

### Circadian Clocks

- Circadian is latin (circa + dia) for “about a day”
- Circadian clocks are chemical pacemakers that have the following properties–
  - They are set to the local environment by cues (light, food, temp)
  - They continue to run once set for long periods (weeks to months)
  - The pace (~24 hours) is not greatly effected by temperature
- Nearly all organisms have a clock (bacteria, fungi, plants, animals, humans)
- Clocks are important for –
  - Anticipating daily and seasonal change
  - Coordinating within and between organisms
  - Conserving energy between feedings
  - Sex

---



---



---



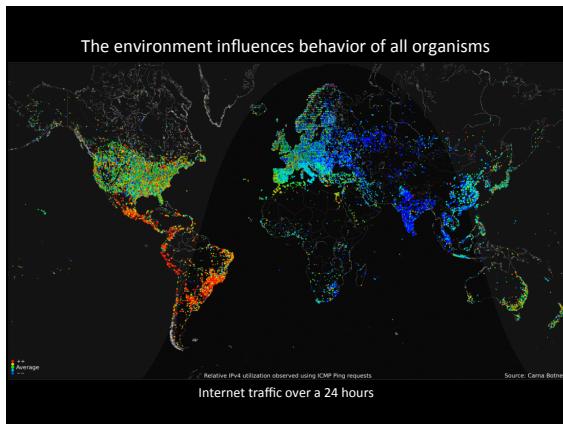
---

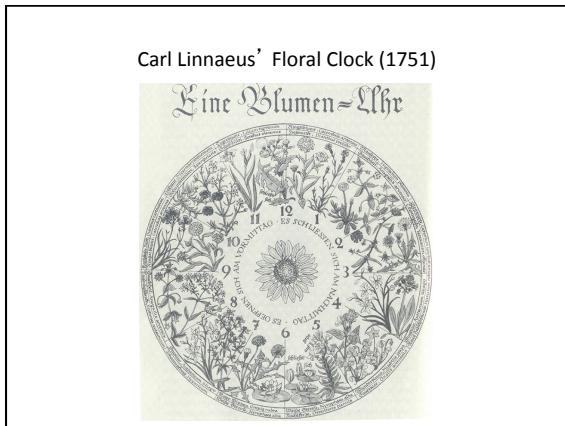


---



---






---



---



---



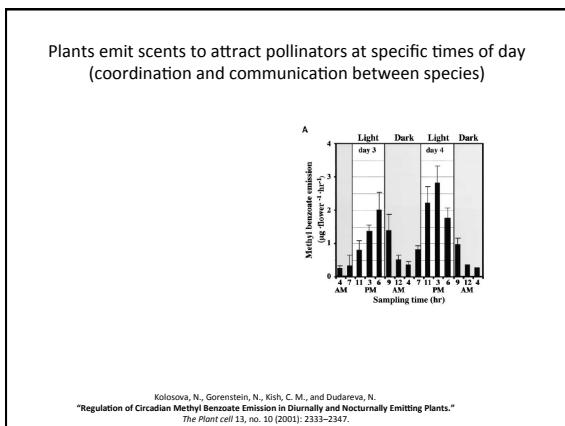
---



---



---




---



---



---



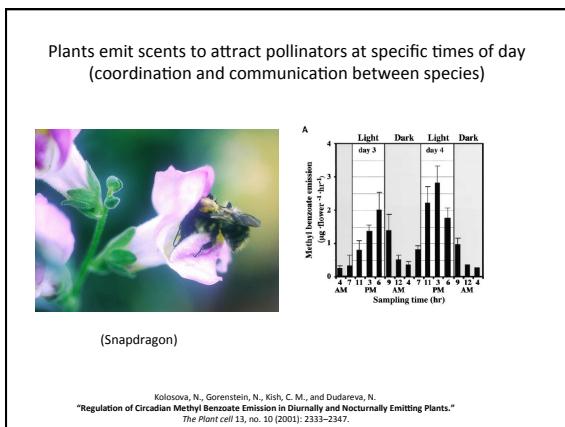
---



---



---




---



---



---



---



---



---

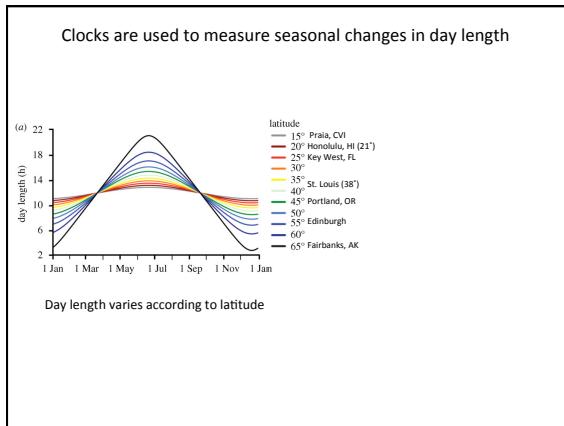
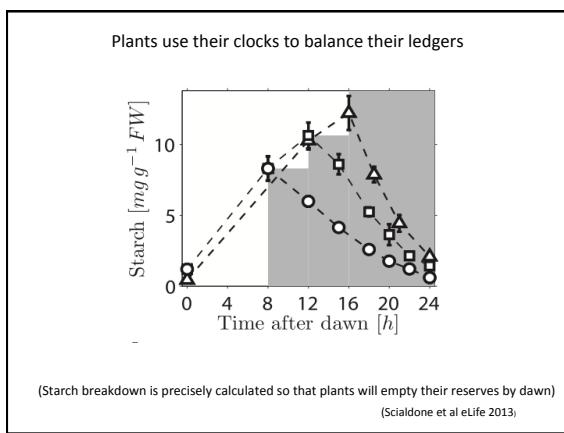
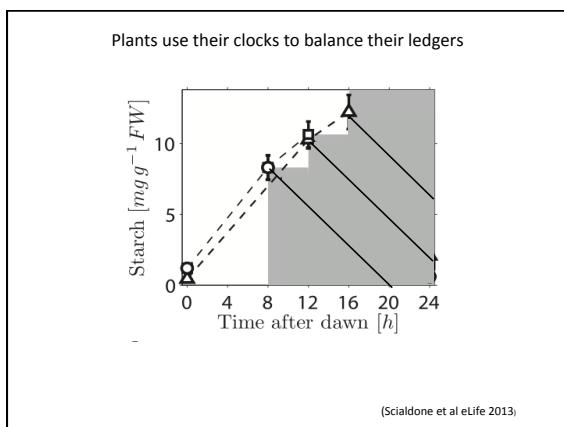
**Hawk moth**

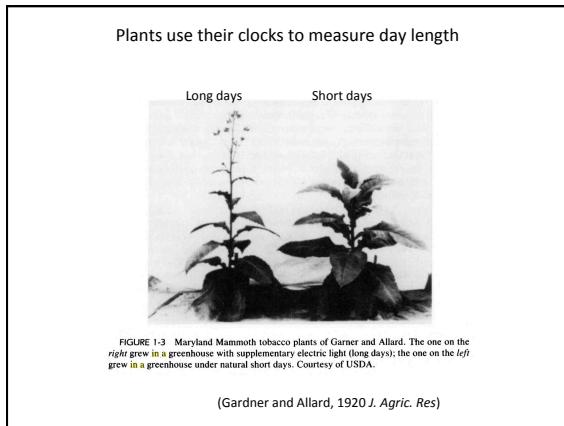
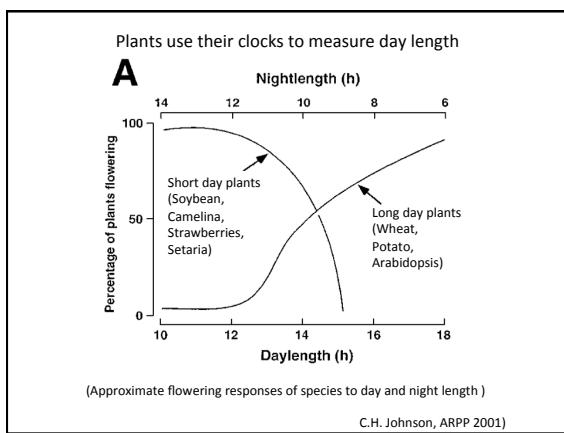
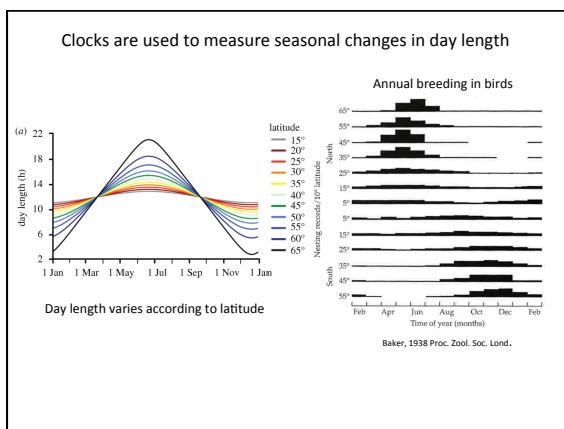
*(Nicotiana suaveolens)*

