ECOLOGY & ETHOLOGY

Migration & Navigation

Gincy C George
(Assistant Professor On Contract)

MIGRATION
&
NAVIGATION

Types of migration

- Migration –individual and species migration
- Individual migration –accidental and non accidental
- Non accidental –calculated and non calculated calculated –seasonal and sporadic
- Non calculated- dispersal.exploratory,removal

Patterns

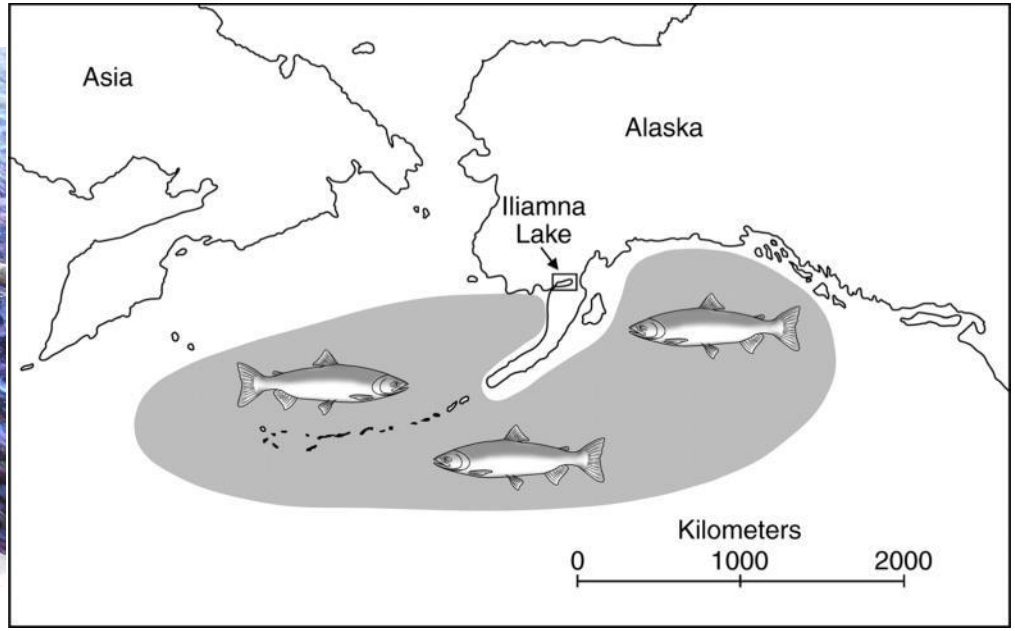
- Diurnal and tidal migration –crabs
- Seasonal movt between habitats-altitudinal migration –American elk and mule deer move up during summer
- Long distance migration:swallows

- Migration in birds-artic terns
- Mammals -zebra
- Reptiles-turttles
- Amphibians-californian newts-breeds in mountain stream in springs and spend summer underground.
- Fishes-eels can detect beta phenyl ethanol
- Invertebrates

Migration

Reproductive success

- Sockeye salmon (lifecycle migration and homing)



- **Animal navigation** is the ability of many animals to find their way accurately without maps or instruments.
- Birds such as the Arctic tern,
- insects such as the monarch butterfly
- and fish such as the salmon regularly migrate thousands of miles to and from their breeding grounds
- and many other species navigate effectively over shorter distances.

Fish migration

- Diadromous
- Anadromous: sea to freshwater-Salmon
- Catadromous:fw to sea ,eel
- Amphidromousmigrate from sea to fw and vice versa but not for breeding -gobies
- Semi migratory:from sea to estuaries -Chanos
- Potamodromous live and migrate only within fresh water eg:carps
- Oceanodromous –live and migrate only within sea eg; Sardine

