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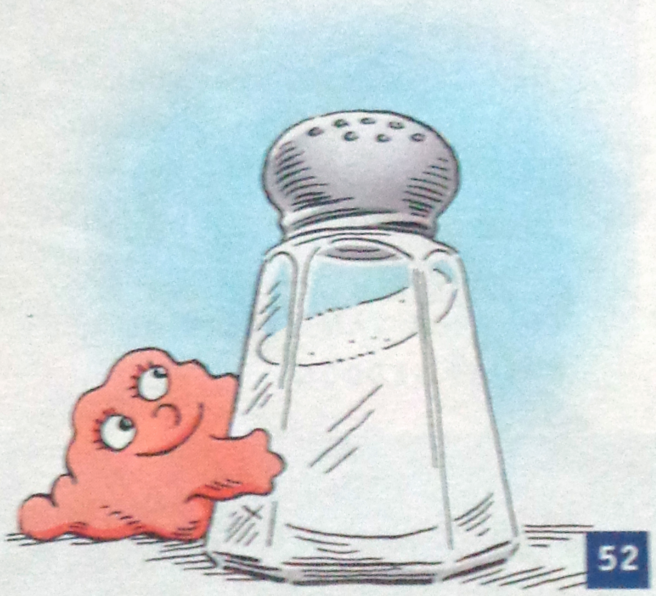

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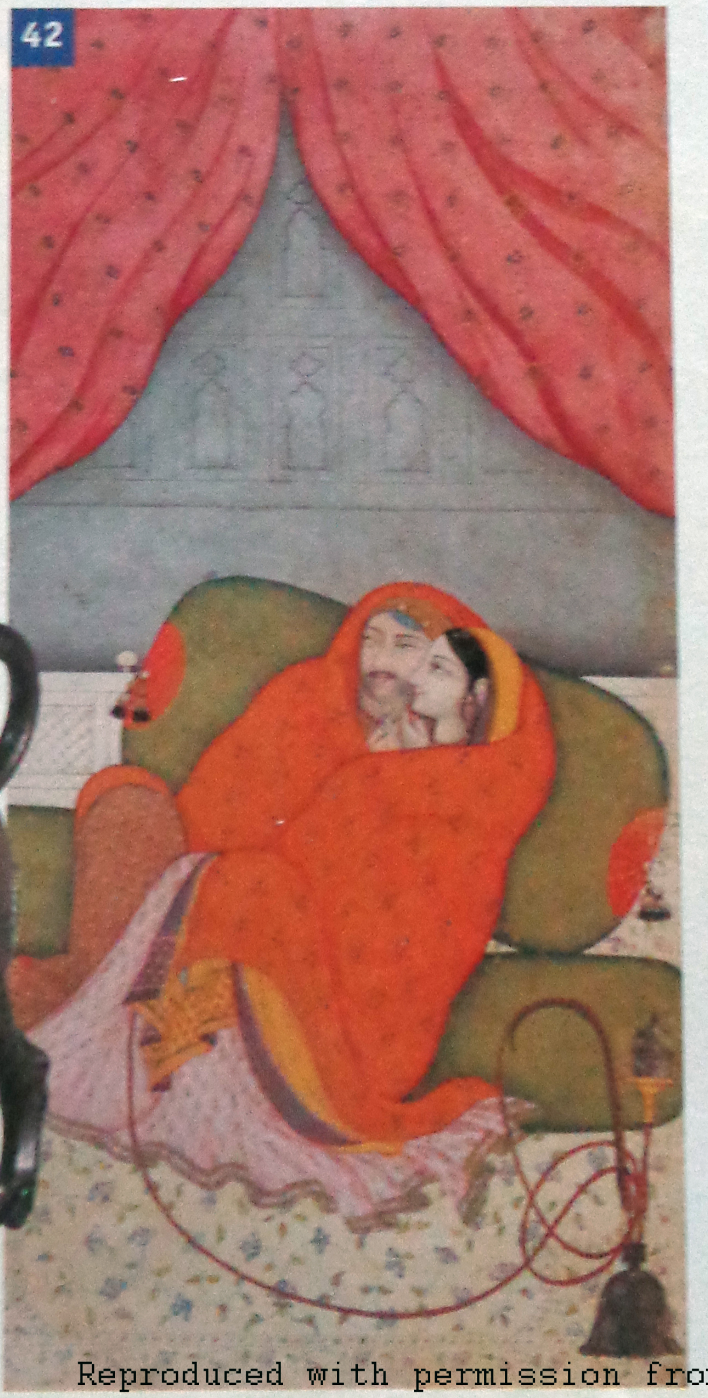

OF GENES AND GENOMES

Halfway through this gene-conscious year, *Natural History* looks at some small things with big implications.

COVER Our bodies have two kinds of genomes. The larger one (recently sequenced) is found in the center of each of our cells. But a different set of genes, of bacterial ancestry, dwells in the mitochondria, the cells' powerhouses. Our innards and skin also host hundreds of microbial species, each with its own genome. Artist **Alexis Rockman** adds mitochondria (green ovals) and bacteria (spirals and rods) to a fanciful "portrait" of our species.

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of Earth's salty puddles, NRC-1 grows on the degrading carcasses of less sturdy organisms that die off as salinity mounts due to evaporation. The genome of *Halobacterium* NRC-1 facilitates this process by including instructions for generating such exotica as a putrescine transporter—a molecular version of a waste-disposal truck. The microbe also contains the directions for making proteins that can eject toxic heavy metals such as arsenic and cadmium.

NRC-1 can prosper in water ten times saltier than Earth's oceans and can function happily with hypersalty innards. Unlike many other exotic microbes, it is easily grown in the lab, making it a potential workhorse for future research on the entire group of archaeal microorganisms known as extremophiles.

International efforts have resulted in the discovery that NRC-1 genes are carried on three replicating units, only one of which is as big as a typical chromosome; the other two are "minichromosomes." The genome sequence was used to predict about 2,600 genes, a third of which do not resemble any other known genes. Yet many of NRC-1's genes do carry instructions for familiar proteins—for example, those that facilitate molecular signaling across the cell membrane and those that are used for metabolic (housekeeping) functions. In fact, NRC-1 carries genetic instructions for making many cellular systems similar to those found in plants and animals.

Microbiologist Shiladitya DasSarma, of the University of Massachusetts Amherst, led the international sequencing project. He explains that NRC-1's trick to surviving in ever saltier water is to have proteins on its inside that carry a high negative charge. Bacteria that lack such proteins succumb to salt poisoning.

Also found in NRC-1's genes are the machinery for growth in both the presence and absence of oxygen; a primitive photosynthesis system; and a very efficient DNA repair system that protects against damage by harsh sunlight. This hardy strain of *Halobacterium* is also genetically rigged with sensing systems that guide it to the best-lit waters and to the optimal locations where nutrients, temperature, and oxygen can stimulate its growth. NRC-1 even has a protein molecule for a membrane that can be likened to a primitive retina, and a component that in other bacteria (as well as in plants and animals) acts to maintain circadian rhythms.

All in all, the microbe should serve as an impressive genetic ambassador from its ancient kingdom.

Pillars of a Salty World

Sequencing the genomes of the ancient kingdom of microbes called archaea yields evidence that all life shares some basic strategies, despite disparate ways of earning a living. Consider this: the tiny genome of *Halobacterium,* a microbe that thrives in the saltiest, most landlocked bodies of water, shares many similarities with complex (eukaryotic) cells, even those from humans.

Last year, an international team finished sequencing the NRC-1 strain of *Halobacterium*. The vulture