EVOLUTION

Continental drift and the diversity of species

The concept of continental drift has been invoked to explain many different geological events and features—earthquakes, mountains, island chains and deep rifts in the ocean floor.

Dr. James W. Valentine, a specialist in paleozoogeography at the University of California at Davis, believes that the movements of continental plates in the past may also have regulated the ebb and flow of life.

While studying theoretical aspects of the diversity of species, Dr. Valentine said at the annual meeting of the Geological Society of America last week in Milwaukee, he began to notice certain patterns. One was that the diversity of marine shelf biota seems to depend on the stability of food resources. Where such resources fluctuate in abundance and nature, marine shelf animals must be very flexible. They must be able to eat a wide variety of foods, survive in many different environments and reproduce rapidly. Only a few species are normally found in such areas.

On the other hand, he says, where food resources are stable, animal populations can become very specialized, and many species flourish.

The prime factors determining food supply, according to Dr. Valentine's theory, are solar energy and fluctuations in nutrient supply. Solar radiation, of course, varies with latitude. High latitudes, with drastic seasonal changes, have large variations in food supply and small diversity of species. In lower latitudes, the opposite is true.

Longitudinally, he says, the major factor determining food supply is nutrient flow, which in turn depends on the arrangement of continents and oceans. The greatest fluctuation in food supply and least diversity in marine shelf populations, says Dr. Valentine, occurs along large continents facing small oceans, as in the Arctic. The least fluctuation and greatest diversity occurs along small continents washed by large oceans, as in Antarctica.

In addition, since the continent's size determines the influence the seas will have in moderating its climate, large continents would have greater seasonality and less diversity.

Plate tectonic processes, causing alternate fragmentation and reassembly of continents and movement of the land masses across the globe, says Dr. Valentine, have drastically affected marine shelf life.

As continents break apart, he explains, the size of the land masses in relation to surrounding ocean—decreases and diversity of life forms increases. Each continent develops its own biota, and as the continents drift apart, latitudinal variations also increase. Most species have a small latitudinal range, Dr. Valentine points out, so considerable replacement of species along a north-south coast would occur. Conversely, as continents reassemble to form supercontinents, constancy of food supply and diversity decrease.

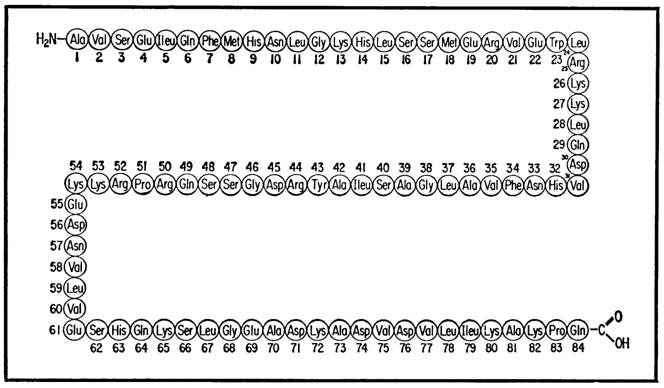
Dr. Valentine has charted the number of families of marine shelf animals against geological time. The resulting curve shows a period of high diversity 400 million to 500 million years ago in the Middle Paleozoic (Ordovician, Silurian, Devonian), when Pangaea I was breaking up (see p. 392). The curve plummets in the Carboniferous, when continents reassembled to form the second supercontinent, Pangaea II. As the second Pangaea broke up into the present continents and these continents began to drift apart, the diversity curve shoots up again, far surpassing any of the previous peaks.

The present great variety of species, says Dr. Valentine, can be attributed to a favorable arrangement of continents. Not only are there many continents spread over all latitudes, but many long continental margins, such as those of Africa and North and South America, are aligned in a north-south direction, maximizing latitudinal variation along a given continental shelf.

Plate tectonics, Dr. Valentine concludes, provides a whole new framework for the study of past life forms. "One might say," he remarks, "that global tectonics has become the handmaiden of paleontology." □

DISPUTE OVER DISCOVERY

Parathyroid stimulates discussion



Parathyroid hormone: The sequence of its 84 amino-acid molecules revealed for the first time.

Dr. Brewer

The meeting was going well; by all accounts, better than most. The topic was cyclic AMP, a chemical which mediates the activity of most, if not all, of the body's hormones. In the five years since its discovery, cyclic AMP has emerged as one of the more exciting and fashionable subjects of biological research (SN: 11/14, p. 382), and a symposium sponsored by the New York Academy of Sciences last week drew more than 400 eager investigators who jammed into a ballroom at the Waldorf Astoria to hear leading researchers present their latest data.

But while the majority of the presentations duly earned the approbations of the sophisticated audience, it was not until late in the afternoon of the second day that anyone said anything to generate real excitement. It was then, at the tailend of a discourse on the role of cyclic AMP in mediating the activity of parathyroid hormone, that Dr. Gerald Aurbach of the National Institutes of Health in Bethesda, Md., went on to announce that, in collaboration with a research team from the Massachusetts General Hospital, the structure of parathyroid hormone had been determined, and part of it had been synthesized. His declaration sent the room buzzing, and scientists who had been chatting in the lobby rushed back to the meeting room to hear the news.

Parathyroid hormone plays a number of roles in the body, its principal function being the regulation of levels of calcium in blood. Hence, parathyroid hormone disorders are implicated in metabolic bone disease, as well as muscle and nerve disturbances. Knowing its structure—the correct sequence of amino acids of which it is constructed—will aid detailed studies of its interactions with other biological compounds. Experiments with a synthetic version of PTH, whose biological activity was confirmed by Dr. Aurbach, will allow investigators to examine its behavior in ways hitherto impossible. Though neither of these new advances in PTH research is of sufficient magnitude to make the evening news, their significance was not underestimated by those scientists who heard Dr. Aurbach speak.

