

STUDY ABROAD: Field Programs

THURSDAY Oct. 11th 12:00 – 1:30 PM

“Red Interaction Corridor” (Bio124)

Open House with Cookies and Coffee

Alexandra Diemer, Round River; Michael Girsch, SFS; Sam Massad, OTS; Eric Stengrevics SEA Semester
Reed Student Health Course Participants

TODAY



Marine Resource Studies
Turks & Caicos Islands



Himalayan Studies-Bhutan

Watersheds of the Tropics-Australia



French Polynesia



Conservation Biology
Patagonia



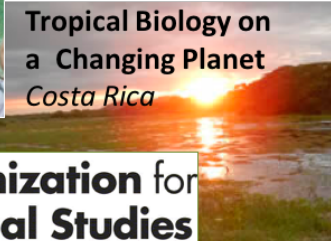
Darhad Valley – Mongolia



Ecology & Conservation
S. Africa



Global Health



Tropical Biology on a Changing Planet
Costa Rica



Organization for Tropical Studies

Hitching – undirected movement

Taxis – following a direct measure of goal

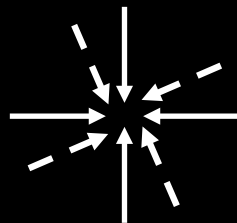
Ded Reckoning = path integration – requires logging

Piloting - requires a map (familiarity)

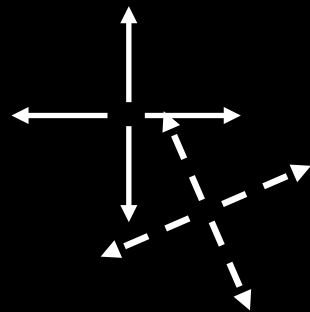
Navigation = Targeting distant goals across unfamiliar territory
– requires a map and a compass

Charting – requires a map, compass, and “map sense”

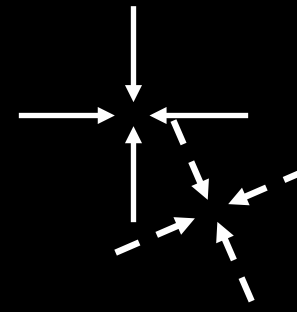
“Attributes”



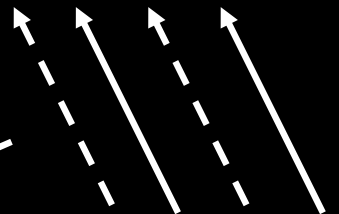
hunting



dispersal



homing



migration

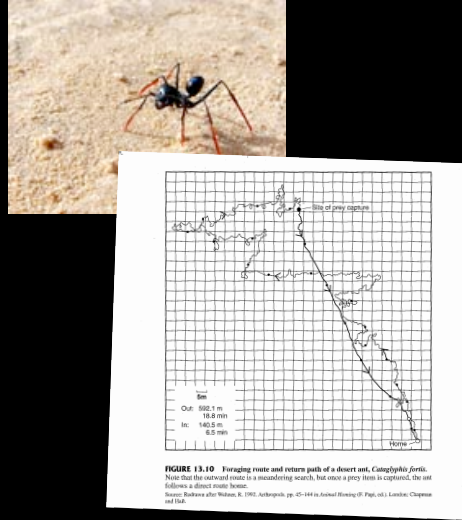
Hitching Strategy



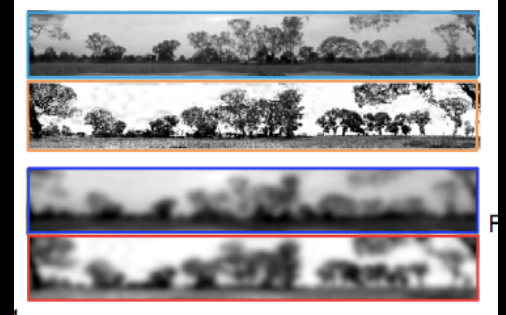
Taxis Strategy



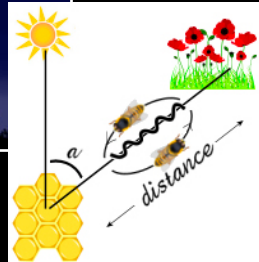
Dead Reckoning



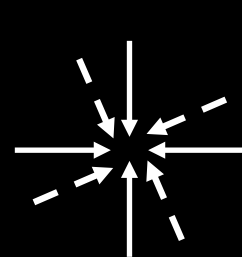
Piloting strategy



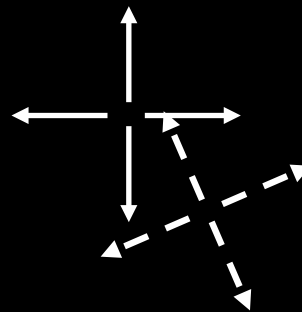
Navigation



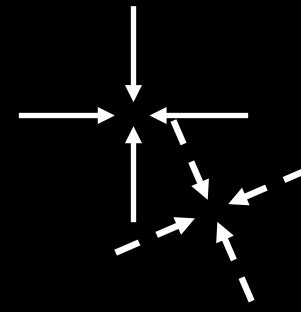
Charting



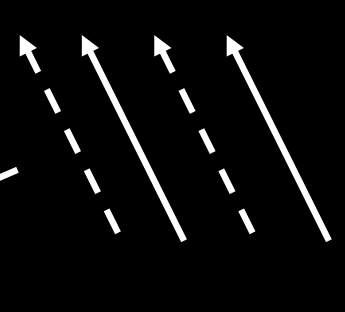
hunting



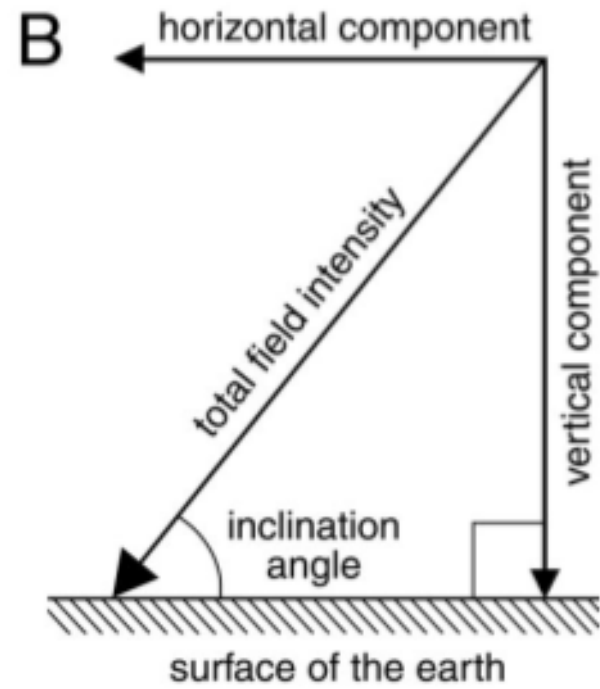
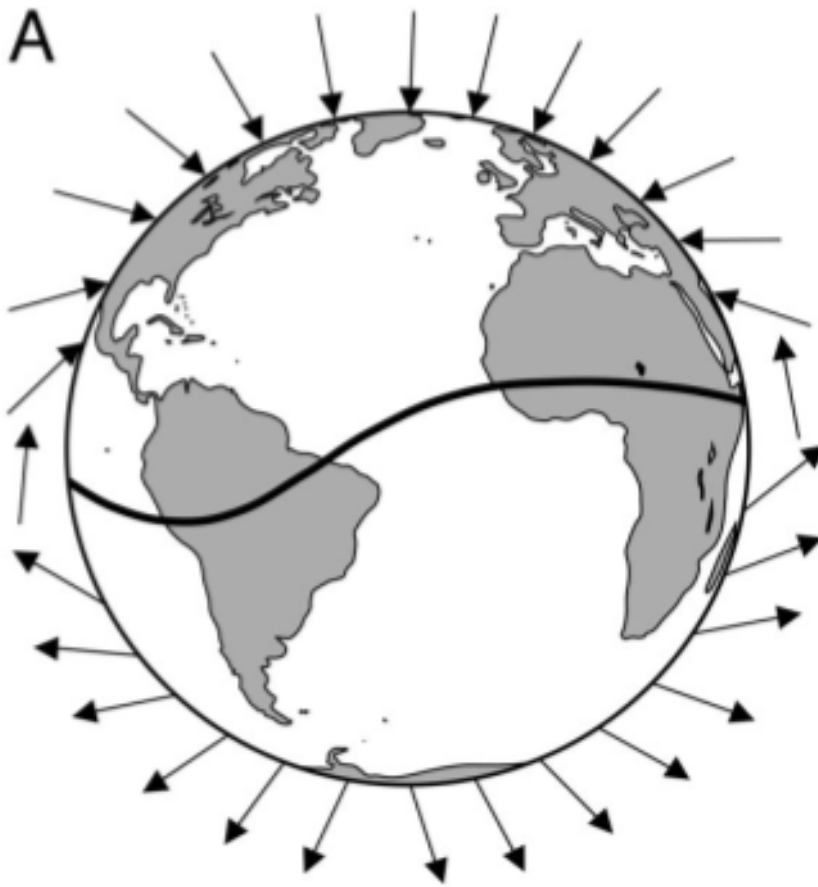
dispersal



homing

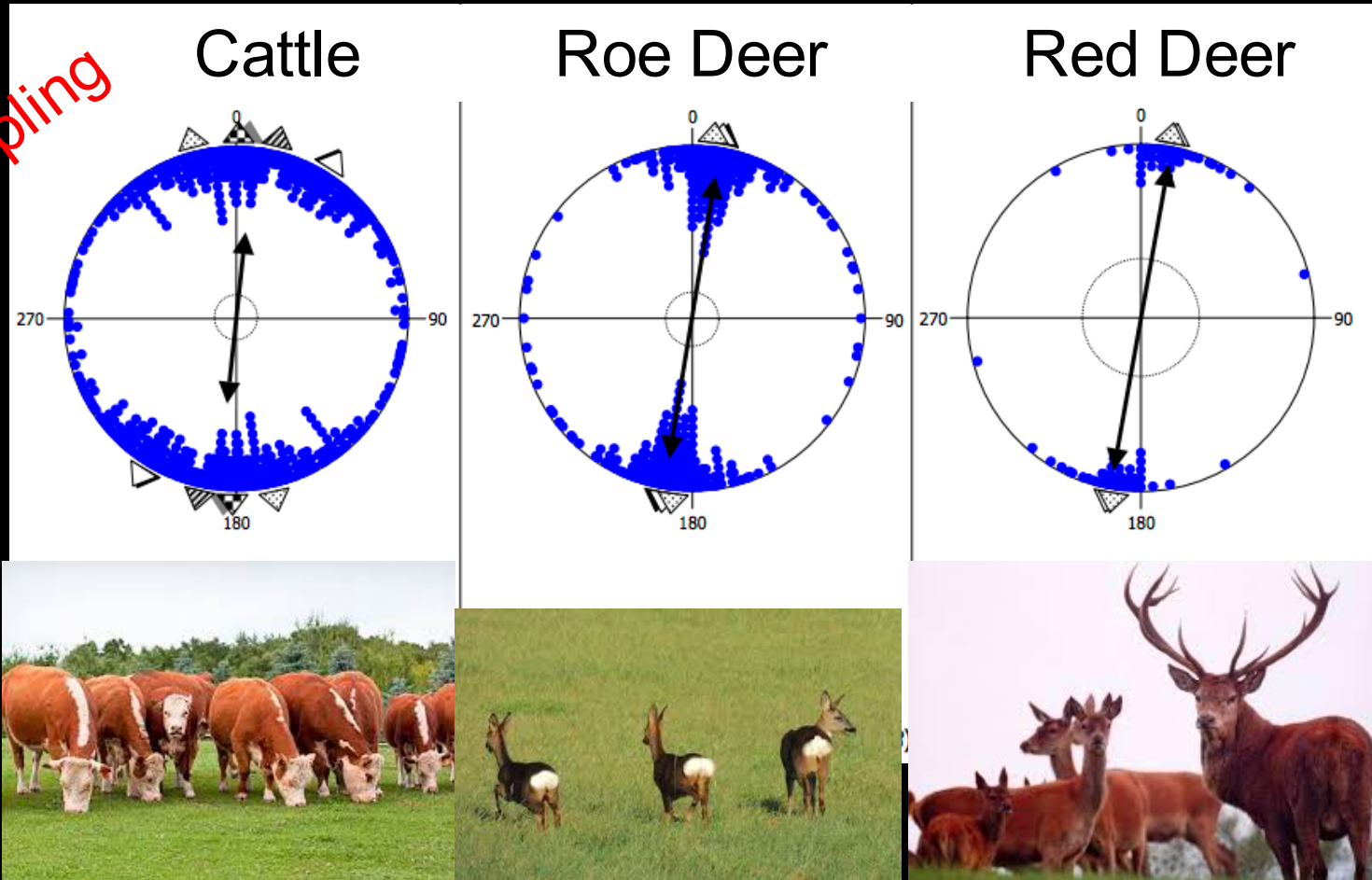


migration



Who can detect the earth's magnetic field?

Scan sampling

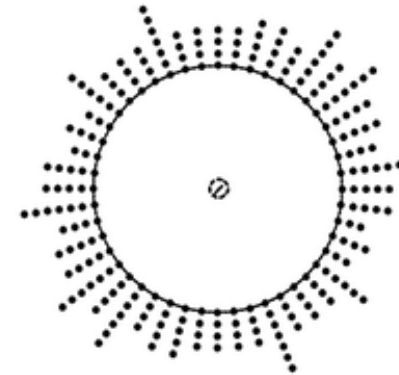
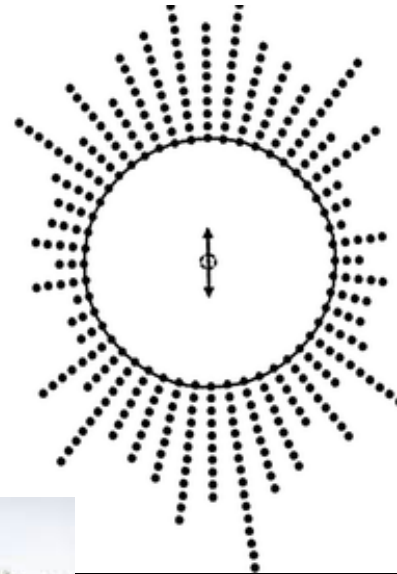
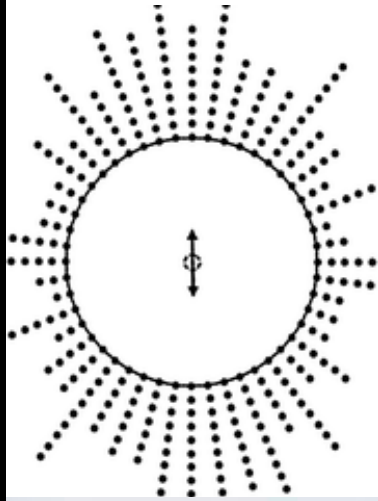


Analysis of Body Position of Cattle Using Google Earth. We determined the axial directions of 8,510 cattle of 308 randomly selected localities (pastures) from six continents: Africa (Morocco, South Africa), Asia (India), Australia, Europe (Belgium, Denmark, France, Germany, Ireland, Netherlands, Russia, United Kingdom), North America (Connecticut, Kansas, Massachusetts, Montana, New York, Oregon, Texas), and South America (Argentina) by using **satellite images freely available at Google Earth** mapping services.