Sampling time (hr)	PM	AM	PM	AM	PM
3	3	6	9	12	4
6	9	12	4	7	11
9	12	4	7	11	3
12	4	7	11	3	6
15	3	6	9	12	4
18	6	9	12	4	7
21	3	6	9	12	4
24	6	9	12	4	7
27	3	6	9	12	4
30	6	9	12	4	7
33	3	6	9	12	4
36	6	9	12	4	7
39	3	6	9	12	4
42	6	9	12	4	7
45	3	6	9	12	4
48	6	9	12	4	7
51	3	6	9	12	4
54	6	9	12	4	7
57	3	6	9	12	4
60	6	9	12	4	7
63	3	6	9	12	4
66	6	9	12	4	7
69	3	6	9	12	4
72	6	9	12	4	7
75	3	6	9	12	4
78	6	9	12	4	7
81	3	6	9	12	4
84	6	9	12	4	7
87	3	6	9	12	4
90	6	9	12	4	7
93	3	6	9	12	4
96	6	9	12	4	7
99	3	6	9	12	4
102	6	9	12	4	7
105	3	6	9	12	4
108	6	9	12	4	7
111	3	6	9	12	4
114	6	9	12	4	7
117	3	6	9	12	4
120	6	9	12	4	7
123	3	6	9	12	4
126	6	9	12	4	7
129	3	6	9	12	4
132	6	9	12	4	7
135	3	6	9	12	4
138	6	9	12	4	7
141	3	6	9	12	4
144	6	9	12	4	7
147	3	6	9	12	4
150	6	9	12	4	7
153	3	6	9	12	4
156	6	9	12	4	7
159	3	6	9	12	4
162	6	9	12	4	7
165	3	6	9	12	4
168	6	9	12	4	7
171	3	6	9	12	4
174	6	9	12	4	7
177	3	6	9	12	4
180	6	9	12	4	7
183	3	6	9	12	4
186	6	9	12	4	7
189	3	6	9	12	4
192	6	9	12	4	7
195	3	6	9	12	4
198	6	9	12	4	7
201	3	6	9	12	4
204	6	9	12	4	7
207	3	6	9	12	4
210	6	9	12	4	7
213	3	6	9	12	4
216	6	9	12	4	7
219	3	6	9	12	4
222	6	9	12	4	7
225	3	6	9	12	4
228	6	9	12	4	7
231	3	6	9	12	4
234	6	9	12	4	7
237	3	6	9	12	4
240	6	9	12	4	7
243	3	6	9	12	4
246	6	9	12	4	7
249	3	6	9	12	4
252	6	9	12	4	7
255	3	6	9	12	4
258	6	9	12	4	7
261	3	6	9	12	4
264	6	9	12	4	7
267	3	6	9	12	4
270	6	9	12	4	7
273	3	6	9	12	4
276	6	9	12	4	7
279	3	6	9	12	4
282	6	9	12	4	7
285	3	6	9	12	4
288	6	9	12	4	7
291	3	6	9	12	4
294	6	9	12	4	7
297	3	6	9	12	4
300	6	9	12	4	7
303	3	6	9	12	4
306	6	9	12	4	7
309	3	6	9	12	4
312	6	9	12	4	7
315	3	6	9	12	4
318	6	9	12	4	7
321	3	6	9	12	4
324	6	9	12	4	7
327	3	6	9	12	4
330	6	9	12	4	7
333	3	6	9	12	4
336	6	9	12	4	7
339	3	6	9	12	4
342	6	9	12	4	7
345	3	6	9	12	4
348	6	9	12	4	7
351	3	6	9	12	4
354	6	9	12	4	7
357	3	6	9	12	4
360	6	9	12	4	7
363	3	6	9	12	4
366	6	9	12	4	7
369	3	6	9	12	4
372	6	9	12	4	7
375	3	6	9	12	4
378	6	9	12	4	7
381	3	6	9	12	4
384	6	9	12	4	7
387	3	6	9	12	4
390	6	9	12	4	7
393	3	6	9	12	4
396	6	9	12	4	7
399	3	6	9	12	4
402	6	9	12	4	7
405	3	6	9	12	4
408	6	9	12	4	7
411	3	6	9	12	4
414	6	9	12	4	7
417	3	6	9	12	4
