By Stefan Andrei, Science Editor

How Do Bats Detect and Use the Earth's Magnetic Field?

Different mechanisms than the one used by birds

Without a map or GPS, we are completely lost in the middle of nowhere. But many species, such as the mole rat, birds, fish, amphibian, have a magnetic compass. Bats have it too, and a new research shows how these mammals can feel the polarity of a magnetic field, detecting the difference between north and south. This cooperation between researchers from China and New Zealand sheds light on the bats' long-distance navigation, foraging abilities, but also on when and how magnetic field compass emerged in mammals and non-mammals. "The fact that the only two flying vertebrates, bats and birds, do not derive the same information about direction from the Earth's magnetic field despite apparently similar navigational requirements has very important implications for the evolution of the magnetic sense in vertebrates," co-author Stuart Parsons from the University of Auckland, New Zealand told PhysOrg.com. "I think it is likely that other mammals possess the ability to detect the field, i.e. have the physiological and anatomical specialization necessary. However, this does not mean that they actually use this information." Investigations were made on Nyctalus plancyi bats in a chamber where the magnetic field could be manipulated. The hanging positions of the bats were detected with an infrared camera, and Helmholtz coils produced a magnetic field twice more powerful than the Earth's and which aligned with the local geomagnetic axis at Beijing (the location of the tests). After the animals passed several days in the induced magnetic field, the team shifted the horizontal and vertical field's components, both simultaneously and independently. By shifting the field's vertical lines, the magnetic inclination is changed, while shifting the horizontal field changes the magnetic polarity. Birds and many non-mammals magnetic sensitive animals are known to perceive the inclination, using the Earth's magnetic field inclination to assess relative latitude. This angle is 90 degrees at the poles (perpendicular to the Earth) and 0 degrees in the equatorial area (parallel to the Earth). There are bird species, like the Arctic Tern, which use this information to make annual journeys from the North Pole to the South Pole and back. But bats appeared to be insensitive to shifts in the vertical field, thus they do not employ the field's angle. But when the horizontal field was shifted, the bats also changed their hanging positions, from the northern to the southern edges of their basket. The researchers had predicted that magnetic polarity could help these flying mammals in thermoregulation, as they need warmer locations to breeding and to decrease energy consume during torpor (in the dry summers) or hibernation (during the cold winter). The magnetic polarity is used more than for roosting: some bats, like Nyctalus noctula, can navigate during their seasonal migrations up to 1600 km (1000 mi). The researchers put the magnetism detection on light exposure, magnetite receptors, or both. Birds can employ a light-connected mechanism in the right eye for directional information, and a magnetite receptor in the upper beak for perceiving the changes in magnetic intensity. As bats have poor vision, they are most likely possessors of magnetite receptors. The birds' mechanism could be linked to their long migrations, crossing the equator, but also to the Earth's magnetic field, which occasionally reverses, so that the birds won't lose their guidance. [img=2]"It has been suggested that the ability of birds to detect the inclination of the Earth's magnetic field means that reversal of the polarity of the Earth's magnetic field will not affect the ability of birds, particularly migratory birds, to set compass courses because there will be a magnetic pole in each hemisphere and the birds will know the direction toward the near pole and the equator as a consequence", added co-author Michael Walker, also from UA. "In contrast, the fact that mammals appear to respond to magnetic polarity suggests they will know where magnetic north is but not which hemisphere they are in and may get misled following a reversal of the polarity of the Earth's magnetic field." This study is the first showing that just polarity is enough for long distance journeys, but also that inclination and polarity detection have different evolutionary origins in birds and mammals.