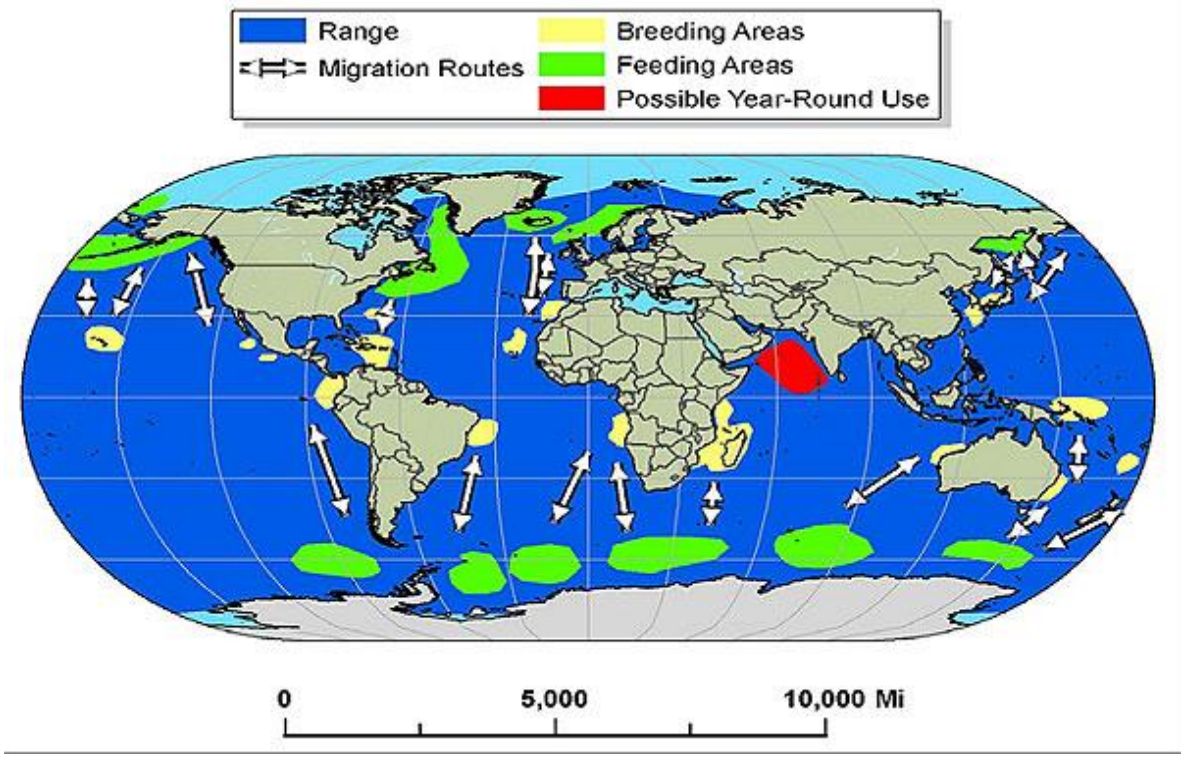
Cause of migration in birds

- Shortage of food
- Enviornmental factors
- Internal factors-hormones
- Photo periodism
- Fat deposition-migratory restlessness

Migration

Food acquisition

- Humpback whales



- Advantages:
- Better climate
- Variety of bird diets
- Pressur of predation is reduced
- Greater adaptibility
- Increase rate of evolution due to dispersal

Terminology

Navigation

- Moving along a course

Migration

- Moving from one region to another

Homing

- Returning back to a *specific* point

disadvantages

- Tiresome for some
- Sudden climatic changes are deleterious
- Young birds are exposed to predation
- Towers light houses affect migration

Navigation Strategies

Trail following

- Employed by invertebrates only (ants)

Piloting

- Using landmarks to navigate (pigeons)

- There are 5 strategies involved when navigating.

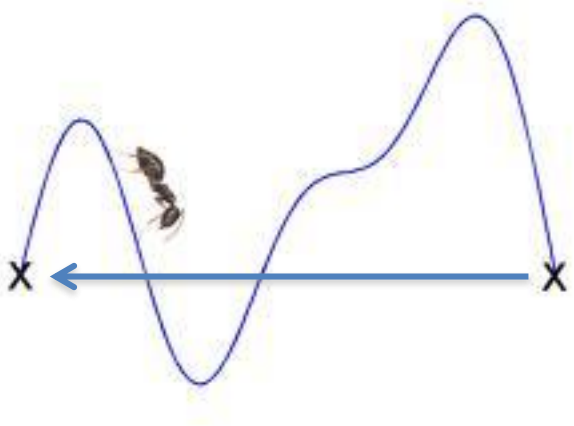
1. Trail following is used by invertebrates such as ants that leave a pheromone for others to follow, thus olfaction is the sense used. In this strategy each ant mirrors the path of the ant before it. I am sure you have seen this type of behavior before.