Individual

Medium

High



[Journal of Comparative Physiology A](#)

August 2013, Volume 199, Issue 8, pp 695–701 | [Cite as](#)

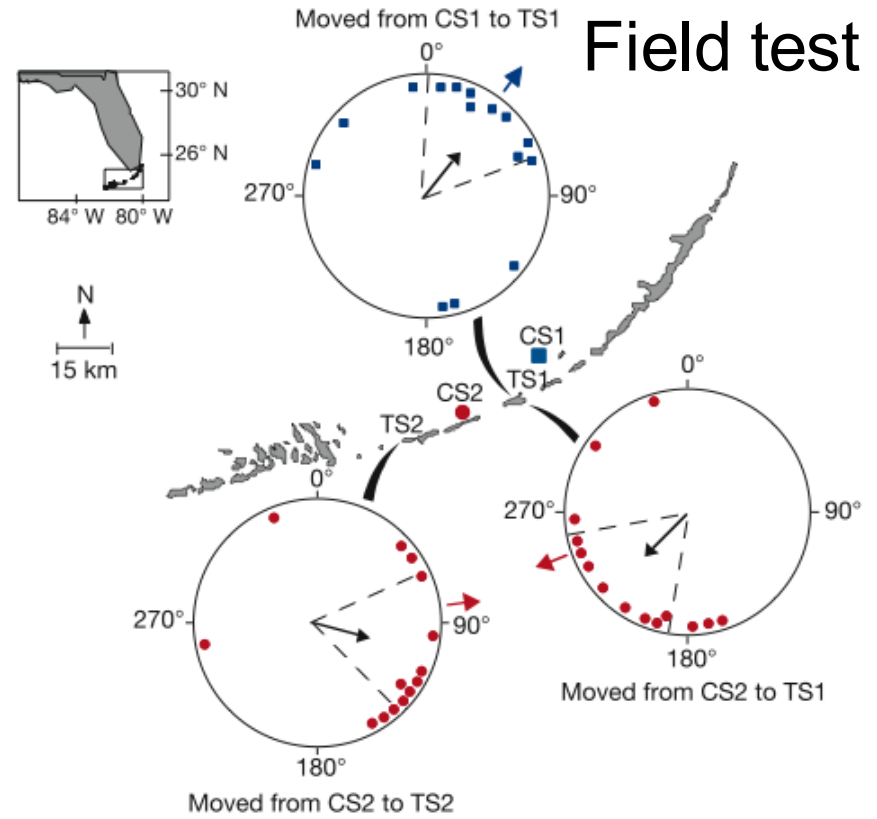
Cattle on pastures do align along the North–South axis,
but the alignment depends on herd density

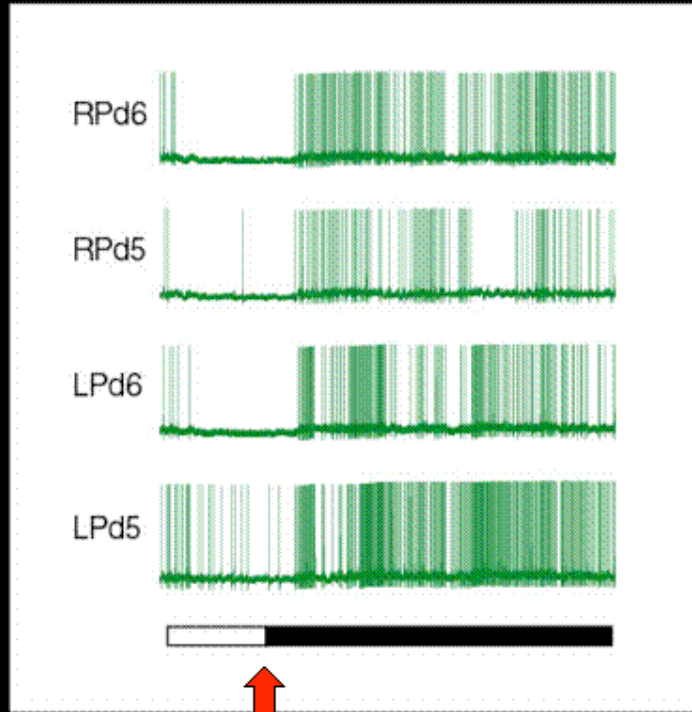
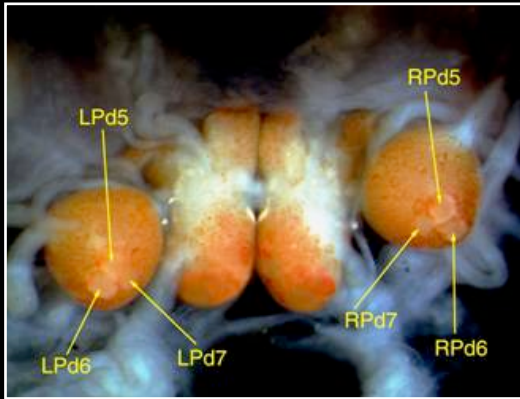
Authors

[Authors and affiliations](#)

P. Slaby, K. Tomanova, M. Vacha

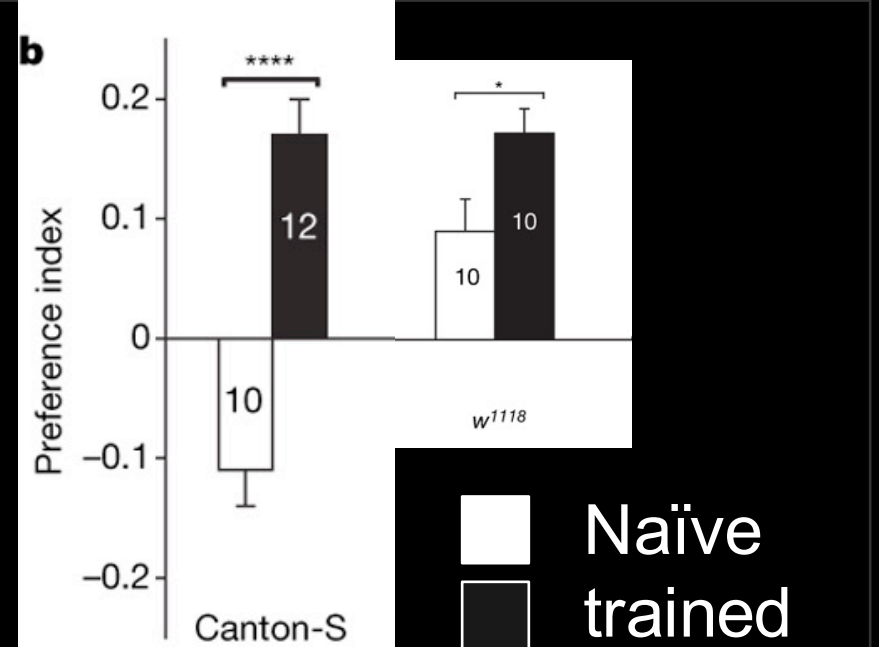
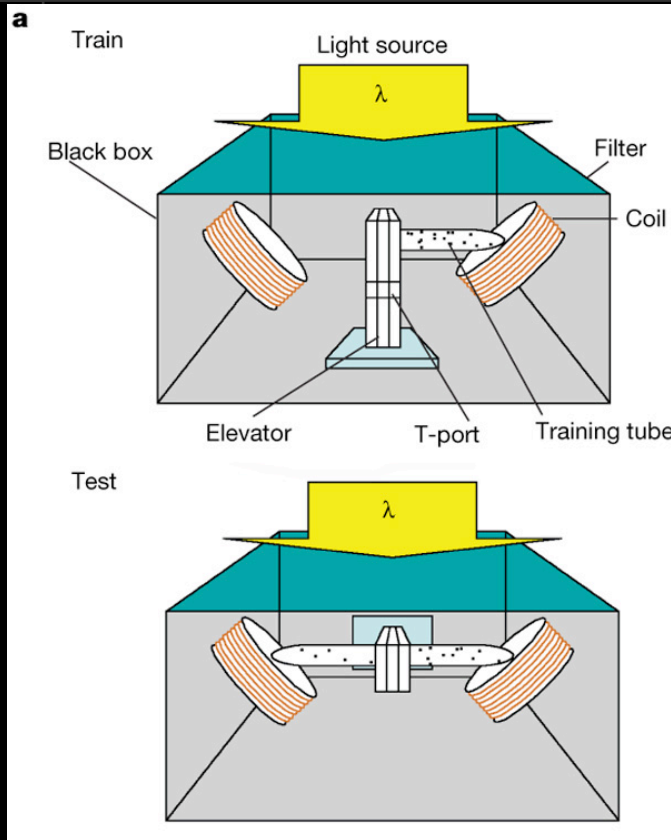
Field test





↑
field changed





Cryptochrome mutants cannot learn a magnetic field

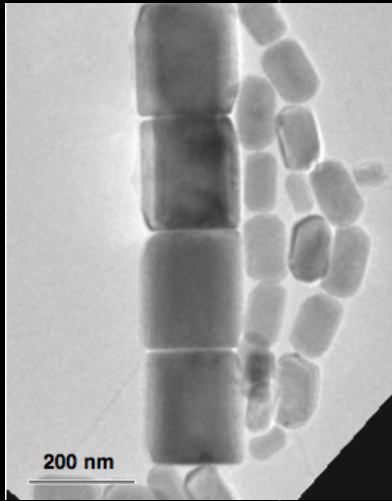
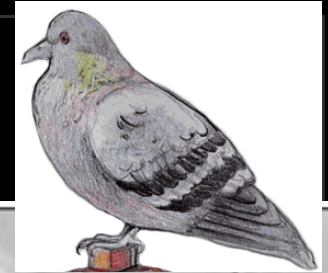
Gegear et al., (2008) Nature 454:1014-1018



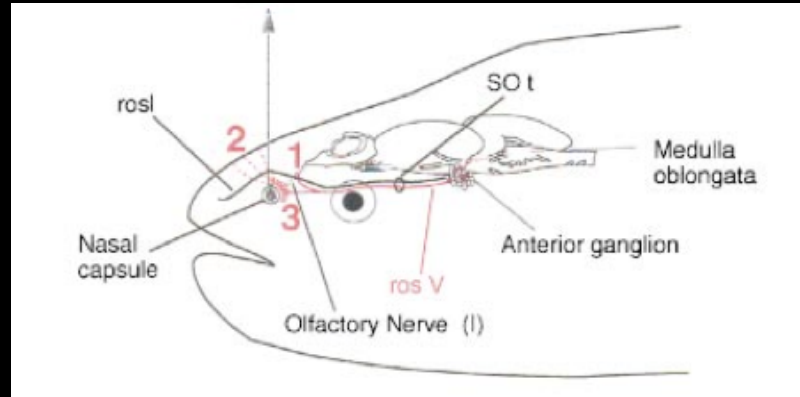
What does a magnetosensor
look like?

Physical Biologist

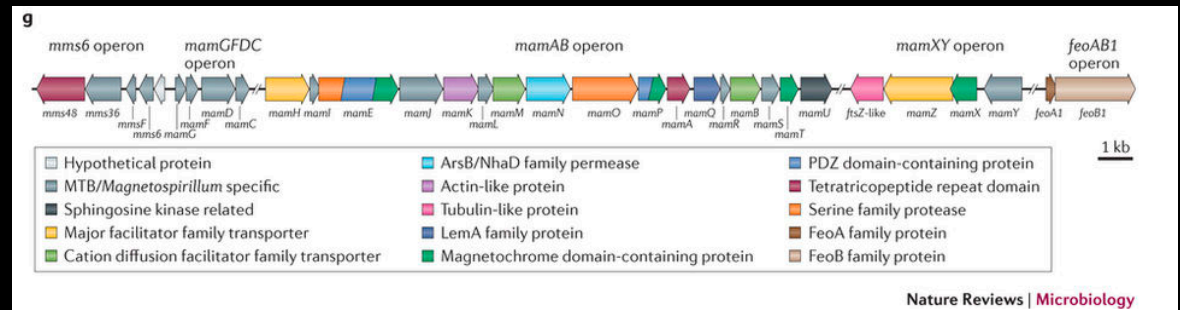
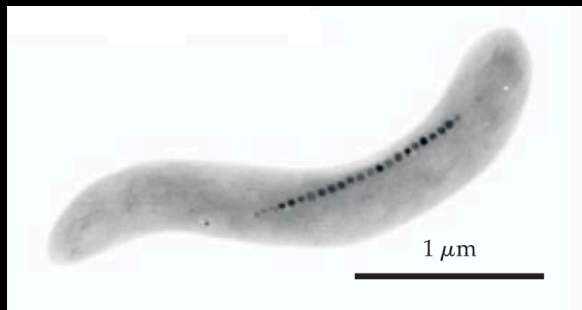
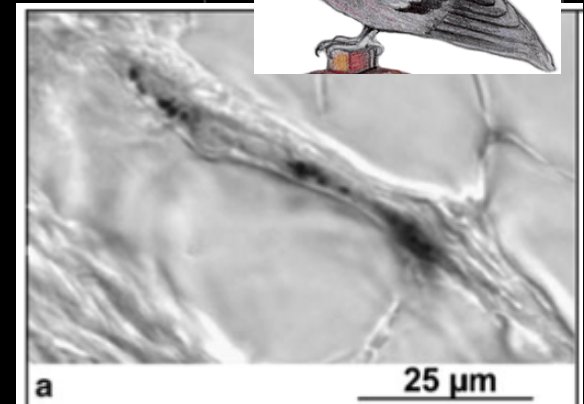
Magnetite based magnetoreception?

