Early Earth may have had two key RNA bases

At some time more than 3 billion years ago, nucleic acids formed in the primordial soup that simmered on primitive Earth. These large molecules, notably RNA and DNA, evolved into the genetic basis of life.

But that prompts the question, What sequence of reactions triggered the evolution of nucleic acids?

The emergence of RNA, believed to be life's chief precursor, presupposes that its basic building blocks—adenine, guanine, cytosine, and uracil—formed first. Although scientists have shown that the purine bases, adenine and guanine, form readily under simulated early Earth conditions, they have also noted that the pyrimidine bases, cytosine and uracil, do not.

Now, Michael P. Robertson and Stanley L. Miller, both biochemists at the University of California, San Diego, have found a way around this obstacle. They describe in the June 29 NATURE an "efficient prebiotic route" for the synthesis of cytosine and uracil.

"What we're envisioning," says Robertson, "is a tidal pool filled with water and urea. As the water evaporates, the urea becomes highly concentrated. The concentrated urea would then have reacted with cyanoacetaldehyde [also present in the primordial soup] to form cytosine. The cytosine would then have gone on to form uracil."

The key to solving the problem, says Miller, lies in concentrating the urea. At low concentrations, little cytosine forms. But seawater pools slowly evaporating under a hot noonday sun can become saturated enough to spawn the requisite chemical reactions. Replicating these conditions in the laboratory, the researchers generated healthy amounts of cytosine.

The cytosine then reacted to produce uracil.

In 1953, Miller first showed that amino acids could form under primordial conditions. Recently, he and Robertson demonstrated that primordial RNA may have had greater enzymatic activity than scientists had previously assumed (SN: 5/6/95, p.279).

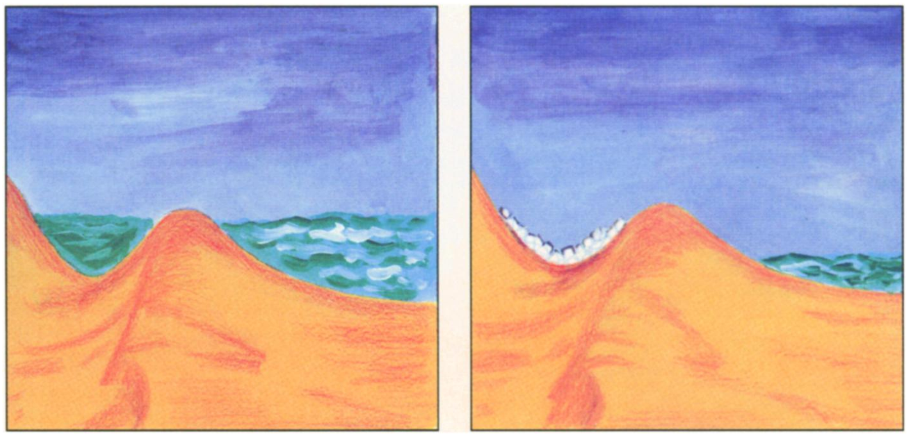
The latest reactions "provide a plausible route to the pyrimidine bases required in a [primitive] RNA world," the two state. "There no longer seem to be good reasons to believe that the bases used in the first [genetic] macromolecules were radically different from those in DNA and RNA."

As scientists try to piece together the path of life's chemical history, Gerald F. Joyce, a molecular biologist at the Scripps Research Institute in La Jolla, Calif., calls this latest report "another brick in the road."

"In trying to understand how life originated, people are wondering how, in a primitive environment, without enzymes, the building blocks of biological molecules could have formed. The pyrimidines have presented a nagging problem. Until now, no one has shown an efficient, plausible chemical pathway by which these molecules could have been made.

"The latest chapter in this story is the Robertson-Miller synthesis, which is darn efficient," Joyce says. "That is news."

— *R. Lipkin*



Marc J. Roth

Tidal pools on primitive Earth, drying under a hot sun, may have spawned cytosine and uracil, two bases needed for emerging RNA molecules.

Seals: The love 'em and leave 'em type?

Seals may not deserve their reputation as purely polygynists, a new study suggests. Far from showing no interest in long-term relationships, many seals will in fact return to a tried and true partner.

In addition, researchers had thought that female seals prefer dominant males, which fight with other males for mating rights. On the contrary, subordinate males, in particular, "establish durable ties [with females], recognizing each other between seasons and coordinating their behaviors," report Bill Amos of the University of Cambridge in England and his colleagues in the June 30 SCIENCE.

Whether the males pick the females or vice versa remains unclear.

"These data challenge our rather smug beliefs about mating systems, says Phil Clapham of the Smithsonian Institution's National Museum of Natural History in Washington, D.C. "This is the first I've seen of something like this in a seal," adds Rob Fleischer of the Smithsonian's National Zoological Park.

Amos and his colleagues marked and took blood from 85 female and 88 male *Halichoerus grypus* seals in breeding areas on North Rona, an island off Scotland. Between 1986 and 1989, almost 70 percent of the females, which generally have one offspring at a time, returned to the island. Using molecular genetic techniques, the scientists examined the parentage of these females' pups, including about 50 pairs of siblings or half-siblings.

The researchers found that any two seal pups born during the study are about 13 times as likely to have the same father if they share the same mother. Those odds, Amos says, suggest "far greater partner fidelity than you could get by chance."

Genetic analyses of the pups and adults ruled out the possibility that a few very successful males, spending a lot of time in the breeding colony, produced most of the full siblings. Tests also revealed that dominant males which returned to the island "actually father disproportionately few full sibs," the scientists report. Therefore, credit for most full siblings goes, by default, to the subordinate males, the authors conclude.

Seeking out a familiar partner could help reduce the death rate of pups, they speculate. Fights over females disturb the clan, sometimes separating mothers from pups, which die if left on their own. Clapham disagrees, saying that motives for the seals' fidelity remain unclear.

— *T. Adler*

National Zoological Park

A gray seal.

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