2. Piloting is the use of local landmarks to navigate. Used in short navigational routes such as by pigeons. Experiments with homing pigeons and fitting them with translucent contact lenses shows that the birds can find their way back home but they cannot pinpoint their particular lofts accurately. This tells us that pigeons use visual cues to navigate, similar to what we as humans do.

Navigation Strategies

Path integration

- Employed by invertebrates only (ants)



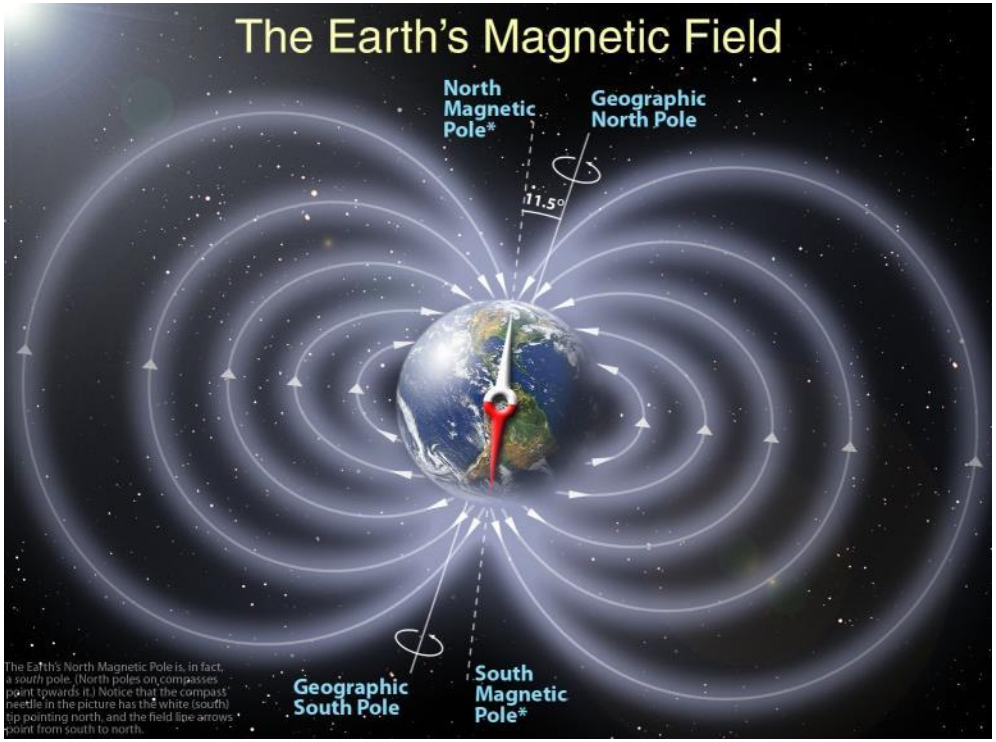
Return journey

- Path Integration This is a mechanism used by invertebrates such as ants. The animal is able to integrate compass headings and distance together away from a source then decrease the distance back to the original source by integrating information from the two.

Navigation Strategies

Map and compass navigation

- Used by long distance migrators (whales and turtles)