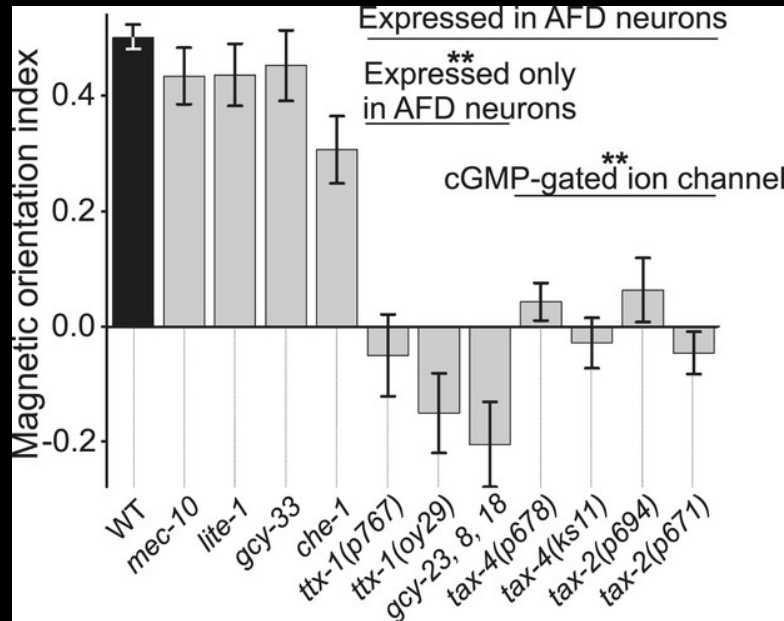
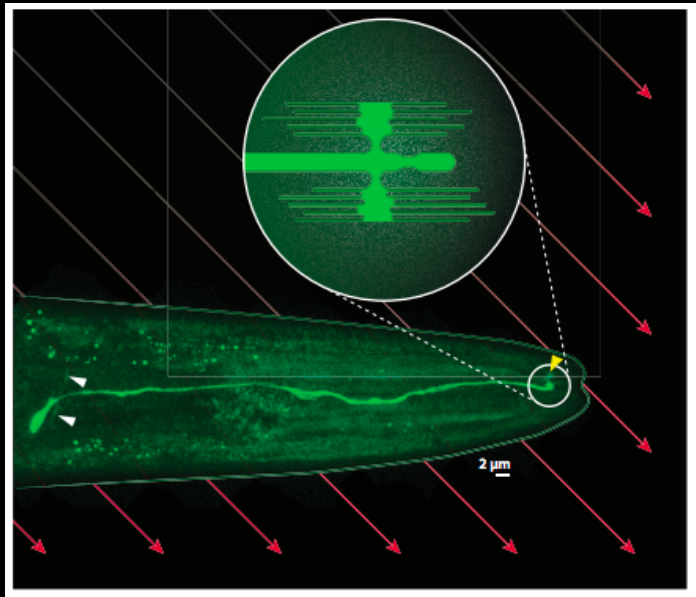


Blackmore 1975



Walker et al., 1997 Nature 390:371.





mechanosensory mutants

AFD neuron mutants

A. Vidal-Gadea et al., "Magnetosensitive neurons mediate geomagnetic orientation in *Caenorhabditis elegans*," *eLife*, doi:10.7554/eLife.07493, 2015.

but....

Worms' Magnetic Sense Questioned

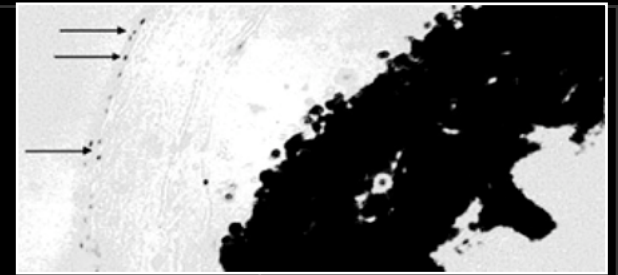
Unsuccessful attempts to reproduce the results of a 2015 study reporting that *C. elegans* orient themselves by Earth's magnetic field spark debate among researchers.

Apr 25, 2018
ABBY OLENA



A contrast-enhanced image of an agar plate showing the tracks that worms carved on the surface while migrating towards a magnet placed beneath the solid circle (top). The control circle (bottom) is in dashed lines. Worms began in the middle of the plate. ANDRÉS VIDAL-GADEA

magnetite

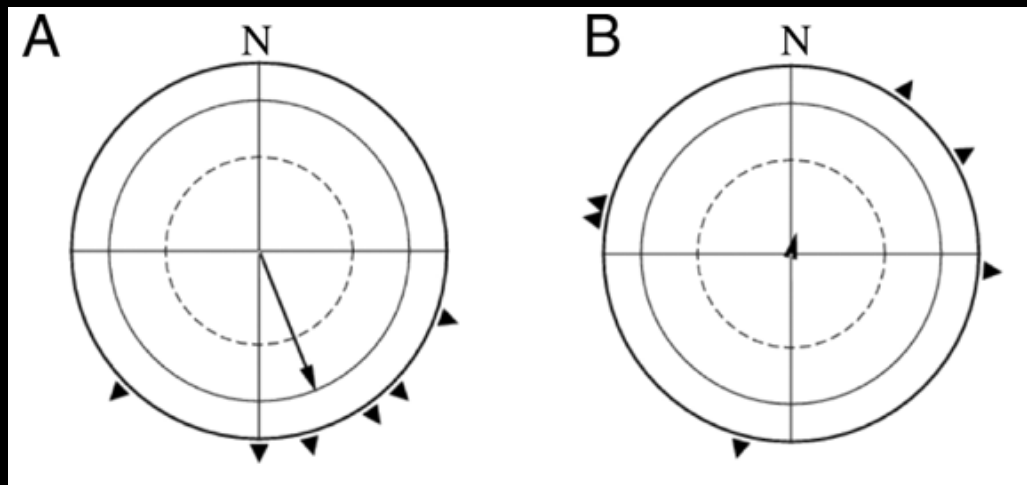


Nest Site

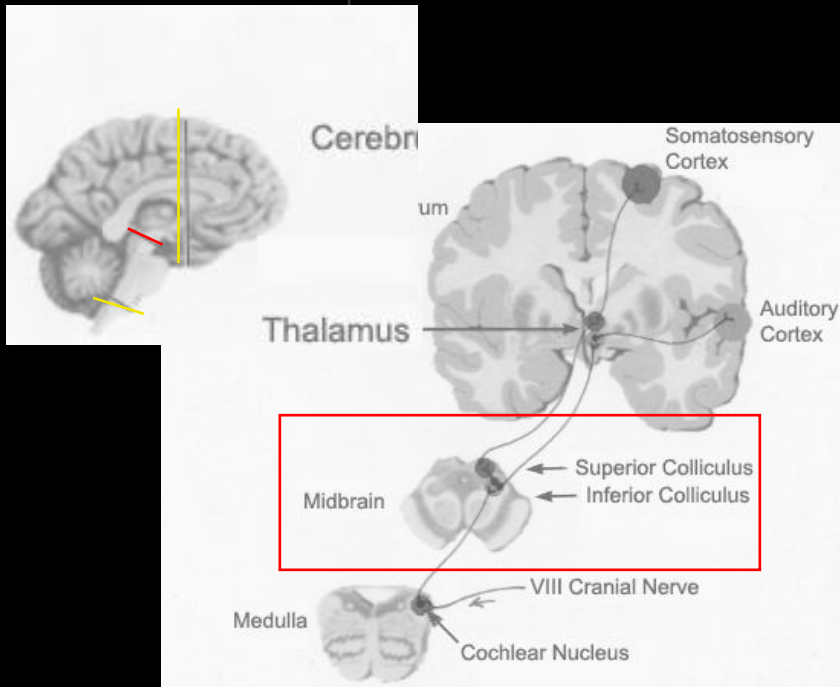
Cornea

Control

Anesthetized

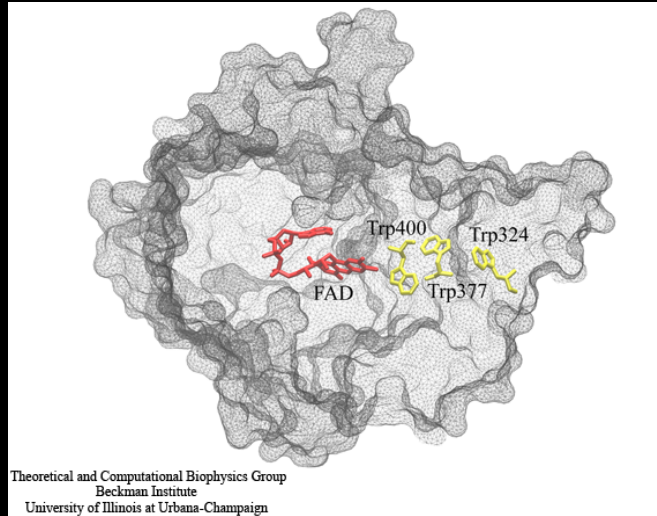


Wegner, Begall and Burda (2006) Magnetic compass in the cornea: local anaesthesia impairs orientation in a mammal. JEB 209:4747-4750.



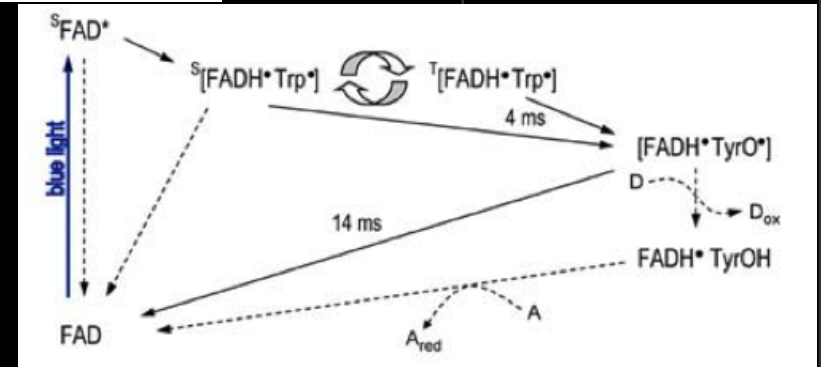
C-fos staining



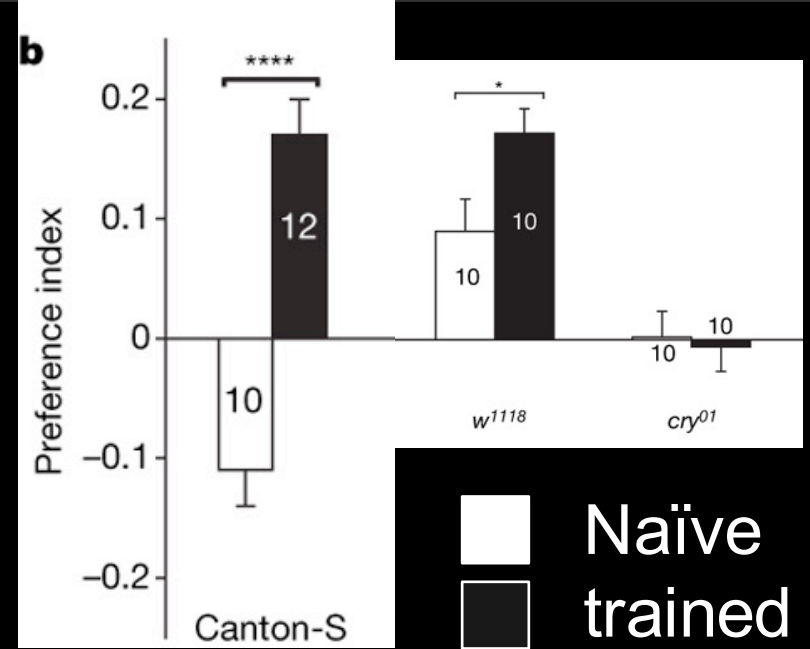
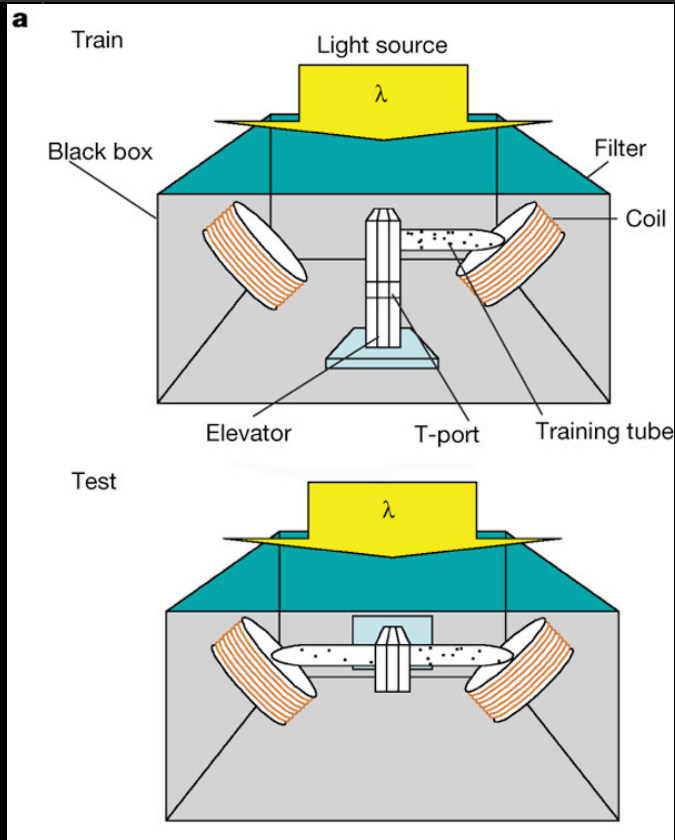