420	6	9	12	4	7
423	3	6	9	12	4
426	6	9	12	4	7
429	3	6	9	12	4
432	6	9	12	4	7
435	3	6	9	12	4
438	6	9	12	4	7
441	3	6	9	12	4
444	6	9	12	4	7
447	3	6	9	12	4
450	6	9	12	4	7
453	3	6	9	12	4
456	6	9	12	4	7
459	3	6	9	12	4
462	6	9	12	4	7
465	3	6	9	12	4
468	6	9	12	4	7
471	3	6	9	12	4
474	6	9	12	4	7
477	3	6	9	12	4
480	6	9	12	4	7
483	3	6	9	12	4
486	6	9	12	4	7
489	3	6	9	12	4
492	6	9	12	4	7
495	3	6	9	12	4
498	6	9	12	4	7
501	3	6	9	12	4
504	6	9	12	4	7
507	3	6	9	12	4
510	6	9	12	4	7
513	3	6	9	12	4
516	6	9	12	4	7
519	3	6	9	12	4
522	6	9	12	4	7
525	3	6	9	12	4
528	6	9	12	4	7
531	3	6	9	12	4
534	6	9	12	4	7
537	3	6	9	12	4
540	6	9	12	4	7
543	3	6	9	12	4
546	6	9	12	4	7
549	3	6	9	12	4
552	6	9	12	4	7
555	3	6	9	12	4
558	6	9	12	4	7
561	3	6	9	12	4
564	6	9	12	4	7
567	3	6	9	12	4
570	6	9	12	4	7
573	3	6	9	12	4
576	6	9	12	4	7
579	3	6	9	12	4
582	6	9	12	4	7
585	3	6	9	12	4
588	6	9	12	4	7
591	3	6	9	12	4
594	6	9	12	4	7
597	3	6	9	12	4
600	6	9	12	4	7
603	3	6	9	12	4
606	6	9	12	4	7
609	3	6	9	12	4
612	6	9	12	4	7
615	3	6	9	12	4
618	6	9	12	4	7
621	3	6	9	12	4
624	6	9	12	4	7
627	3	6	9	12	4
630	6	9	12	4	7
633	3	6	9	12	4
636	6	9	12	4	7
639	3	6	9	12	4
642	6	9	12	4	7
645	3	6	9	12	4
648	6	9	12	4	7
651	3	6	9	12	4
654	6	9	12	4	7
657	3	6	9	12	4
660	6	9	12	4	7
663	3	6	9	12	4
666	6	9	12	4	7
669	3	6	9	12	4
672	6	9	12	4	7
675	3	6	9	12	4
678	6	9	12	4	7
681	3	6	9	12	4
684	6	9	12	4	7
687	3	6	9	12	4
690	6	9	12	4	7
693	3	6	9	12	4
696	6	9	12	4	7
699	3	6	9	12	4
702	6	9	12	4	7
705	3	6	9	12	4
708	6	9	12	4	7
711	3	6	9	12	4
714	6	9	12	4	7
717	3	6	9	12	4
720	6	9	12	4	7
723	3	6	9	12	4
726	6	9	12	4	7
729	3	6	9	12	4
732	6	9	12	4	7
735	3	6	9	12	4
738	6	9	12	4	7
741	3	6	9	12	4
744	6	9	12	4	7
747	3	6	9	12	4
750	6	9	12	4	7
753	3	6	9	12	4
756	6	9	12	4	7
759	3	6	9	12	4
762	6	9	12	4	7
765	3	6	9	12	4
768	6	9	12	4	7
771	3	6	9	12	4
774	6	9	12	4	7
777	3	6	9	12	4
780	6	9	12	4	7
783	3	6	9	12	4
786	6	9	12	4	7
789	3	6	9	12	4
792	6	9	12	4	7
795	3	6	9	12	4
798	6	9	12	4	7
801	3	6	9	12	4
804	6	9	12	4	7
807	3	6	9	12	4
810	6	9	12	4	7
813	3	6	9	12	4
816	6	9	12	4	7
819	3	6	9	12	4
822	6	9	12	4	7
825	3	6	9	12	4
828	6	9	12	4	7
831	3	6	9	12	4
834	6	9	12	4	7
8					