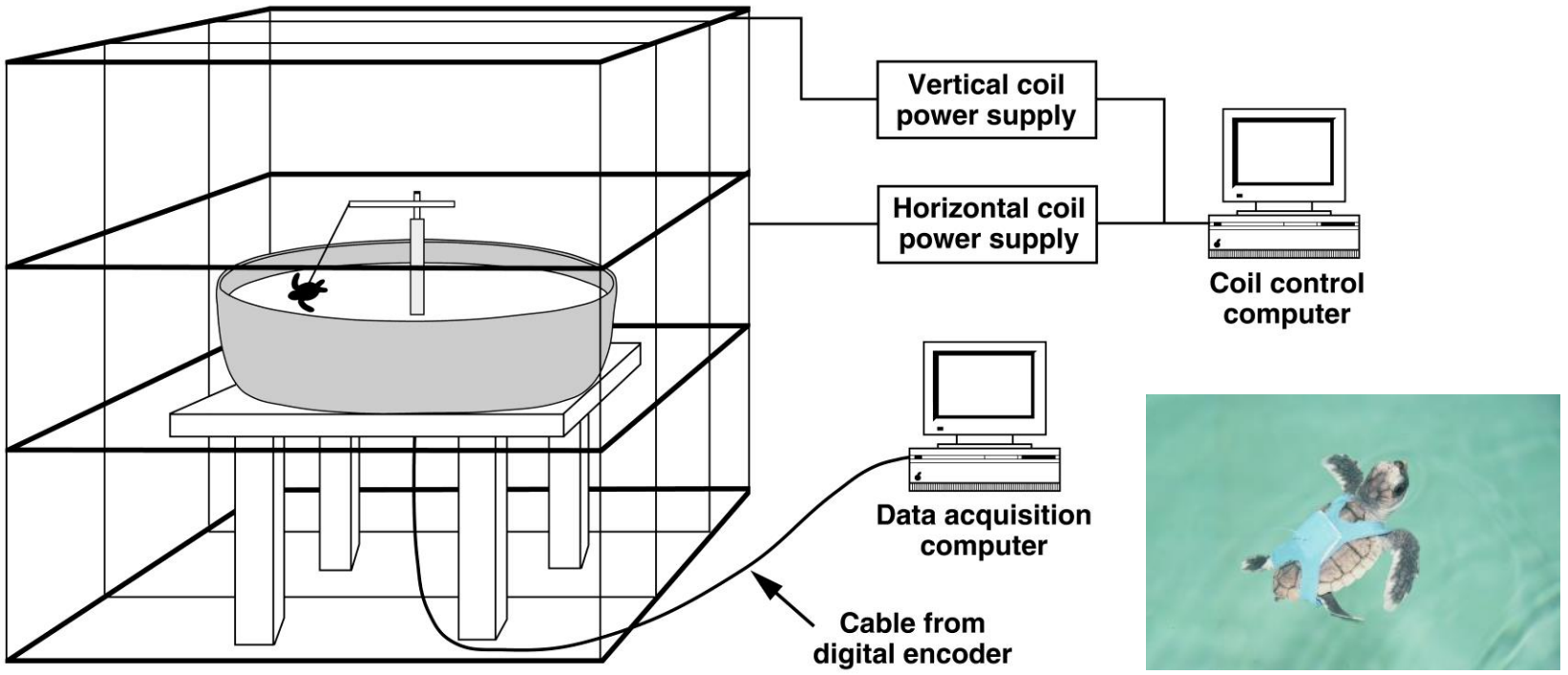


- In addition to providing a source of compass information, the Earth's field also provides a potential source of positional or 'map' information.
- Several geomagnetic elements vary in a predictable way across the surface of the Earth and might, in principle, be used to assess geographic location. For example, at each location on the globe, the magnetic field lines intersect the Earth's surface at a specific inclination angle.
- At the magnetic equator, the field lines are parallel to the Earth's surface, but become progressively steeper as one moves toward the magnetic poles.
- Thus, inclination angle varies predictably with latitude, and an animal able to detect this field element may be able to determine whether it is north or south of a particular area. Similarly, the intensity of the total field, or the intensity of the horizontal and vertical field components, might also hypothetically be used in position finding.