Cry gene
cryptochrome opsin

Vision mediated magnetic sense



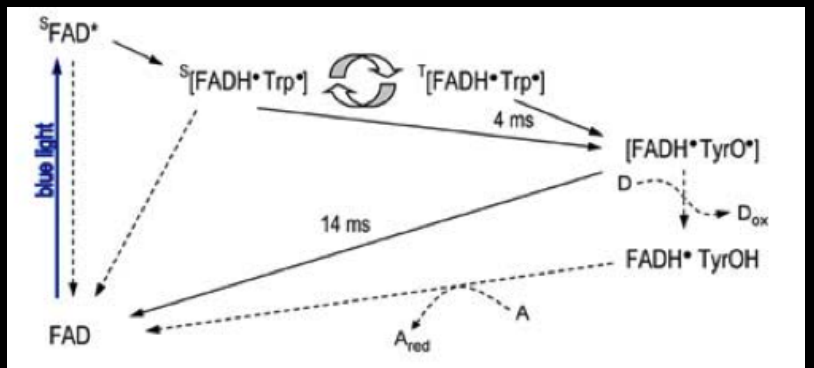
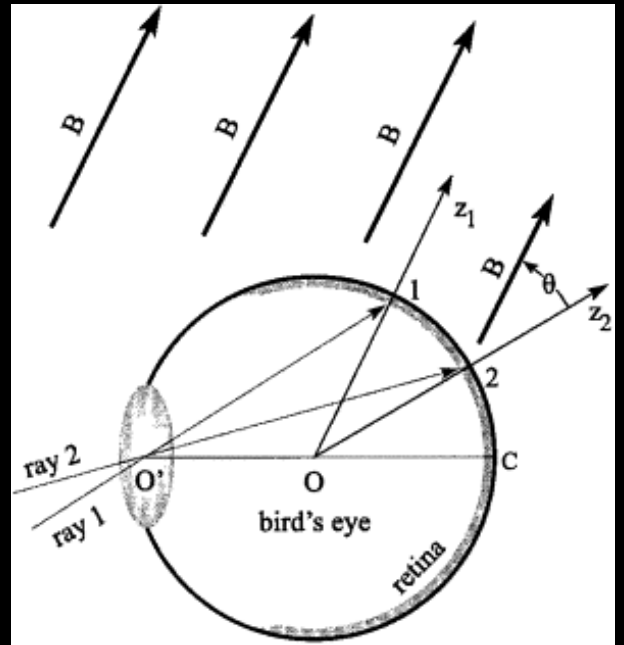
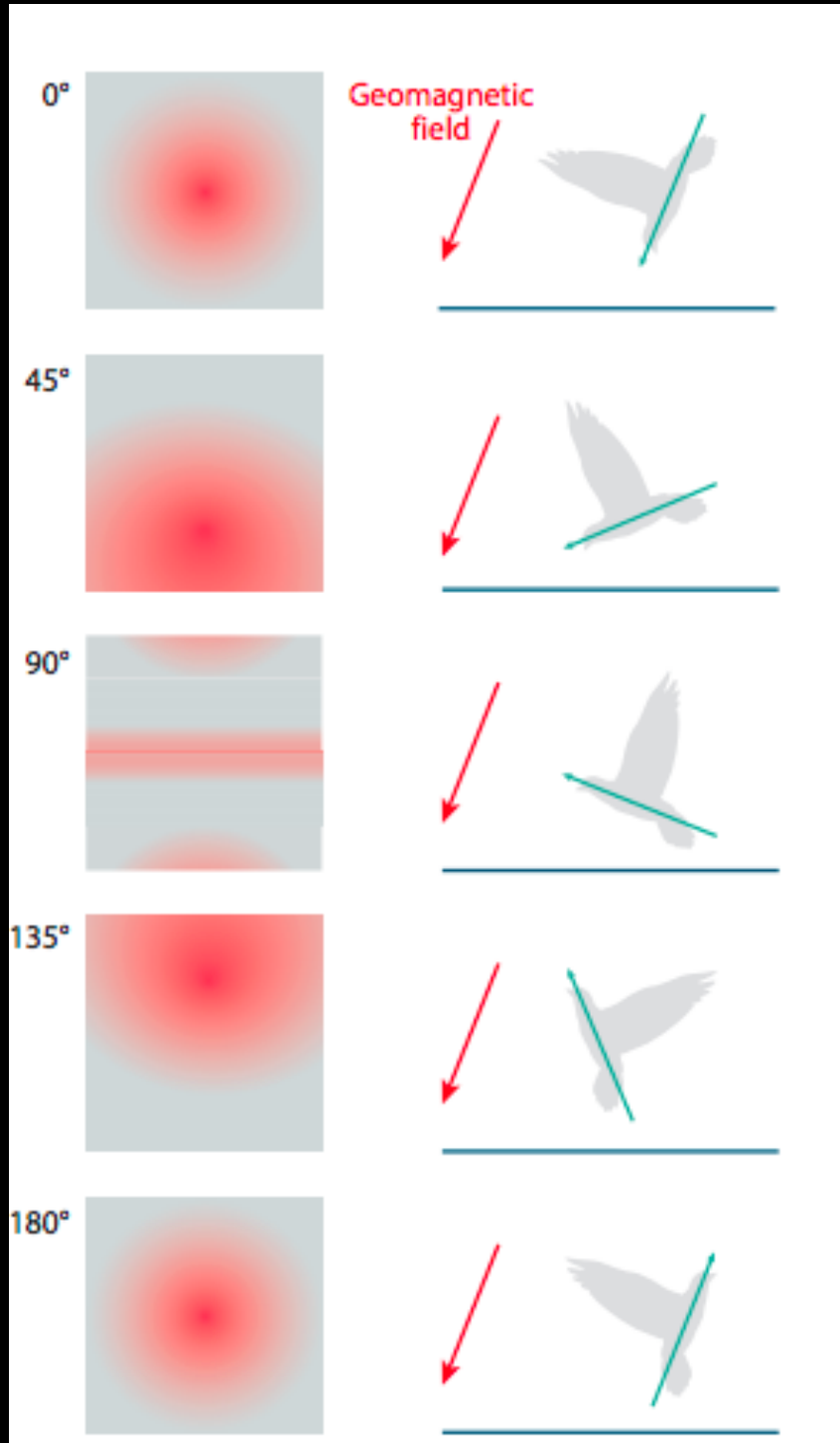
“radical pairs hypothesis” or “chemical sense”

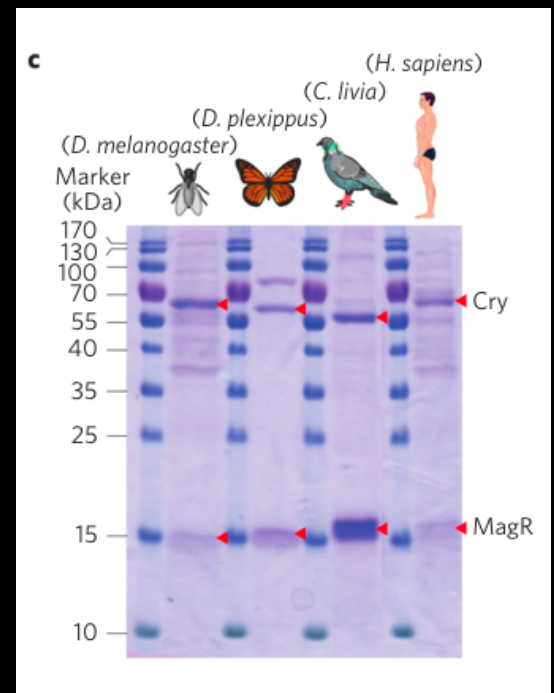
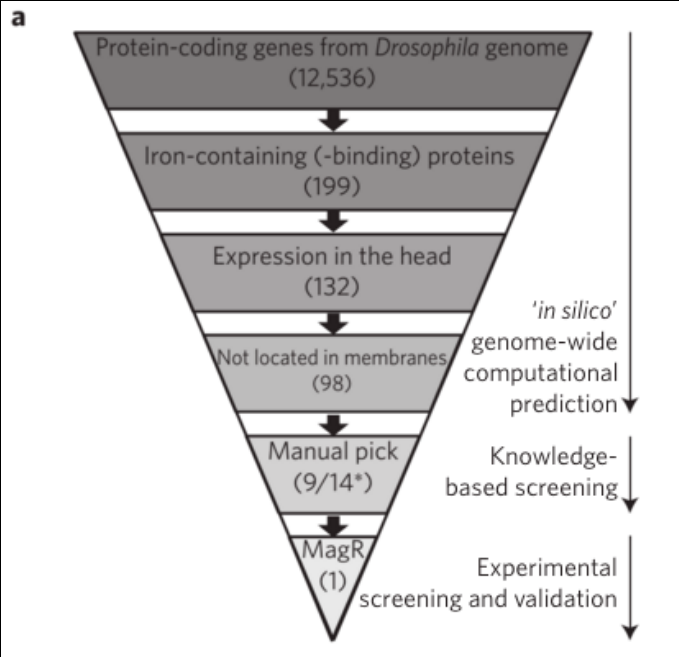


Cryptochrome mutants cannot learn a magnetic field

Gegear et al., (2008) Nature 454:1014-1018







ISCA1

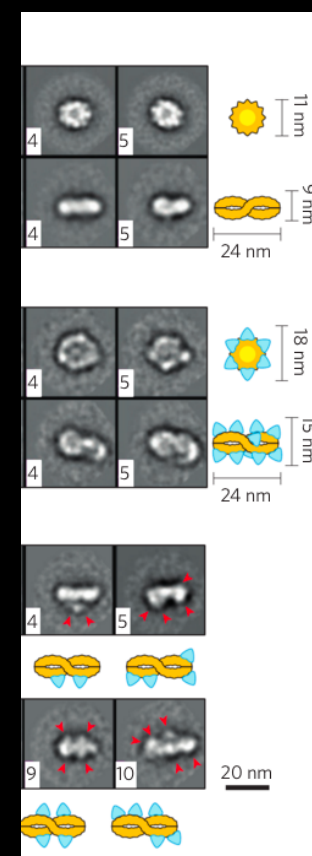
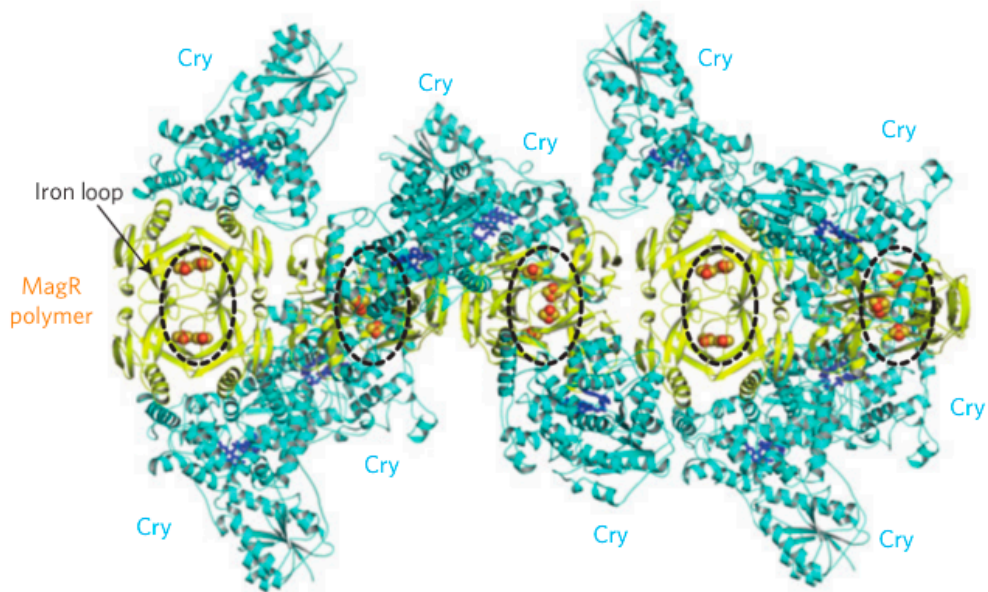
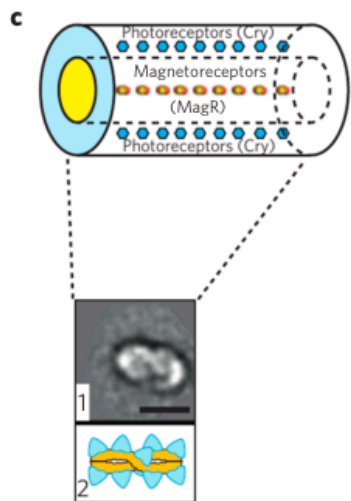
nature
materials

ARTICLES

PUBLISHED ONLINE: 16 NOVEMBER 2015 | DOI: 10.1038/NMAT4484

A magnetic protein biocompass

Siying Qin^{1†}, Hang Yin^{1†}, Celi Yang¹, Yunfeng Dou¹, Zhongmin Liu², Peng Zhang³, He Yu⁴, Yulong Huang⁵, Jing Feng³, Junfeng Hao⁶, Jia Hao¹, Lizong Deng³, Xiyun Yan³, Xiaoli Dong⁵, Zhongxian Zhao⁵, Taijiao Jiang³, Hong-Wei Wang², Shu-Jin Luo⁴ and Can Xie^{1*}



ISCA1

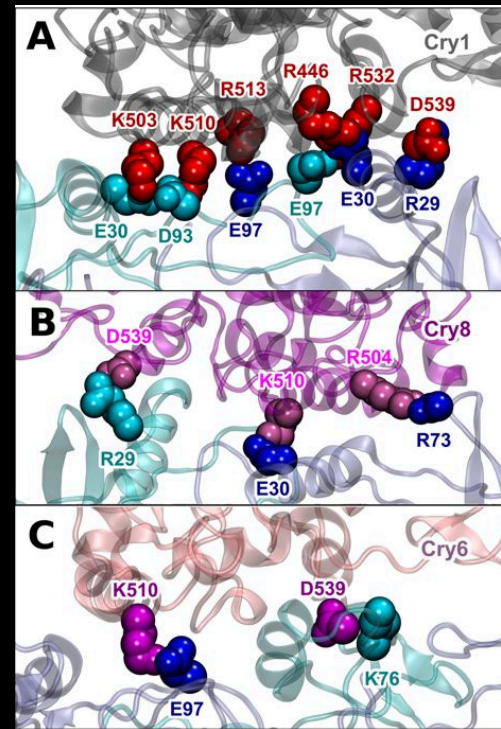
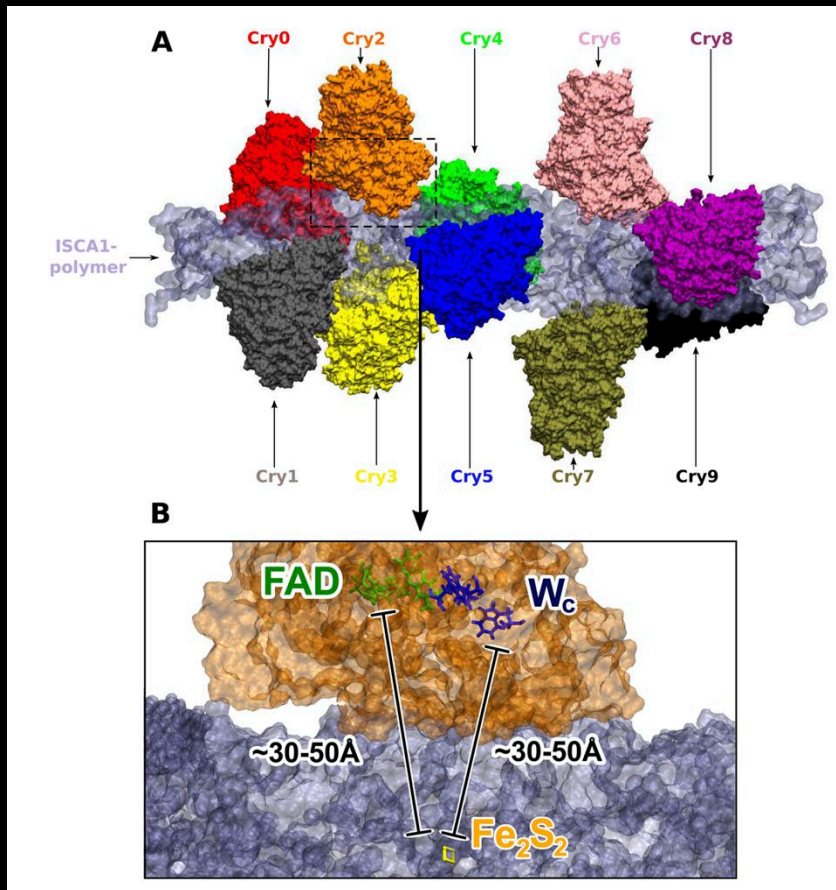
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Computational reconstruction reveals a candidate magnetic biocompass to be likely irrelevant for magnetoreception

Ida Friis, Emil Sjulstok & Ilia A. Solov'yov

Scientific Reports 7, Article number: 13908 (2017) | Download Citation

but....

