6 hours

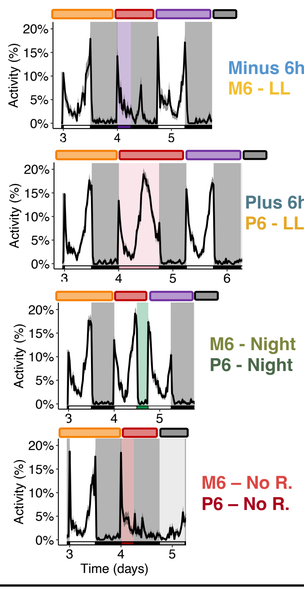
- ❑ Mosquitoes are **easier resynchronized** after **– 6h advance** than **+6h delay** shift

C- Shift cycle

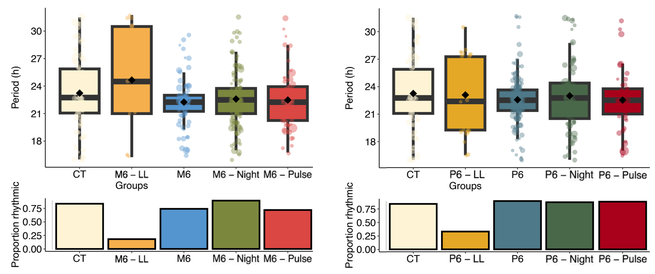
- ❑ Adjusting to a **night shift** is **more difficult** than to a **day shift**

D- Post-shift recovery

- ❑ Lack of **recovery time** hinders **synchronization**

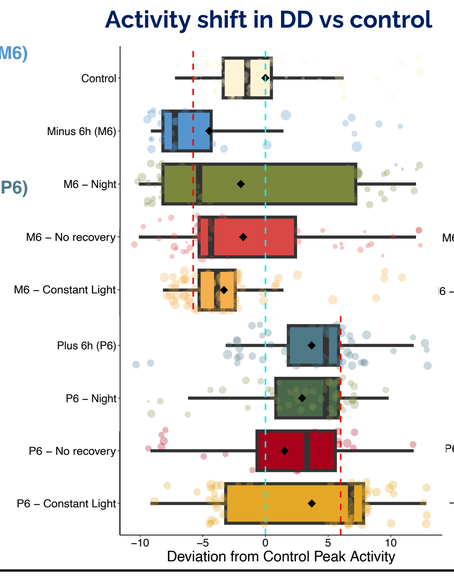


RESULTS

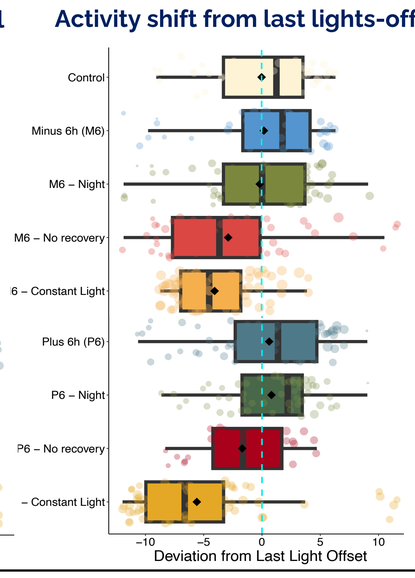


- ❑ **Constant light prevents entrainment** of the **circadian clock**
- ❑ **Free-running period** in constant darkness**: 22 hours**

Activity shift in DD vs control



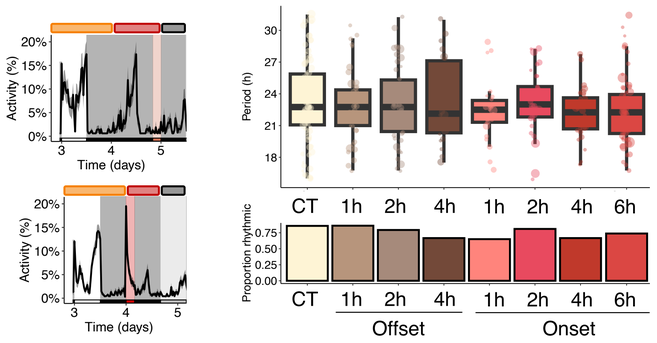
Activity shift from last lights-off



E- Shift magnitude: pulses

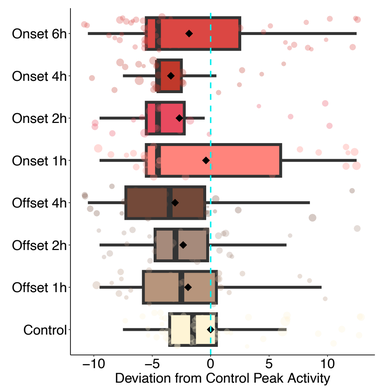
4h Offset pulse

4h Onset pulse

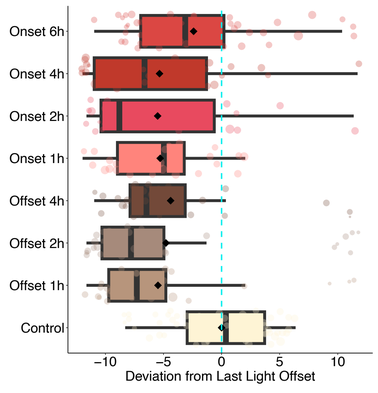


- ❑ **Onset and offset light pulses allow entrainment** of the **circadian clock**

Activity shift in DD vs control



Activity shift from last lights-off



- ❑ **A 1-hour** light pulse is **sufficient to disrupt** circadian clock
- ❑ **At least 6 hours** of light are **necessary** to **resynchronization**

CONCLUSION & PERSPECTIVES

- ❑ Both the **onset** and **offset** light serve as **strong entrainment** cues for mosquito activity
- ❑ No **sex-related differences** were observed
- ❑ Mosquitoes **adjust immediately** to **phase shift** in both directions, even without recovery
- ❑ **Starting at 6h**, mosquitoes are able to **resynchronize** with a **single light pulse**

- ❑ Increase shift **magnitude** (e.g. 14h)
- ❑ **Sleep** disruption
- ❑ Compare WT with **clock genes mutants**
- ❑ qPCR analysis on **clock genes**
- ❑ Other **Zeitgebers**

ECOLOGICAL RELEVANCE

- ❑ **Challenging** conventional views about **insect circadian clocks**
- ❑ **Advancing** rearing **procedures** in mosquitoes' experimental labs
- ❑ Exploring **ALAN** impact on mosquitoes' **synchronization**
- ❑ **Synchronizing** individuals for releases **(Sterile Insect Technic)**
- ❑ **Providing** new technics to **trap** mosquitoes

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