that the poles are piled high with low-density material tossed out by the vulcanism, except that the poles happen to be just the parts of Io in which currently active vulcanism has not been found. Faced with Davies's numbers at the meeting for the first time, scientists posed various possible solutions, but all so far have their problems — such as the one that requires Io to be "rolling" along its orbit so that its poles change position by 90° in as little as 10,000 years. The missing eight kilometers have now upset, at least for the moment, much of what little understanding of Io's interior was thought to exist, and the result, says Torrence V. Johnson of Jet Propulsion Laboratory, is "an extreme quandary."

Another question has been whether Io has an atmosphere, given that gas seems to be a major component of its volcanic eruptions. Voyager infrared data indicated 0.2 centimeter-atmospheres (about one ten-millionth of earth's total surface pressure) of sulfur dioxide gas in a measurement made near an erupting plume, but the implications for the whole of Io are not so clear. According to Fraser Fanale of JPL, the localized 0.2 cm-atm. measurement was taken near Io's subsolar point, where the sun's heat is greatest (thus releasing a maximum of the frozen SO_2 that has been identified in spectra of the surface), and thus ought to imply an average pressure for the whole of Io of about one-fifth that amount. Yet measurements made by the earth-orbiting International Ultraviolet Explorer satellite indicated a global pressure that was five times smaller still, a mere 0.008 cm-atm. The answer, Fanale suggests, may be that Io's SO_2 atmosphere is confined to a near-equatorial band, where most of the eruptions were seen, since the SO_2 molecules migrating from there toward the poles could be picked off during the trip by charged particles in Jupiter's Io-enveloping magnetic field. He says that this could also explain why Io's poles appear darker than the rest of the surface.

The rest of the Galilean satellites, different as they are from one another, share one quality that sets them apart from sulfur-clad, eruptive Io: All are wrapped in thick blankets of ice, cracked and deformed by a variety of barely understood processes. Ganymede, the largest of the group, is crisscrossed by strange patterns of parallel grooves (SN: 5/17/80, p. 315), which Eugene Shoemaker of the U.S. Geological Survey told the meeting look as if they formed when the satellite's whole crust was in tension. Such stress could have been caused by the expansion of underlying strata of dense ice, Shoemaker believes, although, he says, any actual increase in Ganymede's radius would probably have been less than one percent. Fissuring on such a scale might also be expected to cause significant secondary effects, as suggested by Stephen W. Squyres of Cornell, who proposed water rising through the cracks as the origin for a 260-kilometer-wide dome that he said looms some 2.5 km above Ganymede's surface.

The opposite, in a sense, of Ganymede, which has cracks, craters, domes, smooth spots, rough spots and more, is Europa, on which the Voyager photos revealed almost nothing but tangled patterns of streaks — wide, narrow, light, dark, straight, curved and often interwoven (SN: 5/3/80, p. 283). The streaks, like Ganymede's grooves, are believed to be fissures and ridges due to stress on the ice, but they apparently vary by no more than a few hundred meters at most from the surrounding terrain. Trying to unravel the gnarled web, Lawrence Soderblom of the USGS reported that they seem to have formed in three separate episodes — two "one-shot" batches and one grouping that resulted from some longer-term process. Some expansion of Europa would probably have been needed to do the trick, he told the meeting, such as might have occurred when rock settled to the center of the satellite's original mixture of materials to leave the ice on top. But there is a moonful of cracks to be explained, and although Europa shows traces of only eight craters that Soderblom and a colleague could even agree were craters, it is possible, he said, that their formation also had something to do with creating the stripy surface. Even tidal stresses could play a role, as E.M. Parmentier and colleagues from Brown University have suggested, although Europa is farther than Io from Jupiter and may be subjected to only a tenth as much Jovian tidal stress as causes Io's vulcanism. David Pieri of JPL identified further signs of such a process, citing the pattern of polygons created by the intersecting streaks as evidence for stresses on Europa aligned around its Jupiter-facing side.