Moreover, the extraordinarily large edge-to-edge distance of $\sim 30\text{--}50\text{ \AA}$ between the active site of cryptochrome (FAD and the tryptophan triad) and the nearest iron sulphur cluster from the ISCA1 polymer makes the polymer rather useless for a possible electron transfer to/from the cryptochrome and thus also unlikely to influence cryptochrome magnetoreceptive properties.

Lohmann Lab



The UNIVERSITY
of NORTH CAROLINA
at CHAPEL HILL



Photo by Ursula Keuper-Bennett/Peter Bennett www.turtles.org



Ocean Currents

Juvenile feeding

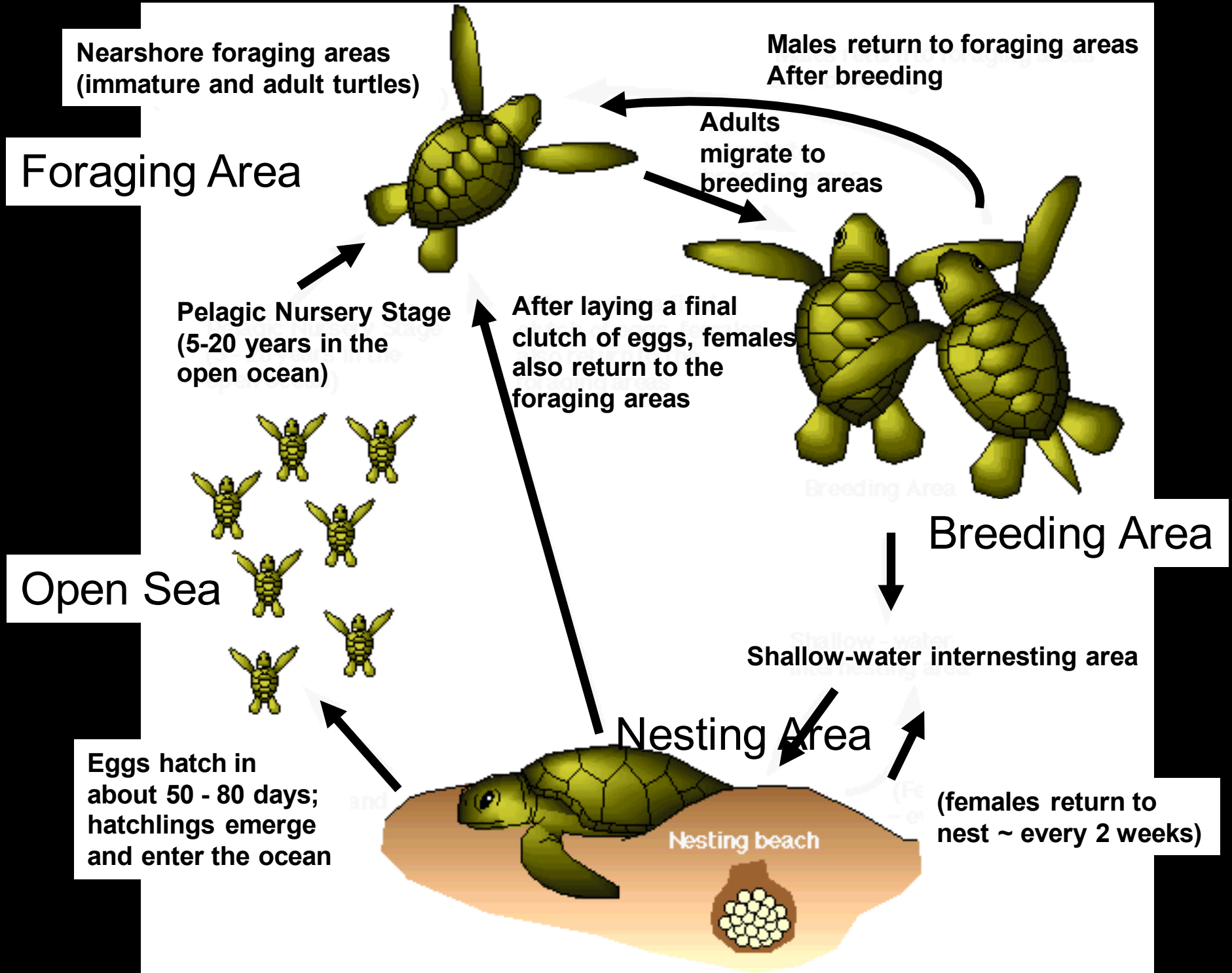
Foraging Area

Hatching

Breeding Area



Juvenile Turtle Path



Migration stages

How does a Hatchling find the Sea?

How does a Hatchling find the deep Sea?

How does a young turtle navigate the N.Atlantic Gyre?

How does an immature turtle identify a feeding ground?

How does a pair meet at a Breeding ground?

How does a female find her natal beach?

How does a male migrate back to his Feeding ground?

How does a female migrate back to her Feeding ground?

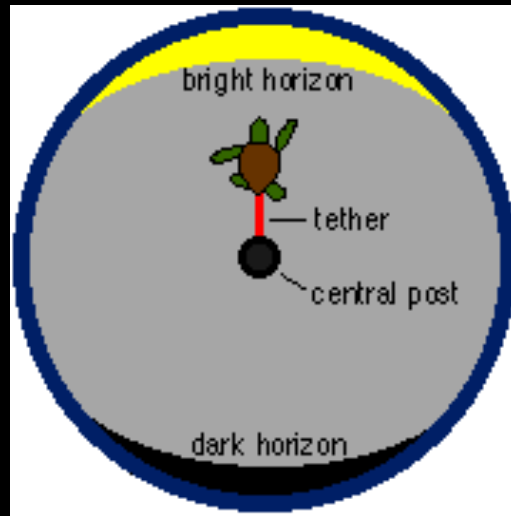
How does a hatchling find the sea?

What cues
are available?



How does a hatchling find the sea?

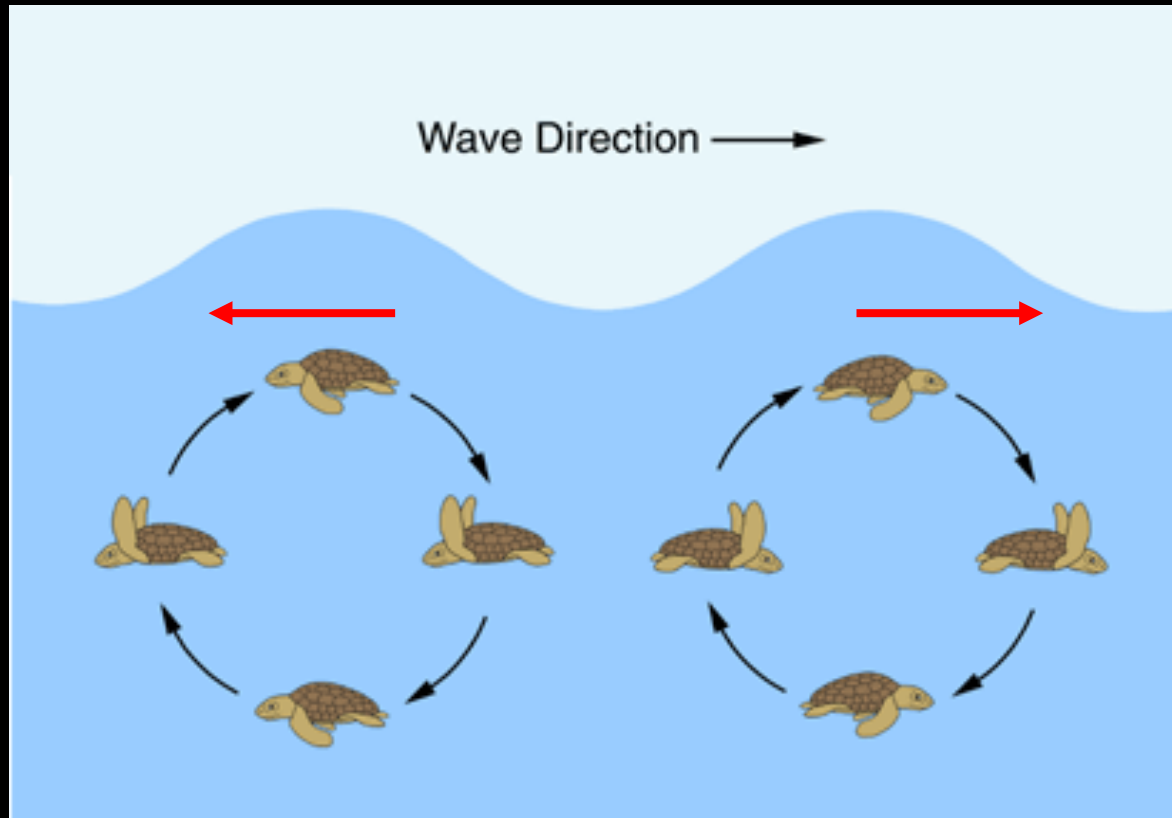
Hatchling experiment



- Down slope with no light
- Light over slope
- Bright over dim light
- Silhouette over uniform light
- Sound had no significant affect

Different sequence of accelerations

O
P
E
N
S
E
A

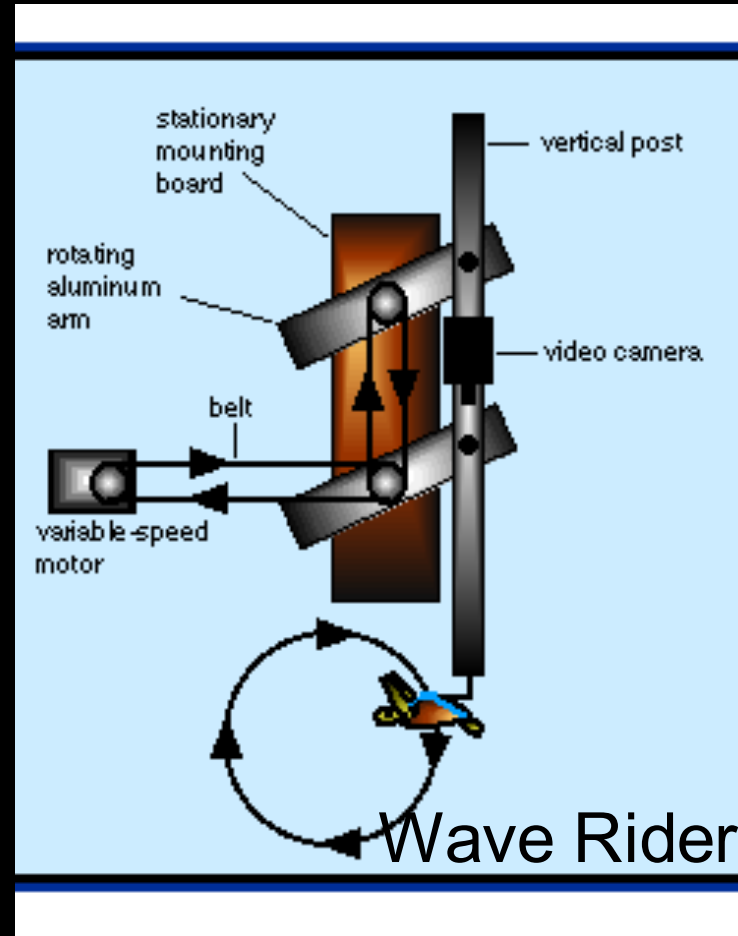


B
E
A
C
H

- 1.Up
- 2.Back
- 3.Down
- 4.Forward

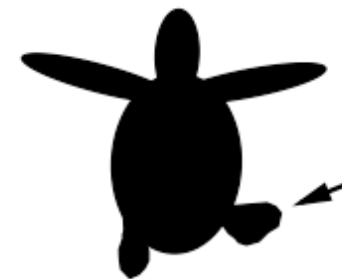
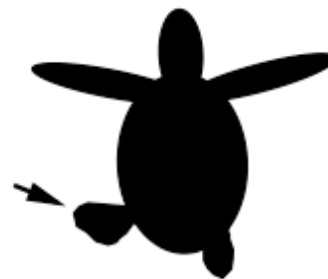
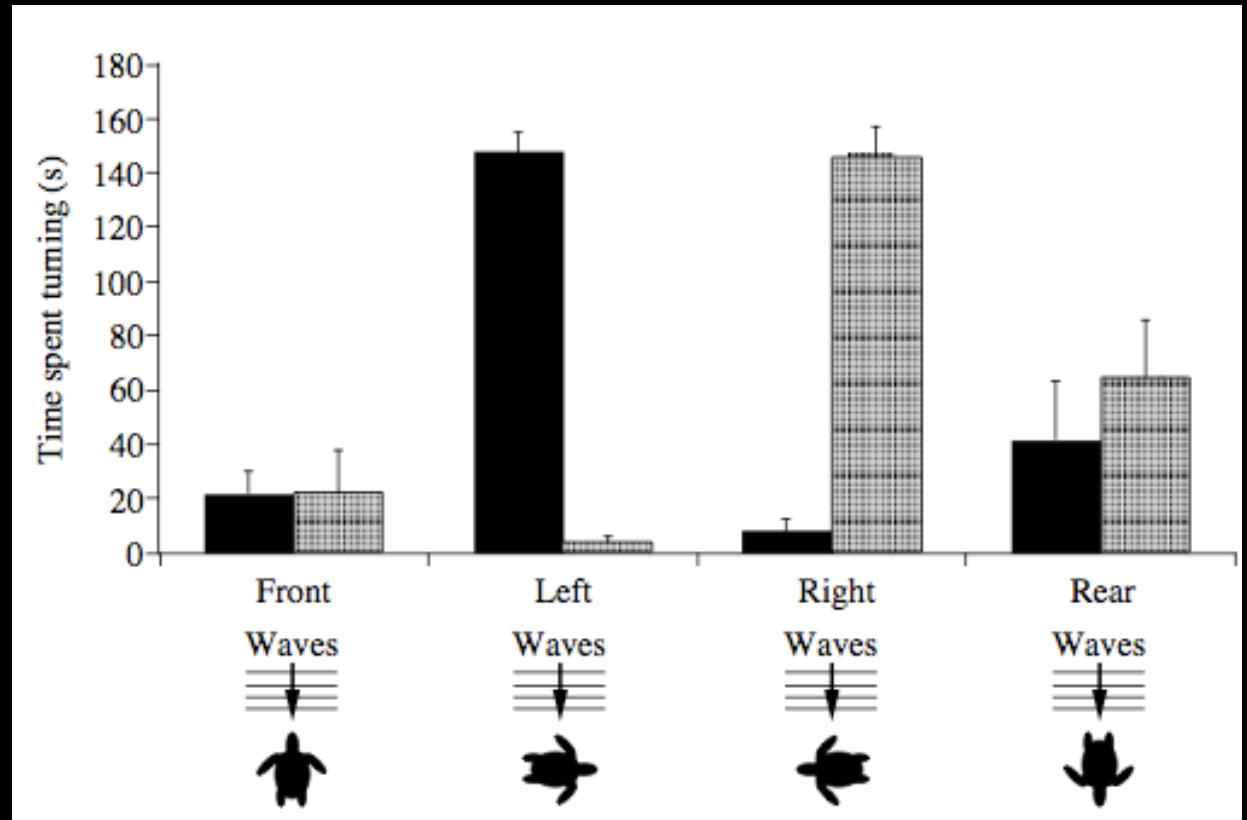
- 1.Up
- 2.Forward
- 3.Down
- 4.Back

How does a Hatchling Find the deep Sea?



