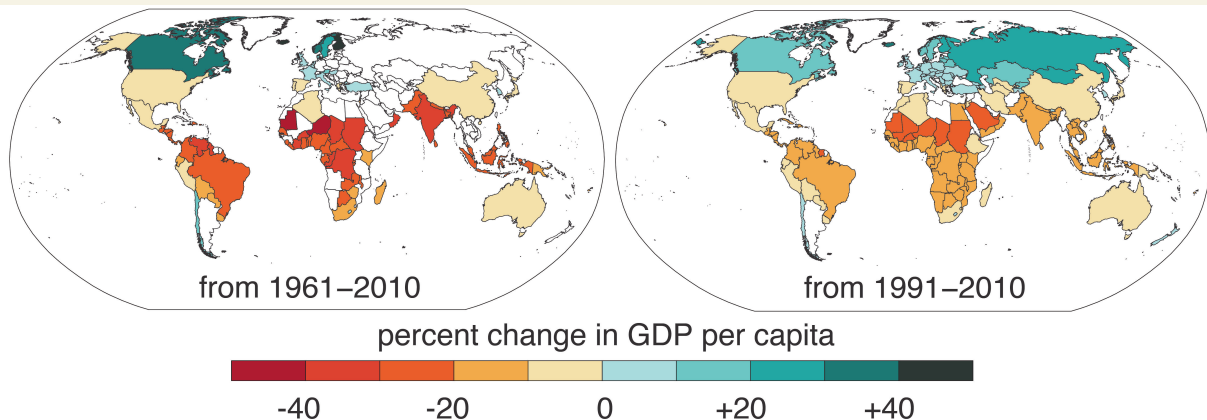


In this issue . . .

Economic inequality and global warming

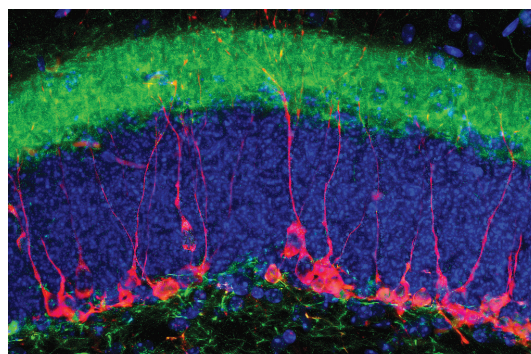
The effects of historical temperature trends on economic inequality are unclear. Noah Diffenbaugh and Marshall Burke (pp. 9808–9813) calculated what the per capita gross domestic product of countries would have been over the past half century if human-caused global warming had not occurred. The calculations combine empirical estimates of the relationship between temperature fluctuations and economic growth, with simulations from 21 models of the countries' estimated historical temperature fluctuations without anthropogenic climate forcing. The authors estimated that long-term global warming has decreased growth in the world's poorest countries that have emitted the least carbon dioxide, and has likely increased economic growth in many wealthy, high-emitting countries. Accounting for the economic impacts in each country, the authors estimate that it is more than 90% likely that global warming has increased the economic disparity between the top and bottom population deciles, thereby generating greater economic inequality than would have occurred without global warming. The findings suggest that the fossil fuel energy consumption of wealthy countries has likely adversely affected the economies of poor countries, suggesting that replacing fossil fuels with low-carbon energy sources may help reduce global socioeconomic disparities. — M.S.



Economic impact of global warming during 1961–2010 and 1991–2010. Value for each country is estimated impact of global warming on country-level per capita GDP. Differences in magnitude of country-level values between the 1961–2010 and 1991–2010 periods reflect influence of accumulation time on net economic impact.

Inheritance of exercise effects on the brain

Exercise has well-known beneficial effects on brain health and function, but it is not clear whether the effects of exercise are heritable. Kerry McGreevy et al. (pp. 10103–10112) compared cognition, neurogenesis, gene expression, and mitochondrial function between male mouse litters from the same father before and after exercise training, and between litters from separate sedentary and exercised fathers. Adult male mice exhibited significant short-term and long-term memory improvements following a 6-week exercise regimen, and litters from these male mice performed better in memory tests than



Staining for immature neuronal markers doublecortin (red) and calretinin (green) in the hippocampal dentate gyrus of an adult male mouse.

litters either from the same male mice before exercise or from different, nonexercised male mice. Similar results were obtained when the litters were produced through in vitro fertilization and embryo transfer. Exercised fathers exhibited an increase in a subpopulation of immature neurons and increased mitochondrial enzyme activity in the brain compared with nonexercised fathers; similar differences were observed between litters of exercised and nonexercised fathers. Hippocampal gene expression differed significantly between exercised and nonexercised fathers, and between the offspring of exercised and nonexercised fathers. Notably, genes associated with microRNA activity showed changes in expression in both the exercised fathers and their offspring. The results suggest that exercise-induced effects on the brain can be transmitted to offspring via sperm and may be mediated through microRNA activity, according to the authors. — B.D.