There was, however, one flaw in an

otherwise brilliant announcement. Dr. Aurbach noted the sequence of PTH's 84 amino-acid building blocks, and the synthesis of the first 34, had been achieved by Dr. John Potts and his colleagues at the MGH in Boston. He then took credit for affirming the activity of the synthetic molecule.

What he neglected to mention was that two weeks earlier, at a meeting at the University of Wisconsin, another NIH scientist had already announced determination of the sequence of parathyroid hormone. At a small and highly specialized Symposium on Sequence Determination of Amino Acids in Proteins and Peptides, Dr. Brian Brewer detailed the structure of PTH, amino acid by amino acid. At that same gathering, Dr. Hugh Niall, an associate of Dr. Potts, presented his group's evidence of the sequence of the first 45 amino acids only.

Scientists, like other men, want credit for their accomplishments. Perhaps even more than other men, they generally follow a rigid protocol for acknowledging their colleagues. Thus, it was disturbing that the Aurbach-Potts group failed to cite Dr. Brewer's sequence work. For this, they have been accused of a lack, at the very least, of common courtesy.

Commenting on the issue from the stance of an objective observer, one NIH official finds the whole situation regrettable.

It could, he says, eclipse the real significance of what are in fact two clearly important contributions to knowledge: Dr. Brewer's sequence determination of parathyroid hormone and the Potts-Aurbach synthesis of a large chunk of it. □

FROG OTOLITH

Adjusting to space

The experience of 26 American astronauts in zero gravity seems to indicate that man can adapt to weightlessness, at least for two weeks. Biologists, however, want to know how this adaptation occurs—what happens to the internal mechanism of response.

One such mechanism is found in the inner ear sensors that control balance and orientation in earth gravity. Preliminary results of a space biology experiment with two bullfrogs (SN: 8/8, p. 118), announced this week, may provide a key answer.

"We were very surprised that the balance sensors adapted to zero g," says Dr. Torquato Gualtierotti of the University of Milan, Italy, who designed the experiment with National Aeronautics and Space Administration scientists.

The frogs, whose inner ear is similar to man's, were launched into space

NASA

Instrumented frogs: Back to normal.

last week with microelectrodes surgically implanted in the vestibular (inner ear) nerves leading from the sensor cells in the frogs' otoliths. Scientists wanted to see what happened to this sensor when the basic condition or reference point (gravity) was removed. Several possibilities existed. One was that the central nervous system would simply ignore the signals of imbalance being sent from the inner ear. Another was that the inner ear itself would finally adjust to zero gravity and stop sending the signals. On the other hand, says Dr. Gualtierotti, were the otolith to continue sending the signals of disorientation, the signals could have overcome the activity of the brain.

The test results show that the otolith of the inner ear adjusted to the weightless state and assumed a normal pulse rate. The microelectrodes that transmitted the nerve pulse rates were attached to a nerve cell at the bottom of the macula. The macula is the sensor organ of the utriculus—the part of the ear that responds to gravity. The otoliths themselves are calcium carbonate crystals suspended in a jelly substance above the macula. As the otoliths move parallel to the macula, they move the macula hairs. This stimulates the sensors and issues an electrical impulse. It is this impulse that the electrodes transmitted.

Every response of the frogs to the motion of the spacecraft during launch was recorded. The preliminary results indicate that after an initial period of gradually increasing pulse rate, lasting about 51 hours, the rate returned to normal prelaunch parameters for the remaining three days in space. One explanation for the increase in pulse rate, or sensitivity, says Dr. Gualtierotti, may be that the sensors were attempting to find out what had happened to their normal reference point.

But the return of the pulse rate to near normal indicates that both the inner ear and the part of the central nervous system concerned with orientation adjusted to weightlessness.

"Since there was no gravity," says Dr. Gualtierotti, "we don't know what the sensors aligned themselves to. But so far, indications are that as far as the otolith is concerned, we don't need artificial gravity in space."

The secondary significance of the experiment is the biotechnology itself. Since the equipment is designed to transmit pulses, it could be used, says Dr. Gualtierotti, to monitor electrical pulses that come from muscle tissue, nerves or even the cardiovascular system.

The bullfrog flight is part of an overall study being conducted by NASA's Offices of Space Science and Application and Advanced Research and Technology to determine the biological effects of weightlessness and to study the need to equip space stations of the future with artificial gravity chambers. □

RUSSIAN CRAFT

Robot on moon

In a little more than 60 days, the Soviet Union has launched 22 space missions, including Luna 16, which returned moon dust to earth (SN: 9/26, p. 269). This week they scored another technological coup. Luna 17, launched last week, made a soft landing in the lunar Sea of Rains, and deployed onto the moon a remote-controlled, eight-wheeled robot machine shaped like a silver teakettle and adorned with Russian flags and a bust of Lenin.

According to Tass, "Lunokhod 1" (Moonwalker 1) took a 20-yard journey around the landing site, carrying a television and a radio to scan the moon's surface and send telemetry back to earth, an X-ray spectrometer to analyze the soil and an array of French-made mirrors to reflect laser beams sent from the earth. The craft was equipped with a soil-scooping device similar to the one on Luna 16. It was not designed to return to earth.

In addition to discussing future Lunokhod explorations of the moon, the Soviets also described similar automated stations and robots for Venus, Mars and Mercury. These they call "planetokhods" or "marsokhods."

The Soviet achievement is certain to re-intensify debate in the United States over the relative merits of manned versus unmanned explorations of the moon and planets. American scientists and officials hailed the accomplishment as a clear demonstration of the Soviet commitment to scientific studies of the solar system with automated devices. □