Behavioral Assay

Loggerhead

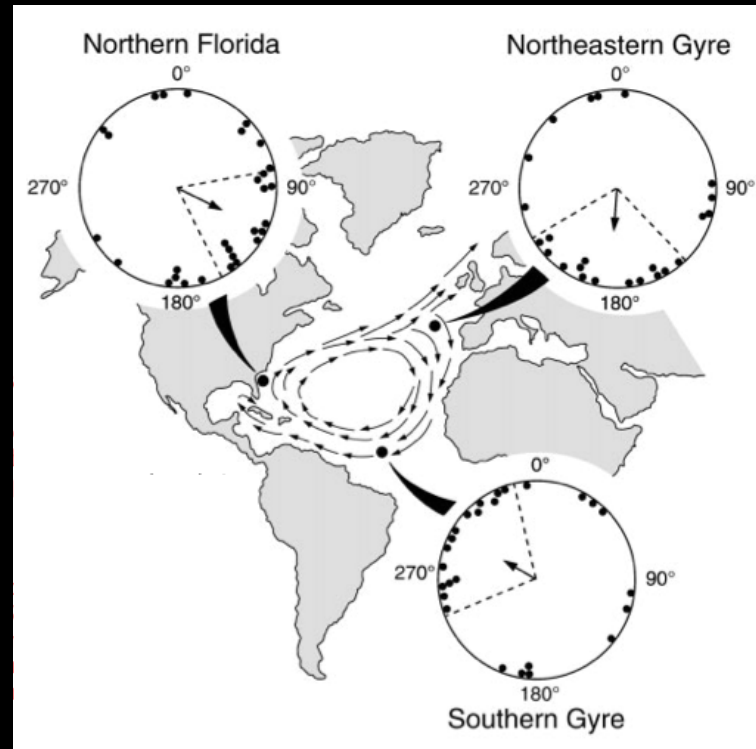


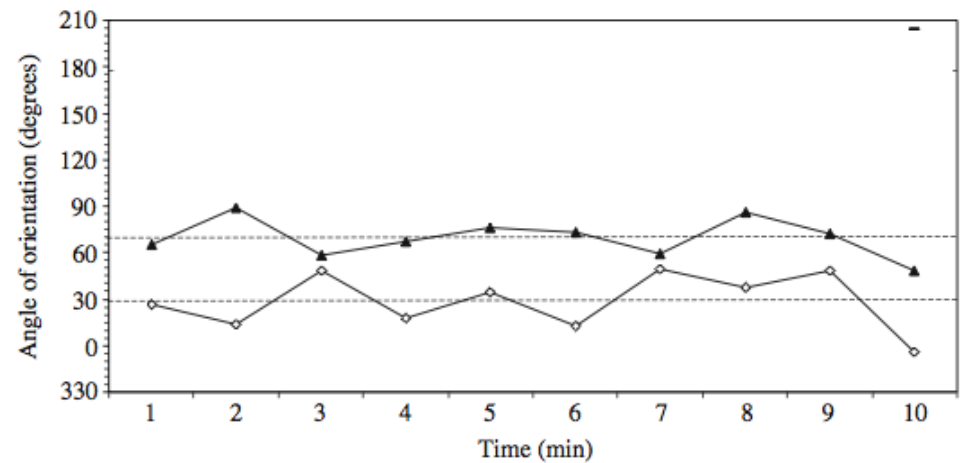
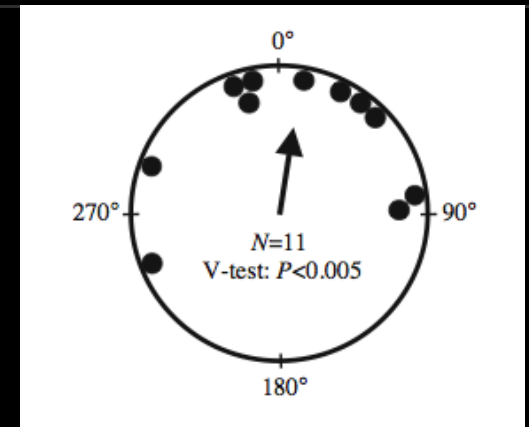
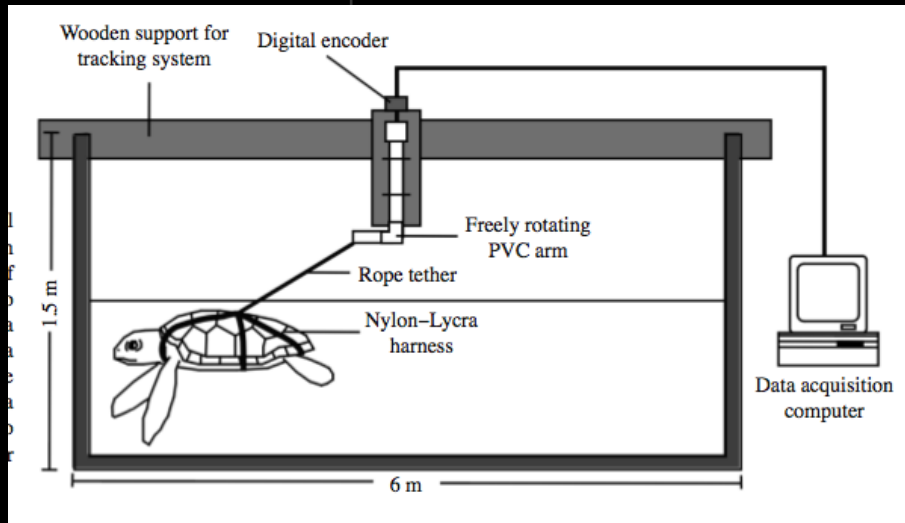


movie

Critical Period for Magnetic Map Sense?

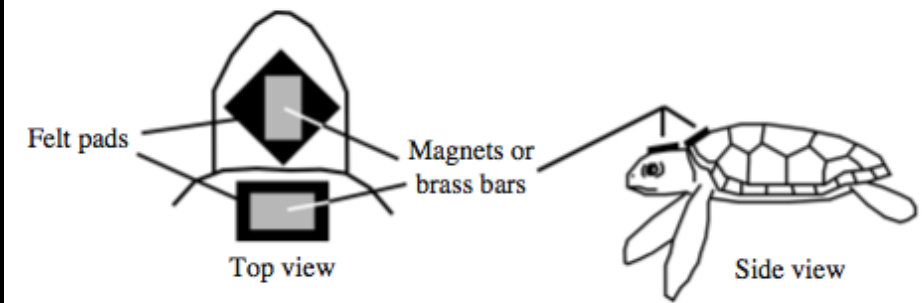
How does a young turtle navigate the N. Atlantic Gyre?

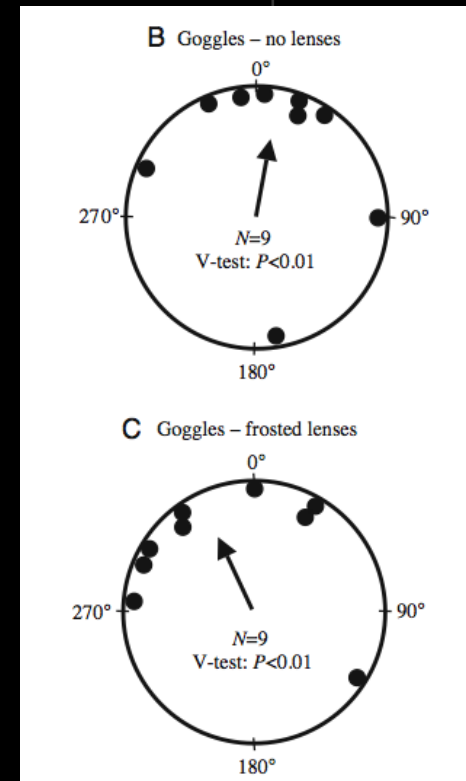
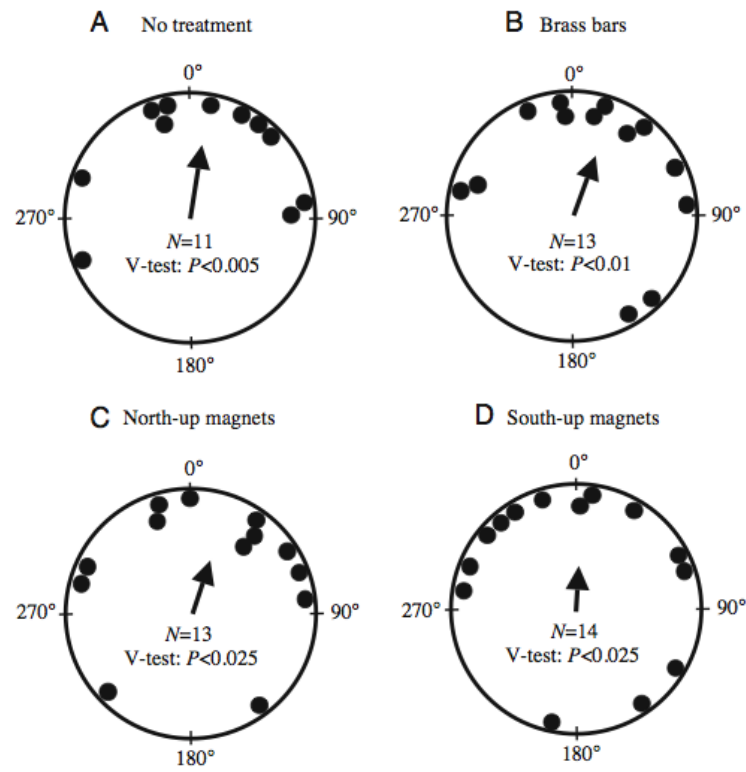




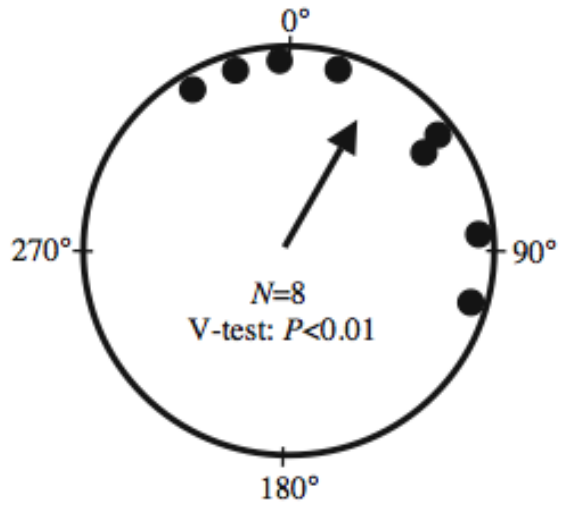
Use of multiple orientation cues by juvenile loggerhead sea turtles *Caretta caretta*