Bioluminescent dinoflagellates use their clocks increase glowing at night to use for defense







Soybeans are very sensitive to day length, and breeder have developed many types that will flower correctly for the latitude

Different soy varieties (000-IX) and the zones where they are planted in the USA (some states span multiple zones - Missouri farmers plant III-V)

<http://genezoo.missouri.edu/soybean.cfm>

---

---

---

---

---

---

---

---

---

### Circadian Clocks

- Clocks are important for –
  - Anticipating daily and seasonal change
    - Knowing when food (and your predators) are around is helpful
  - Coordinating within and between organisms
    - Timing of reproduction between sexes
    - When will pollinators be around to help you reproduce
  - Conserving energy between feedings
    - Generate starch during the day, and efficiently break it down at night
    - We make glucose to feed our brain at night (and eating at night may promote obesity!)
- Time lapse is also good for monitoring plants movements –
- <http://plantsinmotion.bio.indiana.edu/plantmotion/starthere.html>

---

---

---

---

---

---

---

---

---

Time-Restricted Feeding Is a Preventative and Therapeutic Intervention against Diverse Nutritional Challenges

Amane Chik, Arie Zempar, Phuong Ma, Sathyanarayana Pendaboineni  
DOI: <https://doi.org/10.1101/June2014.11.01> |

**Highlights**

- Time-restricted feeding (TRF) confines food access to 5–12 hr during the active phase
- TRF is a therapeutic intervention against obesity without calorie restriction
- TRF protects against metabolic diseases even when briefly interrupted on weekends
- TRF is effective against high-fat, high-fructose, and high-sucrose diets

**Summary**

Because current therapeutics for obesity are limited and only offer modest improvements, novel interventions are needed. Preventing obesity with time-restricted feeding (TRF; 5–9 hr food access in the active phase) is promising, yet its therapeutic applicability against preexisting obesity, diverse dietary conditions, and metabolic diseases is unclear. We show that TRF ameliorated metabolic diseases arising from a variety of obesogenic diets, and that benefits were proportional to the feeding duration. Furthermore, protective effects were maintained even when TRF was temporarily interrupted by ad libitum access to food during weekends, a regimen particularly relevant to human lifestyle. Finally, TRF stabilized and reversed the progression of metabolic diseases in mice with preexisting obesity and type II diabetes. We establish clinically relevant parameters of TRF for preventing and treating obesity and metabolic disorders, including type II diabetes, hepatic steatosis, and hypercholesterolemia.

**Graphical Abstract**

---

---

---

---

---

---

---

---

---