Water storage spurred growth of Maya cities

An oasis on a parched savanna draws a crowd of thirsty animals. That same principle applies on a much grander scale to the emergence of "Classic period" city-states in the Maya lowlands between A.D. 250 and A.D. 900, say anthropologists who have reexamined detailed maps of one such site.

The ancient Maya city of Tikal, in northern Guatemala, lacked a permanent water source such as a river or spring, as did other lowland sites in Guatemala, southern Mexico, Belize and Honduras. To provide water throughout the four-month annual dry season, residents constructed reservoirs fed by clay-lined drainage ditches, report Vernon L. Scarborough of the University of Cincinnati and Gary G. Gallopin of the State University of New York at Buffalo.

Tikal's reservoir system proved a liquid magnet for lowland inhabitants struggling with yearly droughts, and the city's population peaked at 60,000 to 80,000 around A.D. 750. Indeed, Scarborough and Gallopin argue in the Feb. 8 SCIENCE, the ability to control water critically influenced the growth of most lowland Maya cities, as well as the emergence of political control by an elite class serving Maya kings.

At many of these lowland Maya urban centers, spurts of population growth followed by temporary abandonment probably corresponded to fluctuations in annual rainfall and the availability of stored water, adds anthropologist Richard E.W. Adams of the University of Texas at San Antonio, in a commentary accompanying the research report. Adams asserts that the lack of sufficient water reserves in times of drought, rather than military or political conflict, may have caused the permanent abandonment of the earliest lowland cities, such as Nakbe (SN: 1/27/90, p.57).

Scarborough and Gallopin reconstructed Tikal's reservoir system from previously published maps of the ancient city. Six groups of paved drainage systems fed water into at least 10 central reservoirs, they maintain. The researchers estimate that the reservoirs received at least 900,000 cubic meters of water annually through the drainage setup, suggesting a far greater water-storage capacity than previously thought, Adams points out.

The controlled release of water from central reservoirs into smaller storage basins on the outskirts of Tikal would have supported year-round crop cultivation, the investigators note, although it remains unclear how the Maya released water from the central reservoirs.

Central Tikal also contains "residential reservoirs," apparently intended to store water for individual households. A few small reservoirs were attached to domestic residences, but none of these received water from the central reservoirs, the researchers say.

Massive building projects toward the end of the Classic period created quarries that may also have served as reservoirs and helped promote Tikal's growth, Scarborough and Gallopin suggest. In areas with seasonal water shortages, reservoirs acted as an underrecognized spur to urban growth, they conclude.

– B. Bower

Grapefruit juice gives drug an added punch

Tangy grapefruit juice may pack an unwanted punch. Canadian researchers have discovered that an experimental antihypertensive drug, if taken with grapefruit juice, can cause a rash of side effects, including rapid heart rate, facial flushing and dizziness.

"This is the first example of a pharmacokinetic interaction between a citrus juice and a drug," study coauthor David G. Bailey told SCIENCE NEWS. The results underscore the potential for hazardous effects when people consume certain foods with specific drugs, he says.

The new finding has its roots in an earlier study at the University of Western Ontario in London, in which Bailey and his colleagues attempted to determine the interactions between alcohol and an antihypertensive drug called felodipine, used in some European countries and now in clinical testing in the United States and Canada. Bailey recalls using grapefruit juice to mask the slightly sweet taste of alcohol. To their surprise, the researchers found that blood levels of felodipine among the volunteers – even those who drank grapefruit juice without alcohol – soared well beyond the expected values.

At first, the team suspected a problem with the study's methodology. But when painstaking inquiry ruled out other explanations, they decided to investigate the grapefruit juice itself.

They started by selecting six men, aged 48 to 62, with mild hypertension. Each volunteer took 5 milligrams of felodipine followed by water, grapefruit juice or orange juice. After drawing blood samples and recording blood pressure and heart rate, the scientists repeated the process on later days, switching the drinks so that each person eventually took the drug with each of the three liquids.

When the men took the felodipine pill and drank grapefruit juice, their blood levels of the drug reached about three times the amounts measured when they took the same dose with water or orange juice. On average, grapefruit juice doubled the drug's effect on blood pressure (which decreased) and heart rate (which increased), Bailey says. Not surprisingly, grapefruit drinkers reported more cardiovascular symptoms such as dizziness, facial flushing, headache or rapid heartbeat after taking felodipine, the team notes in the Feb. 2 LANCET.

Bailey speculates that grapefruit juice, but not orange juice, may contain a substance that inhibits an enzyme that breaks down felodipine, thereby leaving more of the drug circulating in the bloodstream. Although the researchers used super-concentrated fruit juices in this trial, Bailey thinks felodipine taken with off-the-shelf grapefruit juice could yield noticeable cardiovascular symptoms.

The felodipine finding raises questions about whether other high blood pressure drugs interact with grapefruit juice or other foods. When the researchers went on to study nifedipine, a U.S.-approved hypertension drug, they found that the concentrated grapefruit juice increased the drug's blood concentrations, but only slightly. Among the six healthy volunteers, only one showed an adverse reaction, reporting a mild headache after treatment.

– K.A. Fackelmann

Scorpion toxin tells an evolutionary tale

To thrill visitors at his lab, Hervé Rochat sometimes picks up a scorpion and rubs its belly with his finger. Do not try this at home.

The venom that trickles from the tail of the tickled arachnid contains a cocktail of powerful, protein-based toxins that has kept Rochat and his co-workers busy for two decades. In the Jan. 22 BIOCHEMISTRY, the team reports the discovery of a scorpion toxin that may represent a molecular ancestor of the dozens already identified by scientists who study scorpion venom.