Terrestrial Animals

Compass navigation

- Using Earth's magnetic field



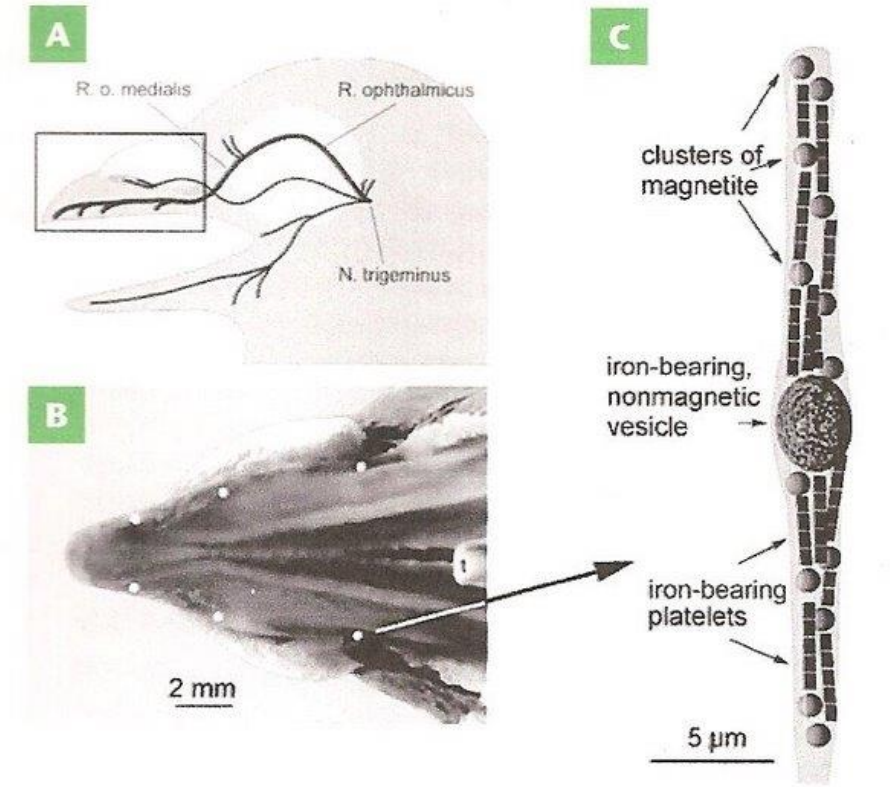
- Compass navigation is a mechanism of navigation proposed to be used by sea turtles. In this experiment a line was connected to a harness and each turtle was tethered to an electronic tracking system in the center of a circular pool of water. Turtles could therefore swim in any direction while the tracking system monitored the direction toward which the turtle swam. This information was relayed to a computer.
- The pool of water was surrounded by a large coil consisted of numerous strands of wire. When the coil system was turned on, it reversed the direction of the magnetic field around the turtles.

- Turtles exposed to a magnetic field equivalent to that existing 337 km north of the test site oriented themselves roughly southwards. By contrast, those exposed to a field matching that of an area 337 km south of the test site swam approximately northwards. The two distributions are significantly different indicating that turtles can distinguish between the magnetic fields that characterize different geographic locations within their usual environment.

- **The results demonstrate that hatchling loggerhead and leatherback sea turtles have the ability to detect the Earth's magnetic field and use it as an orientation cue.**