Larisa Avens^{1,2,*} and Kenneth J. Lohmann¹

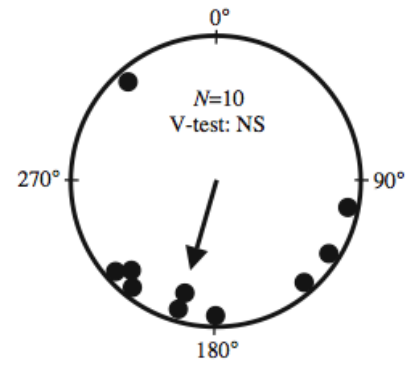




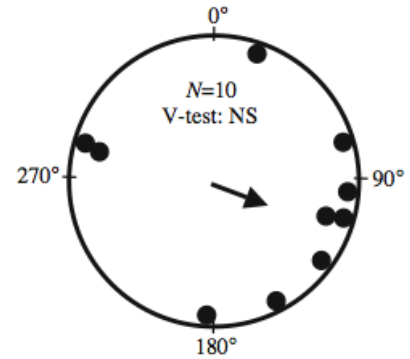
A Brass bars + Frosted goggles



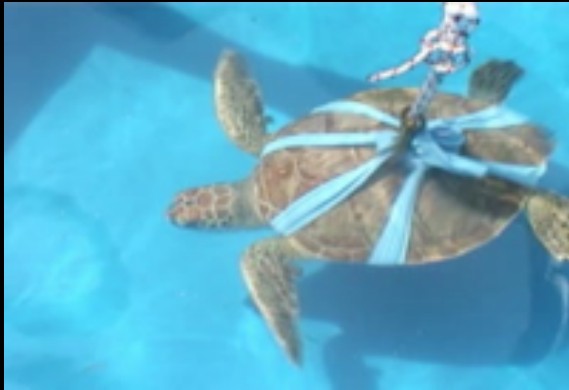
B South-up magnets + frosted goggles



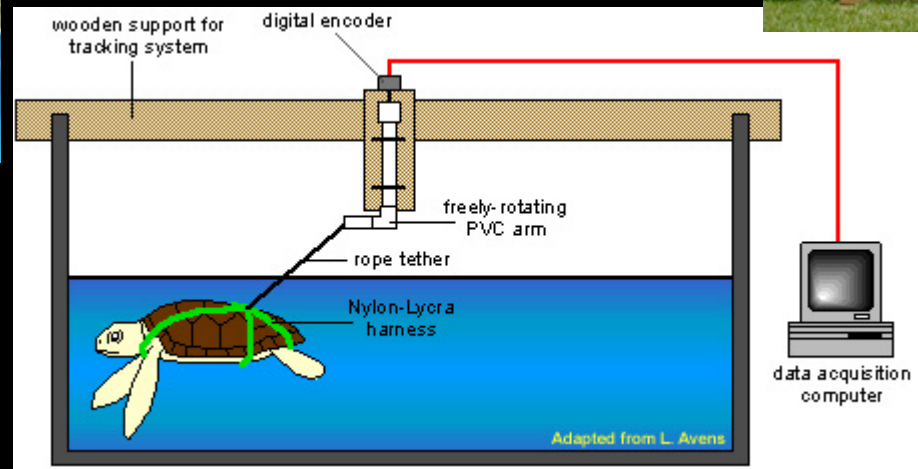
C North-up magnets + frosted goggles



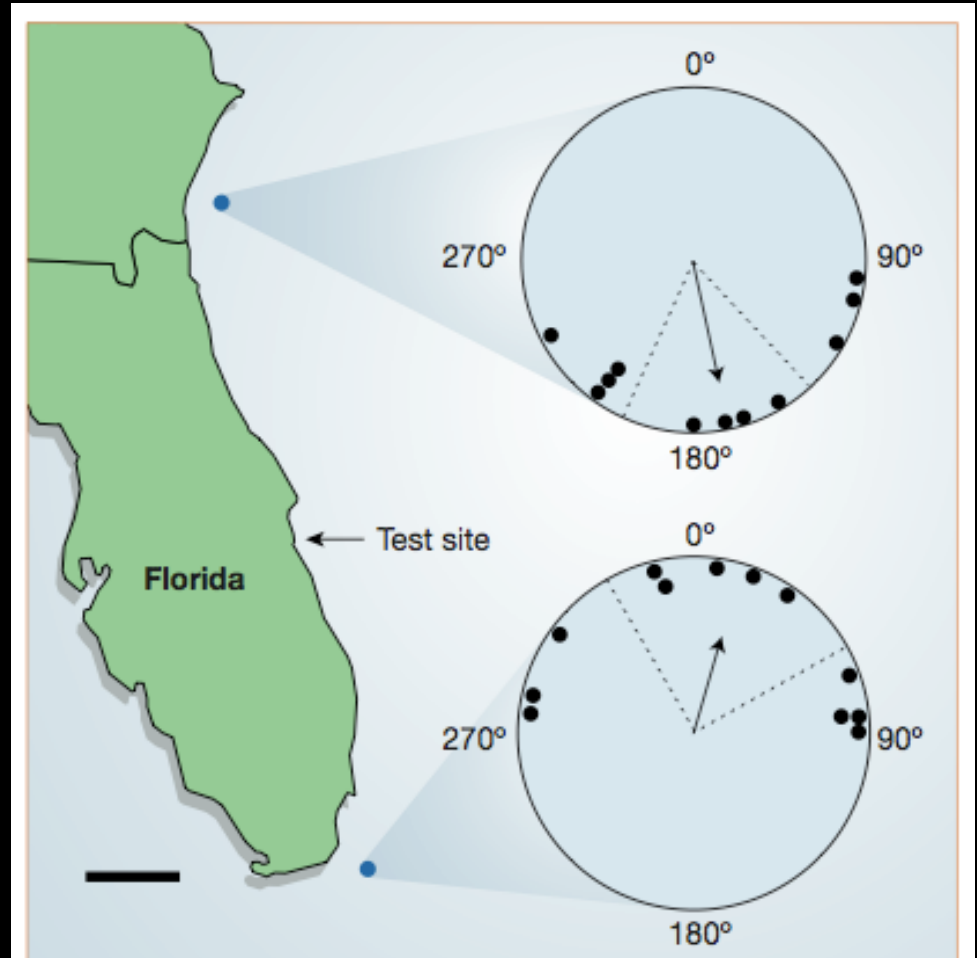
How does a female find her natal beach?

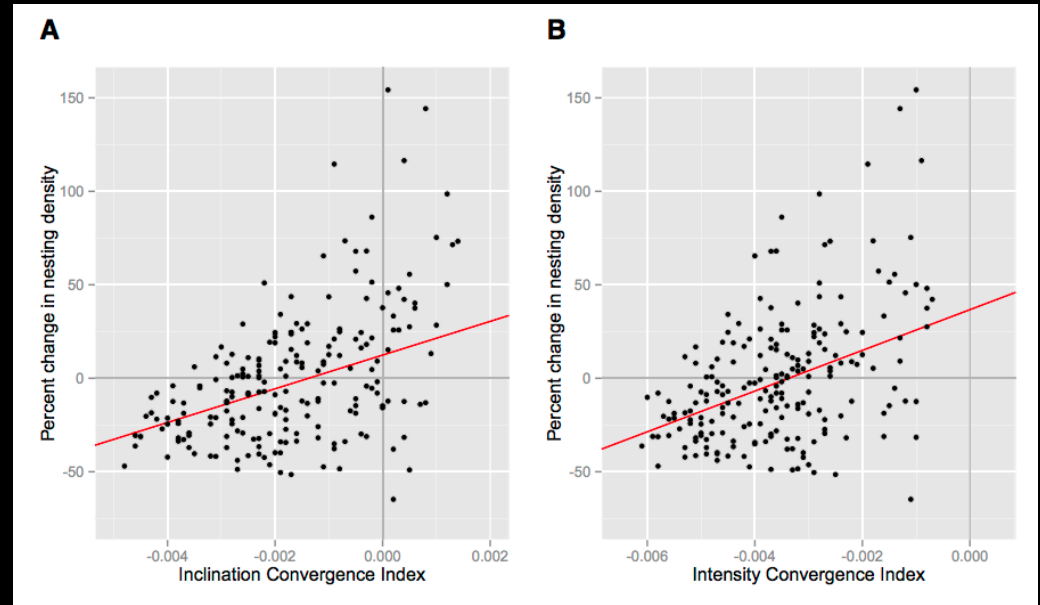
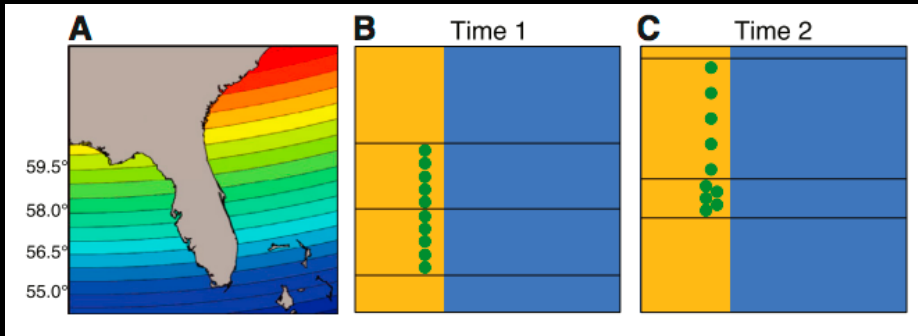


movie



Homing

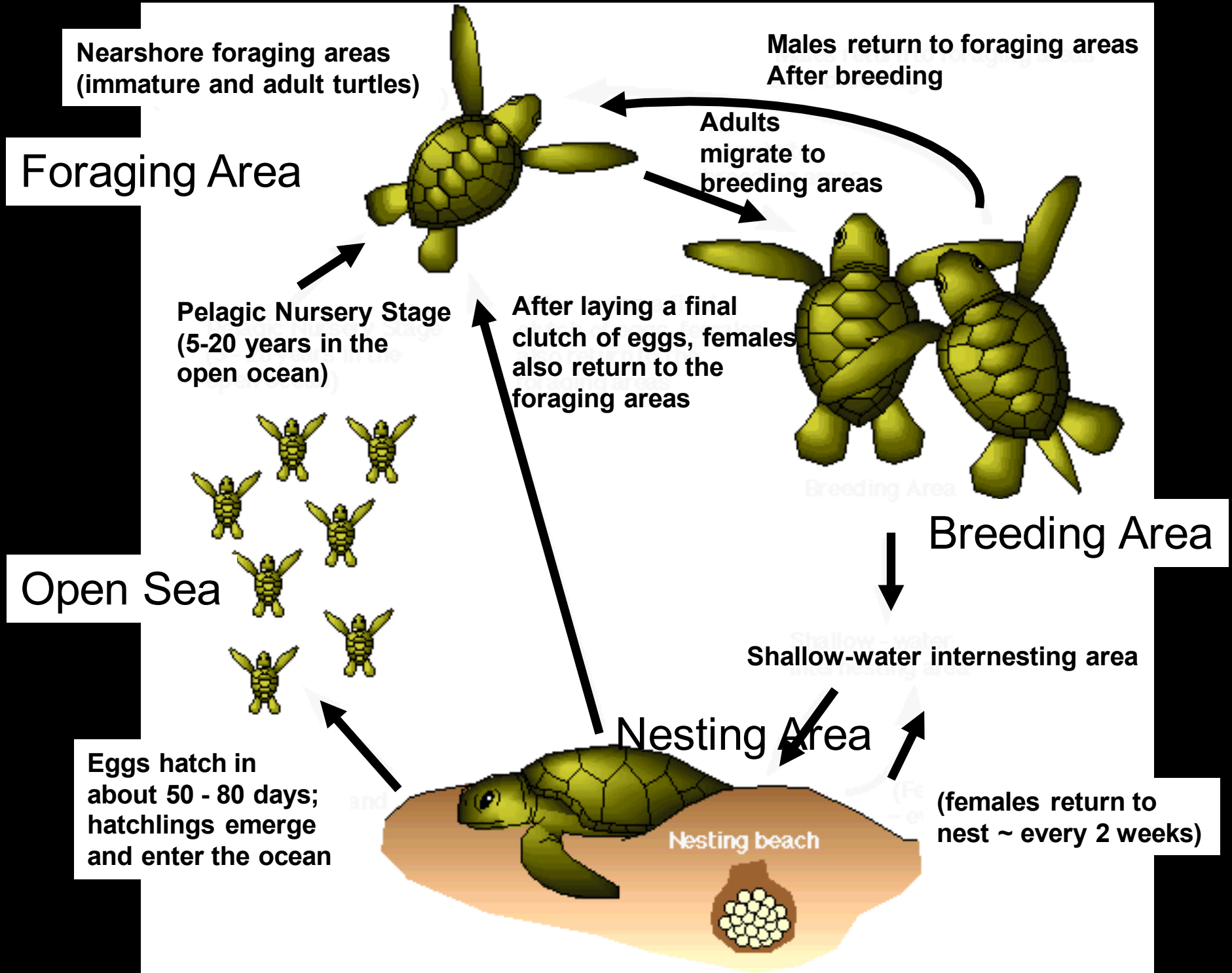




Current Biology 25, 392–396, February 2, 2015 ©2015 Elsevier Ltd All rights reserved <http://dx.doi.org>

Evidence for Geomagnetic Imprinting and Magnetic Navigation in the Natal Homing of Sea Turtles

J. Roger Brothers^{1,*} and Kenneth J. Lohmann¹



Navigation = Targeting distant goals across unfamiliar territory

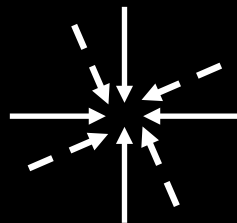
Taxis = hitching – uses direct measure of goal

Ded Reckoning = path integration – requires logging

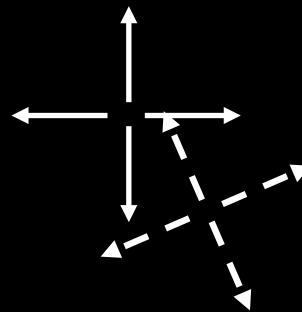
Piloting - requires a map (familiarity)

Navigation – requires a map and a compass

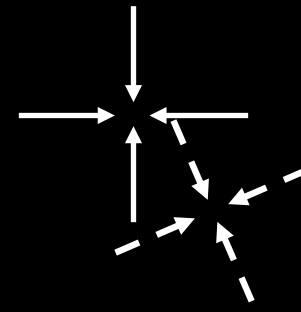
Charting – requires a map, compass, and “map sense”



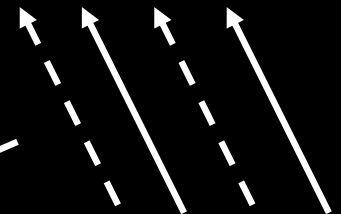
hunting



dispersal



homing



migration

Nearshore foraging areas
(immature and adult turtles)

Navigation: can use
Magnetic compass

Males return to foraging areas
After breeding

Adults
migrate to
breeding areas

Pelagic Nursery Stage
(5-20 years in the
open ocean)

After laying a final
clutch of eggs, females
also return to the
foraging areas

Hitching and Magnetic

Open Sea

charting: can use
Magnetic map-sense

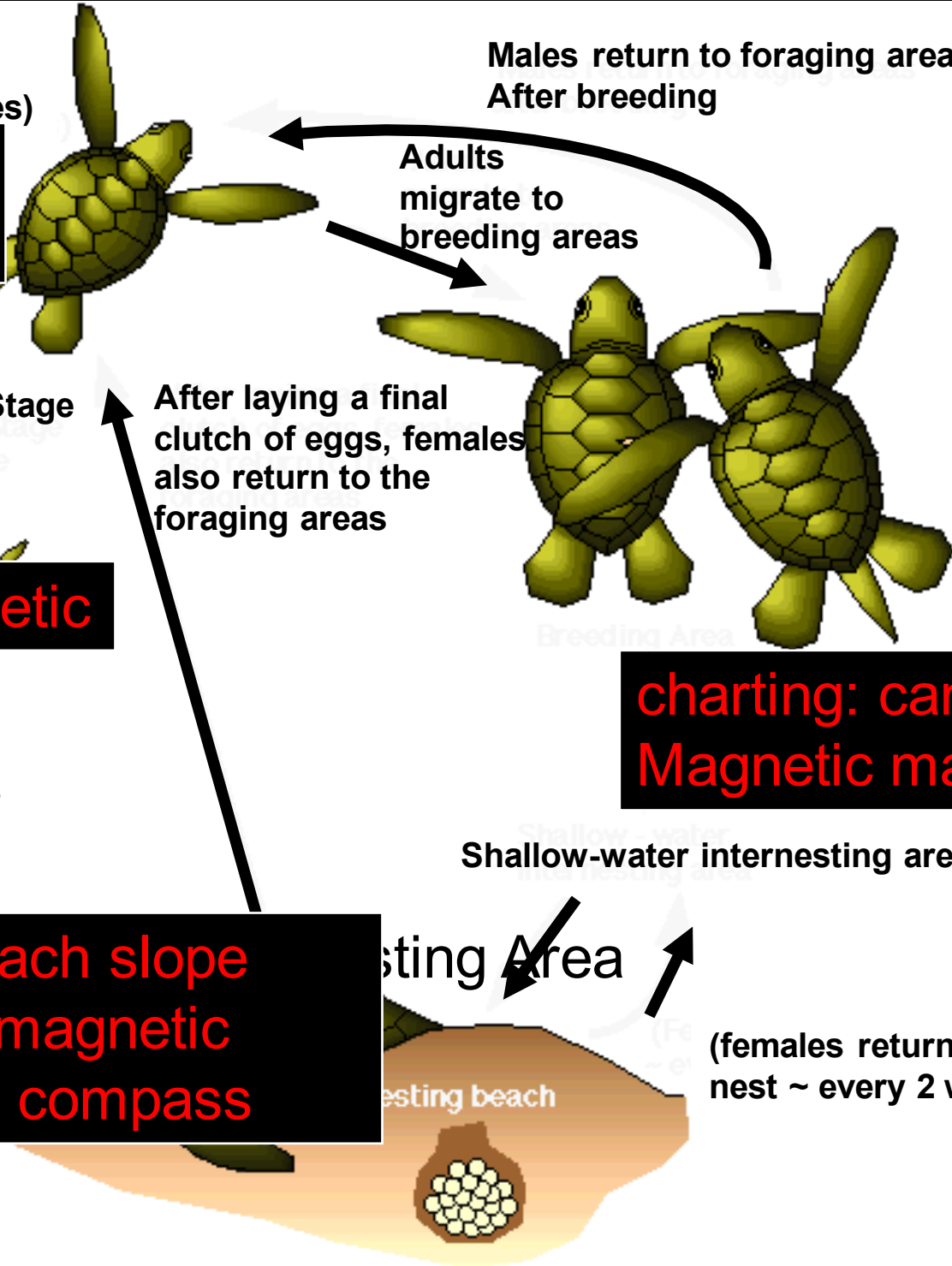
Taxis: Light cues, beach slope
Wave direction sets magnetic
compass

