this, coupled with the strong lightcurve, makes it difficult to identify seasonal volatile transport or active geological effects. New lightcurve data cannot be explained by published, static models of Pluto's surface reflectance, but whether the surface of Pluto is truly changing remains to be determined (M. Buie, Lowell Observatory).

It is also fair to say that physical models of surface–atmosphere interaction have so far not done a good job of predicting what is already known of the distribution of volatiles on Pluto's surface (J. Spencer, Lowell Observatory). This complicates present efforts to work out whether Pluto's atmosphere might condense onto its surface before 2015. If it does so, as the planet retreats from the Sun, we will have missed a unique opportunity to understand the transport of volatiles on bodies like Pluto (Fig. 1), and indeed to study active atmospheric loss (D. Strobel, Johns Hopkins Univ.). In an extended Pluto atmosphere, loss processes and solar-wind interactions similar to those believed to have been important on the early Earth might occur (R. Gladstone, Southwest Research Institute, Texas).

Ongoing geological activity on Pluto is a distinct possibility. Reference was made to analogous processes across the Solar System, from tidal tectonics on Mercury and Europa (G. Collins, Wheaton College, Massachusetts) to martian surface activity, and, naturally, to the nitrogen geysers, cantaloupe terrain and cryovolcanic structures of Triton (J. Moore, NASA Ames Research Center, California). Given that volcanism and other activity on Triton is relatively geologically recent[9], Pluto, similar in size, density and composition, may behave similarly. We have also learned from the Galileo spacecraft's flight to Jupiter that large icy satellites commonly have internal oceans[10], and Pluto could well have an ocean beneath a 200-km-thick ice crust, if the conditions are right (W.B.M.).

Even Charon — half the size of Pluto — may be more geologically active than had been thought. A distinct feature in Charon's spectrum at a wavelength of 2.2 μm has been ascribed to ammonia-bearing ices[11]. Although the reality of this feature was debated (it is not seen at all longitudes on Charon; D. Cruikshank, NASA Ames Research Center), the very presence of ammonia ice has long been equated with active geology. With any luck, however, Charon will not prove to have been so active as to have erased its ancient cratering record. Between it and Pluto, crater counts should determine the flux of impactors in the Kuiper Belt over the history of the Solar System, and thus constrain the character and flux of short-period comets from the belt and into the rest of the Solar System.

The future of Pluto–Charon science looks bright (as bright as it can be, so far away). Pluto is moving into alignment with the Milky Way, and its first observable eclipse of a bright star since 1988 is set for this month; thereafter such eclipses occur roughly twice a year. These will provide first-class opportunities to probe Pluto's atmospheric structure. Next January will see the launch of NASA's Space Infrared Telescope Facility, which will pin down the heat budgets and thermal characteristics of terrains on Pluto and Charon, as well as determining the sizes and albedos of many other Kuiper Belt objects for comparison. And even now, the Advanced Camera for Surveys (recently installed on the Hubble Space Telescope) has begun taking the best-resolved images of Pluto yet. Nothing, however, beats the resolution of a spacecraft encounter. The fate of the New Horizons mission presently rests with the US Congress, but if it goes ahead it will provide the best answers by far to our fundamental questions about Pluto–Charon and the Kuiper Belt. ■

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Reproductive biology

Do the locomotion

HARRY MOORE

After animals have mated, sperm in the female reproductive tract must race to gain that incomparable prize, fertilization of an egg. Because sperm express little of their genetic make-up in their outward appearance, it is difficult to select the good from the bad. So it might be better for an individual's sperm to cooperate rather than compete with one another. For species in which females mate with multiple partners, this will be particularly true if the sperm of one male could unite to defeat those of its rivals.

Elsewhere in this issue, Harry Moore and colleagues describe an amazing example of such altruistic behaviour in the sperm of the common European wood mouse, *Apodemus sylvaticus* (*Nature* **418,** 174–177; 2002). They find that hundreds or thousands of sperm link hooked structures on their heads and swim en masse in a train, which enables them to progress at almost twice the speed of a single sperm. These trains must break up before fertilization, so many of the component sperm commit genetic hara-kiri by undergoing a premature 'acrosome reaction'. This involves the release of enzymes that break down cell adhesion molecules, which also makes it impossible for the sperm concerned to fertilize the egg. Somewhere on the train — perhaps it's the locomotive driver up front — there must be one acrosome-intact sperm that has retained its capacity to perform fertilization.

It might be no accident that the wood mouse is a supreme sexual performer among rodents, with males scrambling to mate polygamously with any and every promiscuous female, and they have relatively large testes to prove the point — as the picture shown here attests. So an individual male not only tries to ensure his reproductive success through sperm collaboration, as Moore *et al.* show, but also by sheer sperm numbers.

The story does not end there. Sperm motility is ultimately driven by the engine of mitochondrial DNA in the sperm's midpiece. An exciting paper by Matthew Anderson and Alan Dixson (*Nature* **416,** 496; 2002) has shown that, in primates, the volume of the sperm midpiece is highly correlated with relative testicular size and mating behaviour, the most sexually athletic species having the largest mitochondrial midpieces to power their sperm. So we can look forward to further work to see whether the wood mice have vast mitochondrial midpieces to power their sperm trains, and whether the sperm of especially promiscuous primates such as chimpanzees would leave their human counterparts for dead in the Olympic swimming pool.

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