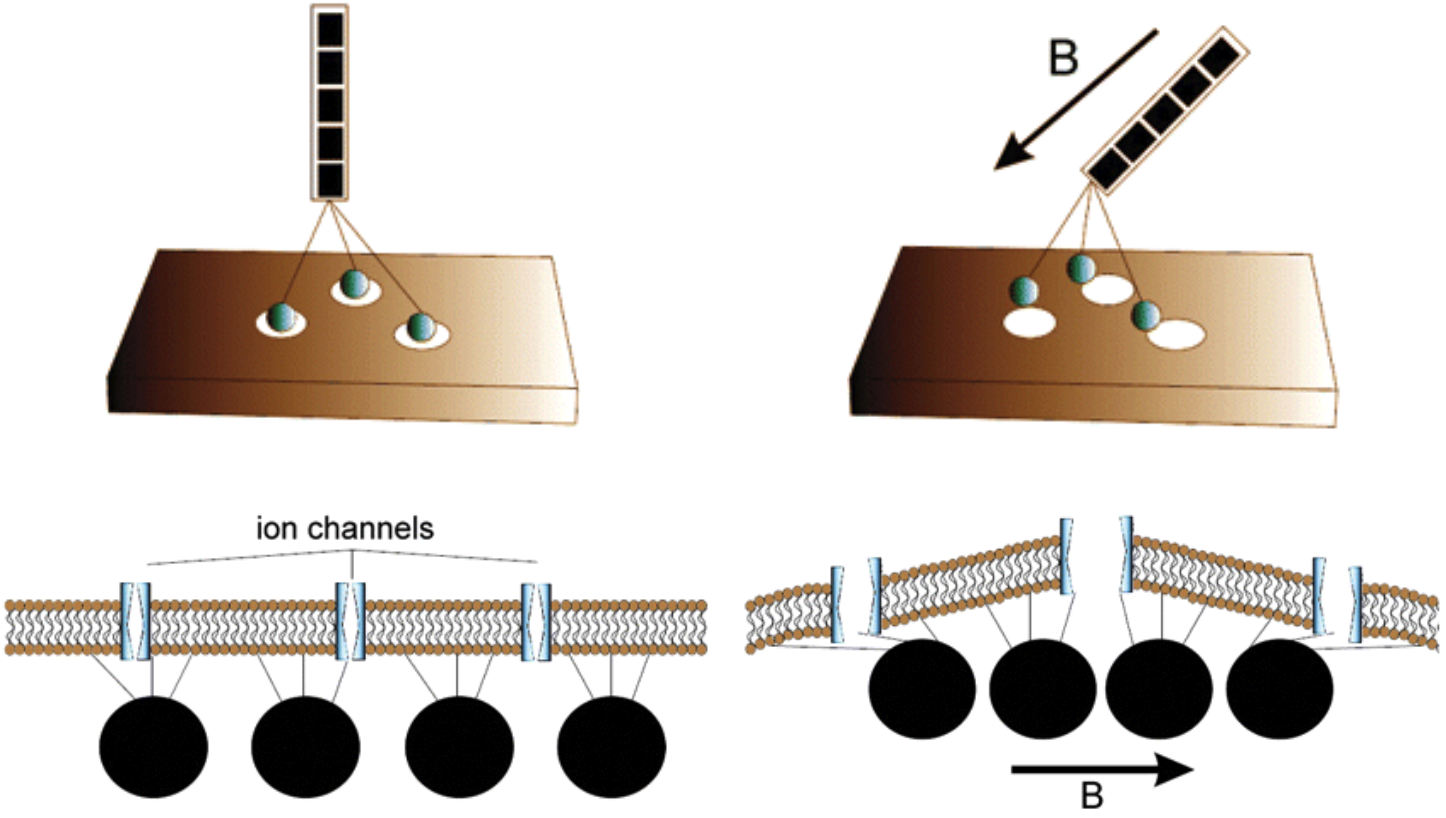
Magnetite Receptors

Located in beaks of birds



Magnetite Receptors

2 possible mechanisms of action



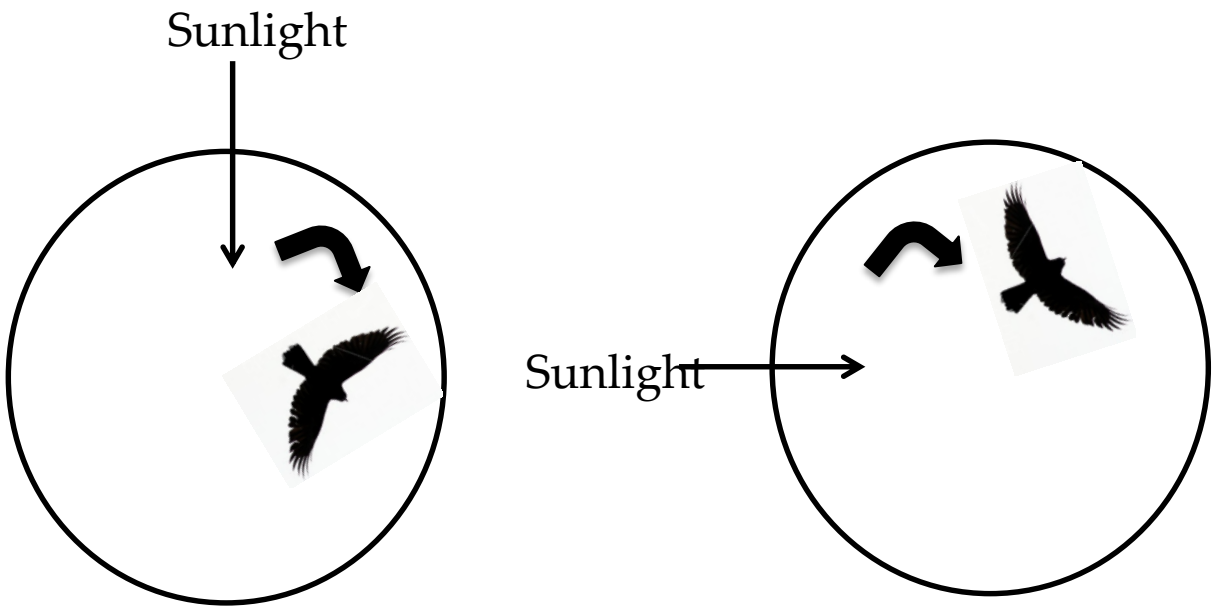
- Top, A chain of magnetite crystals is attached by protein strands to ion channels in a nerve cell membrane. Ion channels open, causing nervous impulses, and close in response to the magnetic field (indicated by the arrow). B). Bottom, Vesicles (black circles) filled with magnetite particles are attached to a membrane by protein strands and, in response to the external magnetic field (arrow, B) the vesicles move towards each other, deforming the membrane, opening the ion channels, and triggering a nervous impulse (From**:** Pósfai and Dunin-Borkowski 2009).