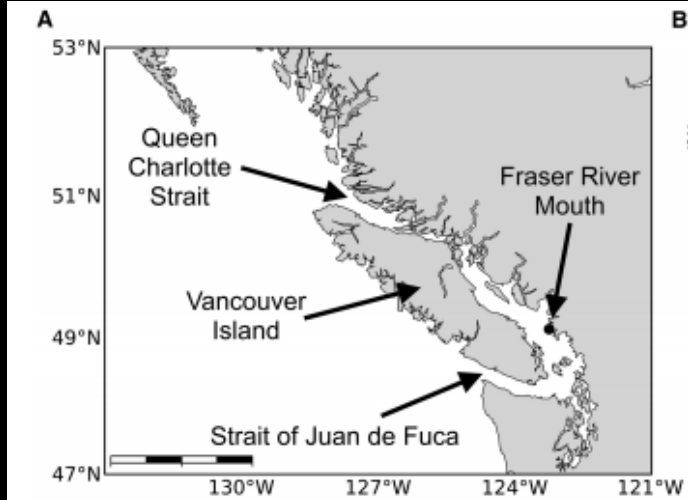
Shallow-water interesting area

Resting Area

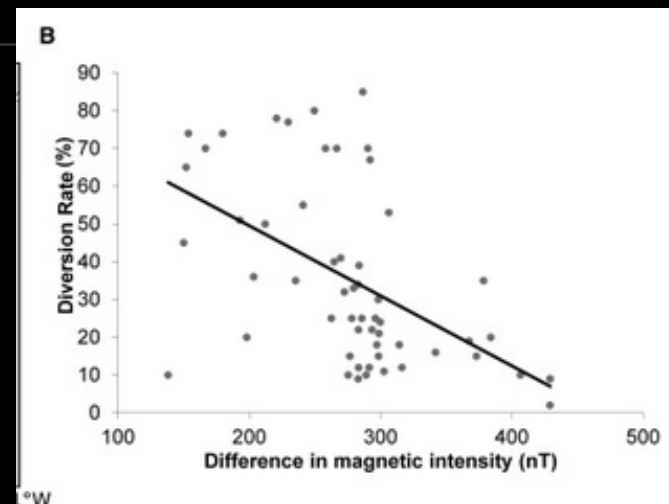
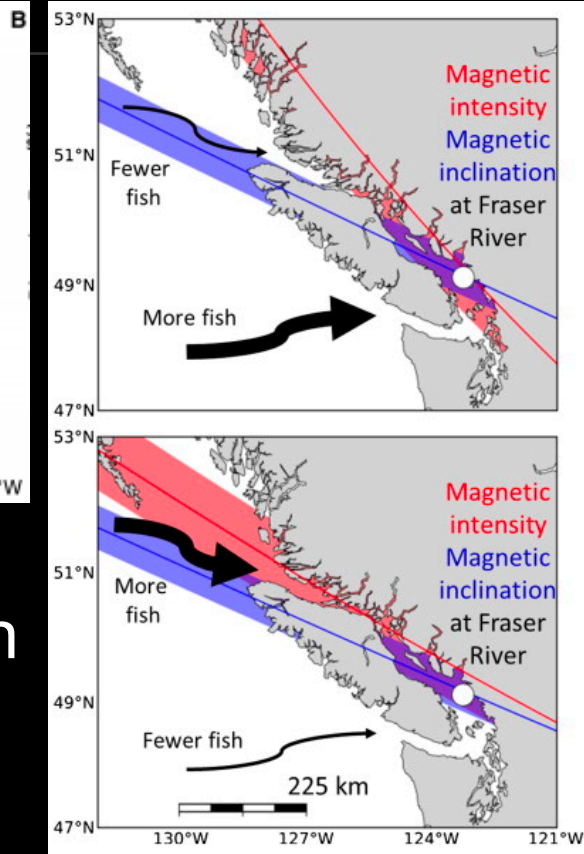
Resting beach

(females return to
nest ~ every 2 weeks)



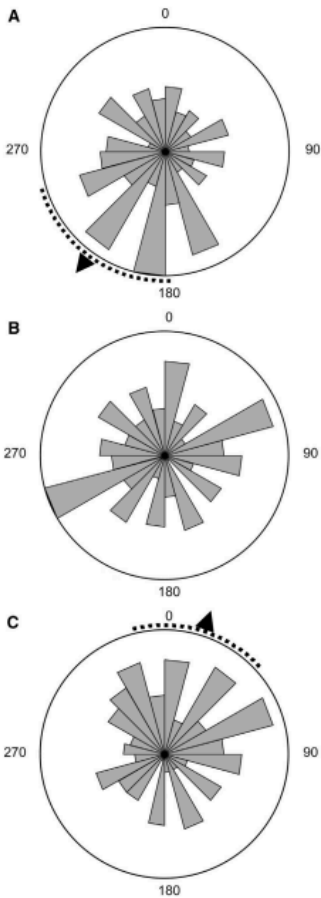


diversion



Evidence for Geomagnetic Imprinting as a Homing Mechanism in Pacific Salmon

Nathan F. Putman,^{1,*} Kenneth J. Lohmann,²
Emily M. Putman,³ Thomas P. Quinn,⁴ A. Peter Klimley,⁵
and David L.G. Noakes^{1,6}



Northern Extreme

Neutral

Southern Extreme



juvenile Chinook salmon respond to magnetic fields like those at the latitudinal extremes of their ocean range by orienting in directions that would, in each case, lead toward their marine feeding grounds.

Charting – requires a map, compass, and “map sense”

An Inherited Magnetic Map Guides Ocean Navigation in Juvenile Pacific Salmon

Nathan F. Putman,^{1,*} Michelle M. Scanlan,¹ Eric J. Billman,¹ Joseph P. O’Neil,² Ryan B. Couture,² Thomas P. Quinn,³ Kenneth J. Lohmann,⁴ and David L.G. Noakes^{1,2}

(Darwin as edited by Suzy)

"Sexual selection depends on the success of certain individuals over others of the same sex, in the arena of competition for reproduction; while natural selection depends on the success of individuals of either sex, at all ages, in all arenas of competition for general conditions of life."

Sexual selection is a special case or a subset of Natural Selection



*"The sexual struggle is of two kinds:
-- in the one it is between the individuals of the same sex, generally the males, in order to drive away or kill their rivals, the females remaining passive;
-- while in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners."*



"The sexual struggle is of two kinds:

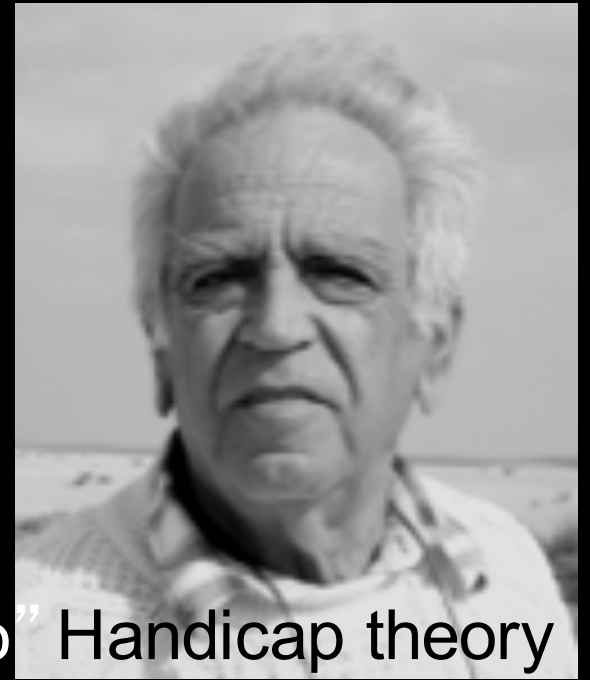
-- in the one it is between the individuals of the same sex, generally the males, in order to drive away or kill their rivals, the females remaining passive.

Male Competition
Intra-sexual selection

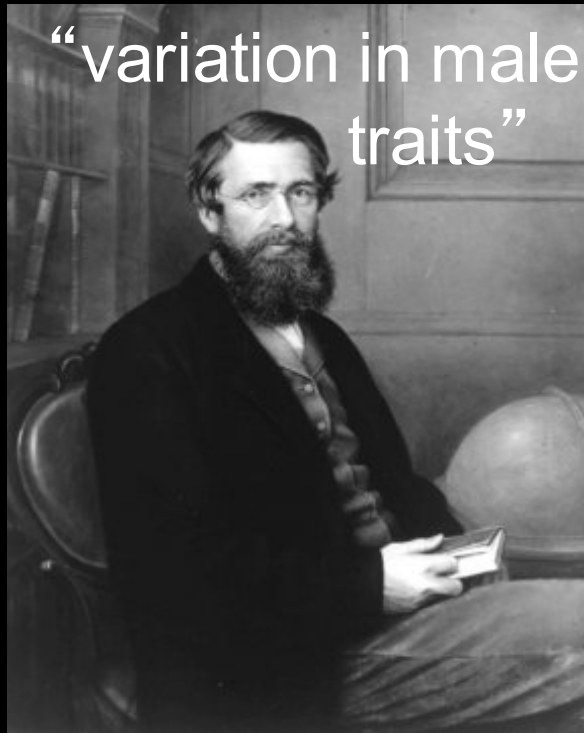
-- while in the other, the struggle is likewise between the individuals of the same sex, in order to excite or charm those of the opposite sex, generally the females, which no longer remain passive, but select the more agreeable partners."

Female Choice
Inter-sexual selection

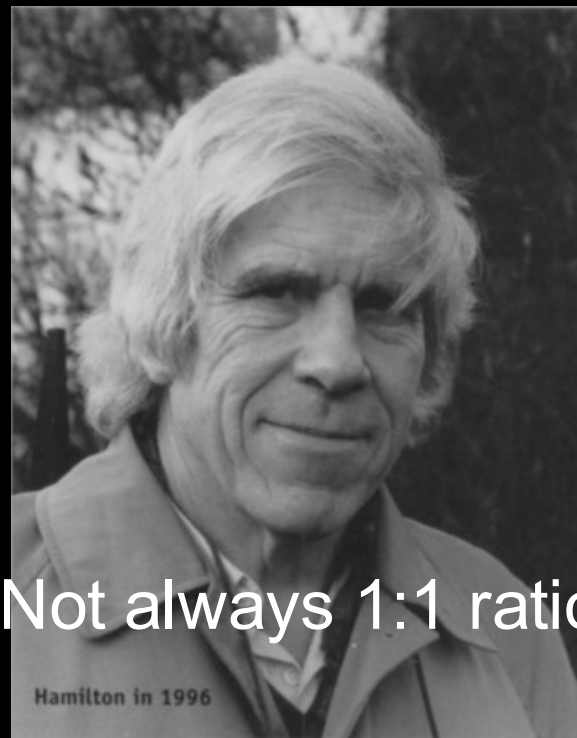




“why a 1:1 sex ratio” Handicap theory



“variation in male traits”

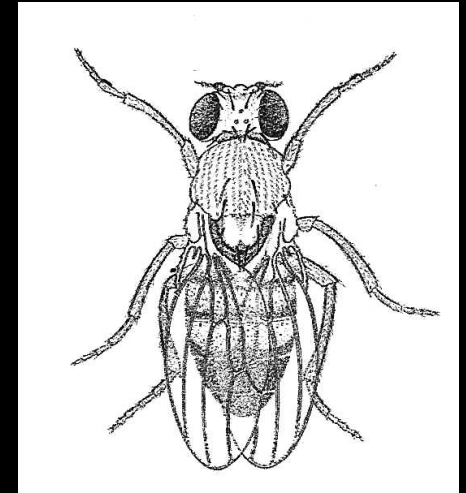
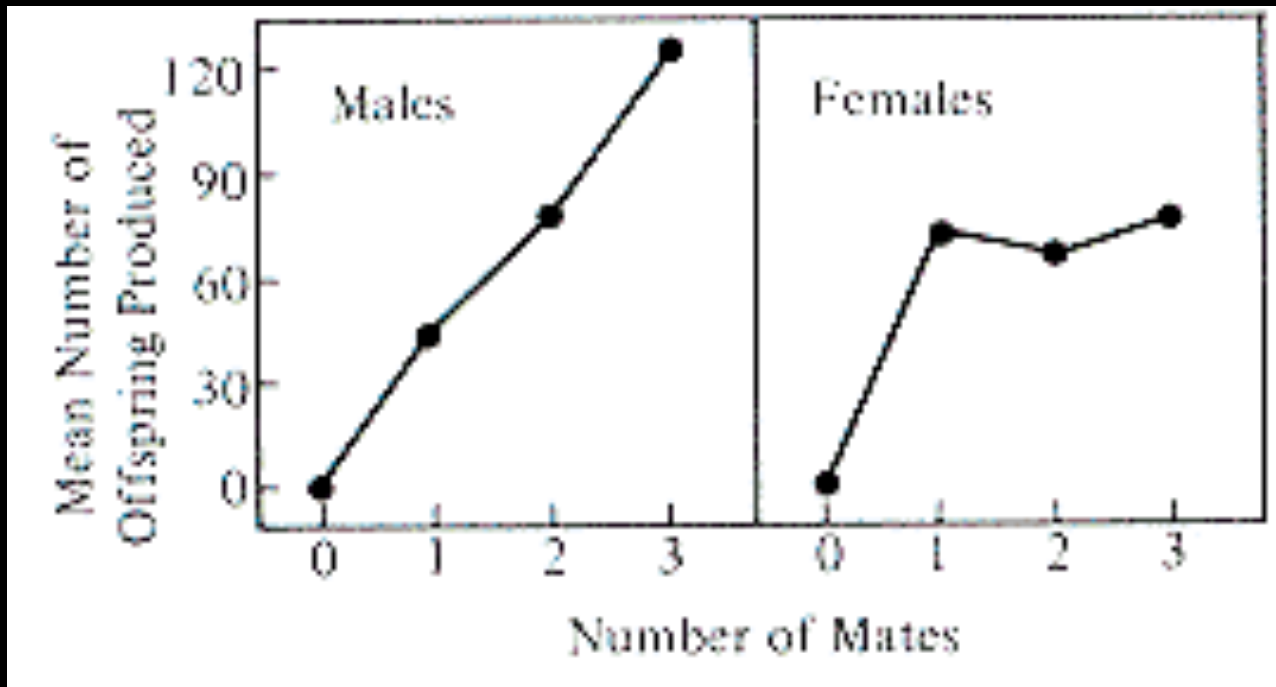


Not always 1:1 ratio

Hamilton in 1996



Parasite load



- 1) males are limited by the access to females while females are limited by resources.
- 2) males have greater variance than females with regard to the number of mates they have.
- 3) Therefore, males have greater variance than females with regard to the number of offspring they produce.