The odd moon out is Callisto, at least compared with the exotica of the other Galilean satellites. Callisto shows no volcanoes, no cracks, no mountains — virtually nothing but craters, packed side by side over the entire surface. As the outermost of the four major moons, it is not subjected to significant tidal stresses, nor does it show the grooves that on Ganymede (the next satellite in) are tentatively being attributed to tensional stresses from expansion or other factors. As with Ganymede and Europa, however, Callisto's craters do show up as bright spots or rings against a darker surface — a darkness that raises questions about what are essentially ice-jacketed worlds. Micrometeoroid dust could presumably account for some of the dark material (the satellites' own rocky stuff supposedly would have sunk to the center), and William K. Hartmann of the Planetary Science Institute in Arizona said that different heating histories for the moons could make major differences in whether such dark layers would stay on the top or form strata at varying depths.

More mysteries remain. □

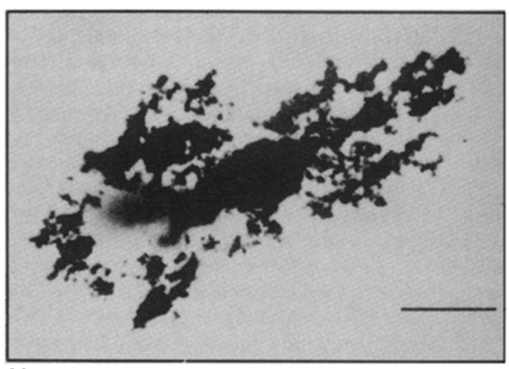
Homing pigeons: A magnet in the neck

There is some bewitching magnetism about the mission San Juan Capistrano that brings the famous swallows back every year. It's a bit harder to believe that there is any magnetism about a guano-covered coop on a roof in downtown Pasadena that brings pigeons back again and again. Unless it really is magnetism. A number of researchers investigating the homing and migrating behavior of various birds, bees and other species are beginning to believe it is magnetism, geomagnetism. A method by which birds may use geomagnetism to such a purpose is proposed by David Presti and John D. Pettigrew of California Institute of Technology in the May 8 NATURE.

Evidence cited in support of the view that magnetism is somehow involved include behavioral experiments that show that changes in the ambient magnetic field affect animals' ability to orient themselves and dissections that have found magnetic material in the bodies of birds, bees and others, including the finding of magnetic chains in some bacteria and the observation that those bacteria seem to use the internal magnets for direction finding (SN: 4/26/80, p. 267).

Presti and Pettigrew propose that the birds get information about the geomagnetic field through a sensory apparatus that resides in a muscle. It is a combination of a small permanent magnet that responds to the geomagnetic field and a sensitive part of the muscle, a spindle fiber that is influenced by the magnet. As a basis for this suggestion they cite anatomical evidence gathered from dissections they did of two species of migrating and homing birds.

The specimens included pigeons *(Columba livia),* both tame and feral, and migratory white crowned sparrows *(Zonotrichia leucophrys).* A high degree of inducible magnetic remanence was found in the heads and necks of the birds. Such a finding indicates the presence of magnetic material. The birds were prepared with a buffered fixative for fear that the acidity of



Nature

Magnetic particles found between complexus muscle and fascia of a pigeon.

unbuffered fixative might react with any magnetic material present. Dissection was done with glass knives to prevent contamination of the specimens with ferromagnetic particles that might come from ordinary metal knives.

Magnetism associated with the birds' heads seems to be diffused over the skull, Presti and Pettigrew report, and, contrary to some earlier reports, they could not find any specific magnetic material there. They did find it in the necks. They found diffuse patches of black magnetic material embedded in the tissue or surrounding fascia of the complexus muscle. From the black color and the magnetic remanence it exhibits, they think this is magnetite or common lodestone (Fe_3O_4).

The sensory mechanism they propose involves a coupling between such tiny magnets and the spindle fibers of the muscle, which are very sensitive to stretch. Changes in the geomagnetic field would cause torques on the magnets. These would be communicated to the spindles, and the bird would feel the geomagnetic field in its muscles.

Not only birds, people too. The phenomenon of dowsing has puzzled observers. Presti and Pettigrew suggest that the deflections of the dowser's rod may be amplifications of minute movements of the dowser's muscles in response to changes in the geomagnetic field caused by the presence of water. □

Panda predicament at home and abroad

The recent announcement of the artificial insemination of the National Zoo's giant panda Ling-Ling reminds zoo director Theodore Reed of the old Italian post-marital-night custom of hanging a sheet out the window "so the neighbors would be able to know that...breeding had taken place." Although Reed now can "hang a sheet" for Ling-Ling, he is quick to point out that the successful injection of sperm extracted from her mate Hsing-Hsing does not necessarily mean conception has occurred: Washington zoo officials must wait four and a half months (panda gestation period is about five months) before they will know whether to expect a 5-ounce cub addition to their panda house.