- Changes in the direction and strength of the magnetic field cause ion channels associated with the magnetoreceptors to open or close (Figure above), and the resulting nervous impulses provide birds with information about the magnetic field. Because of the differing alignments of the dendrites, these receptors appear to act as a three-axis magnetometer, allowing birds to sense both magnetic field duration and the strength or intensity of the magnetic field

Navigation Strategies

Compass navigation

- Using the sun (starlings)



- Some animals use the sun. Experiments with starlings show that these animals migrate along certain compass bearings depending on the location of the sun.

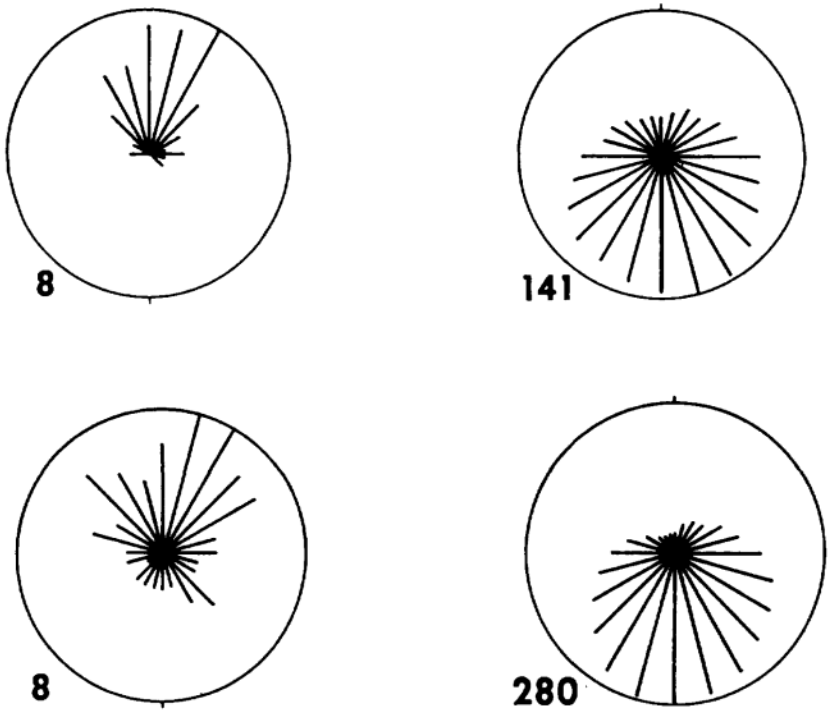
- Fig. A. Birds were placed in a circular cage with a window through which sunlight was shone. Birds fluttered to align themselves in the direction they would normally travel if they were free.