Natural, nonbiological light-harvesting system on Earth

Solar energy fuels both biological and inorganic processes on Earth. While solar-to-chemical energy conversion via photosynthesis in biological systems is well understood, a corresponding nonbiological light-harvesting system has not been previously observed. Anhuai Lu, Yan Li, Hongrui Ding, et al. (pp. 9741–9746) performed physical and chemical analyses of naturally occurring varnishes from desert rock surfaces in northern China, as well as surface coatings from karst and red soil particles in southern China. Electron microscopy and X-ray spectroscopy revealed that the coatings consist mainly of iron (Fe) and manganese (Mn) (oxyhydr)oxides, and are particularly enriched in Mn relative to the underlying rock. In situ photoelectric measurements in rock varnish samples yielded detectable

photocurrents in the Fe-rich or Mn-rich mineral coatings, but not in the rock substrate. Currents were stable under steady illumination but shifted rapidly in response to illumination changes and exhibited constant photon-to-electron conversion efficiency. Irradiation-dependent photocurrents were also observed in coatings from karst and red soil. The authors attribute the photoelectric response of the coatings to naturally occurring Fe and Mn (oxyhydr)oxide minerals, such as birnessite, hematite, and goethite, which are solar light-responsive semiconductors. The photoelectric behavior of the mineral coatings may play important roles in biogeochemical processes, according to the authors. — B.D.

Detecting and editing DNA methylation in oocytes

Some mammalian diseases result from abnormal methylation of oocyte DNA. By modifying a technique called bisulfite sequencing, which is used to detect methylation of specific nucleotides, Yanchang Wei et al. (pp. 9883–9892) measured site-specific DNA methylation in individual mouse oocytes and



Yellow mice generated by targeted DNA demethylation in oocytes derived from pseudoagouti mothers.

their associated first polar bodies (PB1). PB1 is a genetic sibling of the oocyte formed during meiosis but is not required for subsequent development. Although methylation patterns differed among oocytes from the same mother, each PB1 had a methylation pattern similar to that of its associated oocyte. The authors showed that methylation status of specific DNA sites in PB1 could predict the methylation of the same sites in the oocyte, and hence predict offspring phenotype. Next, the authors developed a method to alter methylation patterns in individual mouse oocytes using an inactive Cas9 enzyme fused to DNA methylating or demethylating enzymes. Using this method, the authors altered the coat color of offspring, generated bimaternal embryos that developed to full term, and corrected familial Angelman syndrome, which results from incorrect methylation of maternal DNA, in a mouse model. The results suggest a strategy for preventing or correcting maternally inherited DNA methylation disorders and may facilitate the study of maternally transmitted epigenetic information, according to the authors. — B.D.



Photoelectric conversion on the planetary surface via widespread Fe and Mn mineral coatings.

Fossils illuminate variation and continuity in early Asians

Fossil evidence for human evolution in East Asia during the Pleistocene is often fragmentary and scattered, complicating efforts to evaluate the pattern of archaic human evolution and modern human emergence in the region. Xiu-Jie Wu et al. (pp. 9820–9824) report the discovery of most of a skull and associated remains, dating to around 300,000 years ago, in Middle Pleistocene cave deposits of Hualong Cave in southeastern China. The features of the Hualong fossils complement those of other East Asian fossil remains, indicating a continuity of form through the Middle Pleistocene and into the Late Pleistocene. In particular, the skull features a low and wide braincase with a projecting brow but a relatively flat midface, as well as an incipient chin. The teeth are simple in form, contrasting with other archaic East Asian fossils, and its third molars are either reduced in size or absent. According to the authors, the fossil remains add to the expected variation of these Middle Pleistocene humans, recombining features present in other individuals from the same time period, and foreshadow developments in modern humans, providing evidence for regional continuity. — P.G.

Carthage's lead and silver resources during Punic Wars

The Punic Wars, in which the powers of Carthage and Rome battled for the western Mediterranean between 264 and 146 BC, are well-documented. However, the factors that allowed Carthage to display economic resilience against the Romans are poorly understood, in particular the role of mineral resources available in Carthage during the wars. Hugo Delile et al. (pp. 9764–9769) analyzed sediment cores from Utica, Tunisia, at the outflow region of the Medjerda watershed. Around half of the 147 samples taken from the eight cores contained elevated levels of lead, linked by multiple lines of evidence to tailings likely derived from lead–silver mining. Mining activity appears to have begun in the middle of the 4th century BC, around the time



Utica. North view from the promontory to the Great Baths and the ancient marine bay.

of the Greco-Punic Wars, and coincides with the first minting of Punic coins at Carthage. The mining is probably linked to the development of Punic coinage and the increasing monetization of the Carthage economy. According to the authors, the availability of lead–silver mines within Carthage's North African territory enabled Carthage to pay massive war reparations and support further warfare against Rome even after the loss of its silver-rich territories in southern Spain. — P.G.

Agriculture and bird populations in Costa Rica

Tropical agriculture contributes to biodiversity loss, but agricultural sites may become habitats for various species. Çağan Şekercioğlu et al. (pp. 9903–9912) mist-netted 57,255 birds of 265 species



Male green honeycreeper (*Chlorophanes spiza*).

from 19 sites in Costa Rica, including forests and coffee plantations, between 1999 and 2010. Overall, more bird populations declined than were stable or increasing. Insectivores suffered the greatest decline. Compared with forests, coffee plantations had higher ratios of immature and juvenile birds to adult birds for nonmigratory species. Whereas 49% of species preferred forests to coffee plantations, 39% of species preferred coffee plantations, and 12% of species used both habitats. Compared with coffee plantations with less tree cover, plantations with more shade had increases in species that were forest-dependent, range-restricted, and of conservation concern. Wintering migratory birds also preferred shaded coffee plantations over forests. Population declines were greater in the 250-hectare Las Cruces forest than in 3 to 5-hectare forest fragments. The findings suggest that large protected forest areas are critical for forest bird conservation. Moreover, coffee plantations may be an important habitat for migratory birds, some forest-dependent birds, and young birds unable to find forest territories, according to the authors. — M.S.