Should the artificial breeding of Washington's panda pair result in a surviving cub, it would be the second one of its kind — the only other surviving panda born of artificial insemination belongs to the Beijing (Peking) zoo in China. A new cub also would be a much needed boost to the morale of panda lovers distressed by the Chinese panda population decline.

More than 10 percent of all giant pandas have died of starvation or been killed by earthquakes since 1975, says Lee Talbot of the World Wildlife Fund (WWF) Swiss Conservation Branch. This population decline has prompted a collaborative effort between WWF, Chinese scientists and the New York Zoological Society to gather data about the 300-pound bear-like creature and its relationship with its natural habitat.

Jessie Cohen/Nat'l Zoological Park

Repeated failures of the natural breeding attempts of male Hsing-Hsing (left) and female Ling-Ling prompted National Zoo veterinarians to artificially inseminate Ling-Ling. Reproductive success would be a brightener in the otherwise gloomy international panda picture.

To collect such information, researchers "are going to have to overcome great obstacles," says William Conway, zoological society director. The black and white giants live in rough terrain — the mountains of central China — and have no permanent dens. An attempt will be made this fall to overcome these obstacles, though, when George B. Schaller of the zoological society assists in leading an expedition to survey the Chinese panda reserves. Schaller and colleagues recently completed a week-long, preliminary fact-finding stint in the Wolong reserve — about 150 miles west of the provincial capital of Chengdu — to prepare for the fall expedition.

One panda perplexity Schaller and coworkers hope to unravel is the role of bamboo in the panda diet. Even though the panda population decline has been attributed partially to the sudden death of two bamboo species, "Nobody knows how much of the panda diet is composed of bamboo," says Conway.

Bamboos, members of the grass family, differ from their relatives in that they flower only after many years, says bamboo specialist Thomas R. Soderstrom of the Smithsonian Institution. In fact, umbrella bamboo *(Thamnocalamus spathaceus)* and another, as yet unnamed, bamboo — two species that pandas feed on — bloom only once at the end of their approximately 100-year life span.

The flowering phenomenon was observed in 1976 by Chinese researchers in the panda region. A rare treat for botanists, the nearly centennial flowering is a natural handicap for the giant pandas — although the bamboo flower produces seeds, it takes several years for the new bamboo plants to ripen for panda nourishment.

Researchers, therefore, are interested in learning how the panda survives the massive loss of bamboo. Conway theorizes that pandas living during the 1880s — the approximate time of the penultimate bamboo flowering — may have fared better because of a wider range in which to forage. □

PCB ban in food production proposed

Equipment containing the toxic chemical PCB is to be removed from food and animal feed production facilities and agricultural chemical plants, according to rules proposed jointly by the Environmental Protection Agency, the Food and Drug Administration and the Department of Agriculture. Since 1971 there have been at least nine separate incidents of accidental PCB contamination of human food supplies, including the Billings, Mont., leakage from a stored electrical transformer. That incident contaminated millions of pounds of food (SN: 10/6/79, p. 228).

The proposed rules, published in the May 9 FEDERAL REGISTER, would require that within a year no food, feed, fertilizer or agricultural pesticide production facility maintain liquid PCB's in excess of 50 parts per million. The FDA estimates that approximately 685 million pounds of fluids containing PCB's are in use in transformers and capacitors in the United States. A consultant to the EPA says electrical equipment manufacturers have developed non-PCB equipment that performs adequately in almost every application.

The EPA estimates that 1,200 PCB-containing transformers and 31,000 PCB-containing capacitors covered by the ruling (capacitors with less than 3 pounds of PCB's are exempted) were in agricultural chemical facilities in 1979. Removal of that equipment is expected to cost the owners approximately $44 million. The agency points out that the clean-up costs from the Billings contamination ran into millions of dollars. It expects the cost of removing and replacing the PCB equipment to equal the projected clean-up costs for potential accidents over a 20-year period.

The PCB's to be removed from the food, feed and chemical facilities will pose a disposal problem. Some liquids with in-

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