- Fig. B. The angle of the sun was deflected with a mirror. Birds maintained the same relative position as in Fig. A. These experiments demonstrate that the birds use the sun as a compass.

Navigation Strategies

Compass navigation

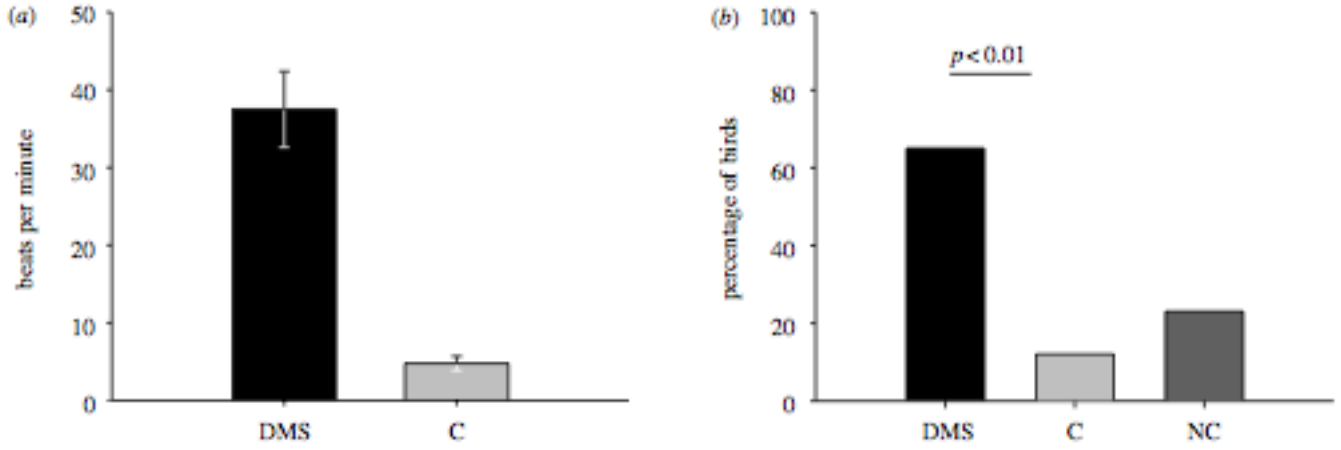
- Using the stars (Indigo buntings)



- Indigo buntings use the stars to navigate. In a planetarium experiment if the star position is reversed (numbers represent degree of orientation) buntings alter their position and attempt to migrate in the opposite direction.

Navigation Strategies

Olfactory cues: Detection of dimethyl sulphide (DMS)



- Over the seemingly featureless ocean environment sea birds such as petrels and albatrosses can detect local emissions of scents released by phytoplankton such as dimethyl sulphide.

- These are important because such features enable birds to detect shelf breaks and seamounts. These studies suggest an odor landscape that may provide birds with orientation cues.

- In the experimental results above (A) heart rate increased in birds exposed to DMS. In (B) birds were able to detect MDS presented to them in a maze as opposed to C control and NC, made no choice.

- **Types of Movements**
  1. Seasonal
  2. Sporadic
  3. Dispersal

What drives Migration?

- On a basic level, the spinning of the earth drives migration. The earth is on a tilt so that the winter and summer have different amounts of light. Thus, at different times of the year there are differential amounts of productivity, depending on the time of the year.
  - Birds will usually breed in areas that are high in productivity, and then leave that area in the off-season.
  - Sunlight is a function of the earth's tilt and location from the sun.

(non-continental movements)

- • Pennant-winged Nightjars breed in southern Africa during the rainy season, and then migrate across the Congo to its winter quarters in the Sudan in time to enjoy the insect-rich rainy season there.
- The Nacunda Nightjar in South America makes a corresponding migration between Venezuela and Argentina.

- **(large migrations)**
  - Golden Plover – North to south America.
- **Unique migrators**
  - Bronzed Cuckoo – is from New Zealand that is a brood parasite that never sees its parents. It flies from N.Z. 1900 Km to Australia and then 1600 km to the Soloman Islands.
  - Blackpoll Warblers – from New England to Venezuala non-stop.