Scorpions, notorious for the defensive stings they inflict when disturbed by humans, also use their poisons offensively to paralyze prey such as insects, other scorpions or small vertebrates. Their specific neurotoxic action makes these chemicals useful as molecular tools for studies of nerve-cell behavior. They may also hold promise as models for safer and more selective insecticides.

Biochemist Erwann P. Loret, working with Rochat's group at the National Center for Scientific Research in Marseilles, France, isolated the new toxin from the venom of the North African species *Androctonus australis* Hector. In Greek, Loret notes, *androctonus* means "killer of man." These large scorpions – some the size of a hand – kill several thousand people each

year, estimates biologist Gary A. Polis of Vanderbilt University in Nashville. The molecular diversity of their venomous brew limits the effectiveness of current antivenom treatments, notes Dean D. Watt, a scorpion venom specialist at Creighton University School of Medicine in Omaha, Neb.

Although the newly identified toxin, labeled AaH IT4, doesn't rank among the most potent scorpion poisons, it stands out in its ability to smite both mice and insects, says Loret, now at Oregon State University in Corvallis. Laboratory experiments show that AaH IT4, like anti-insect toxins secreted by other "Old World" scorpions, paralyzes insect larvae by binding to sodium channels on the larvae's nerve-cell membranes. And, like anti-mammal toxins from "New World" scorpions in North and South America, it also kills mice. Although researchers have identified several New World scorpion toxins that show both anti-insect and anti-mammal action, those toxins bind to only one of two possible sites on mammalian sodium channels. AaH IT4, unlike any other scorpion toxin known, can bind to either type of site on mammalian cells while also possessing anti-insect properties.

This unprecedented breadth of action suggests that AaH IT4 is an "ancestral scorpion toxin," Loret and his co-workers assert. According to their reasoning, it's a more primitive, less specialized toxin that covers more ground at the expense of potency.

That flexibility shows up in the toxin's molecular structure: a folded string of 65 amino acids that does not include the amino acid proline. Loret believes the absence of proline allows the molecule to change its shape so that it can conform to any of several sodium-channel sites featuring subtly different configurations. A strict molecular shape would restrict the toxin's versatility.

Loret plans to use AaH IT4 to study why some scorpion toxins affect only insects while others affect only mammals and other vertebrates. In the long run, he and others hope to exploit this natural selectivity to design potent new insecticides. Watt, noting that scorpion toxins appear effective only when injected, suggests that getting scorpion-inspired insecticides into their targets will take some technical creativity.

Most early investigations of scorpion venom focused on the development of antidotes or vaccines, but the various toxins have now become an important research topic in their own right. "In science," says Loret with a laugh, "you begin working on a serum antidote and you may end up with an insecticide."

– I. Amato

Two reports take aim at asthma jeopardy

Concerned by the rising rate of U.S. asthma deaths, a federal panel this week recommended ways to curb lethal episodes of the disease. At the same time, researchers reported evidence suggesting that a common mold can trigger potentially catastrophic airway constriction in some asthma sufferers.

The scientific panel, convened by the National Heart, Lung, and Blood Institute in Bethesda, Md., urges physicians who treat the nation's 10 million asthma patients to prescribe drugs that target the underlying inflammation of the lung's bronchial tubes, instead of relying primarily on the short-term breathing relief provided by inhaled bronchodilator drugs. Recent reports have suggested that overuse of bronchodilators may encourage progression of the disease, perhaps contributing to the rise in asthma death rates (SN: 12/15/90, p.373).

The panel also recommends that asthma sufferers reduce their exposure to indoor and outdoor allergens, such as dust, pollen and mold spores. These tiny particles can precipitate the airway constriction of an asthma attack. A severe asthma attack can escalate into a life-threatening respiratory arrest if the bronchial tubes close up enough to block the patient's breathing.

The cautionary advice on allergens dovetails with a report in the Feb. 7 NEW ENGLAND JOURNAL OF MEDICINE by Martin I. Sachs and his colleagues at the Mayo Clinic in Rochester, Minn. The researchers found a 200-fold increase in the risk of potentially lethal respiratory arrest among asthmatics who react to the mold *Alternaria alternata,* compared with asthmatics who show no heightened sensitivity to it.

"One of the factors which appears capable of causing the muscle in the airway to clamp down is exposure to that allergenic mold," Sachs told SCIENCE NEWS.

The team reviewed the medical records of 11 males and females, aged 11 to 25, who had experienced respiratory arrests between 1980 and 1989. The analysis revealed that 10 of the 11 asthmatics showed an allergic reaction to *A. alternata* in skin-prick tests. In contrast, only 31 of 99 asthmatics in the study's control group showed sensitivity to the mold.

A. alternata grows on harvested corn and other grains, and is particularly common in the Midwest from June through November, says Sachs. Allan T. Luskin, an immunologist at the University of Illinois at Chicago, notes that the ubiquity of environmental allergens underscores the importance of controlling the chronic inflammation of asthma, and thus reducing the riskiness of an allergic encounter.

– K.A. Fackelmann

Helium theory gets high-precision test

The basic equations of quantum mechanics are so difficult to solve that theorists have no straightforward way to calculate the energies emitted or absorbed by even so simple an atom as helium. Nonetheless, by starting with a rudimentary model describing the behavior of the two electrons in a helium atom and then adding, step by step, the effects of more subtle interactions, they can make remarkably precise predictions concerning the energy-level transitions a helium atom can undergo.

Experiment has now caught up with theory. By making the most precise measurements to date of a particular energy-level transition in different helium isotopes, researchers have performed an unprecedented experimental check on the details of these calculations. The results reveal close agreement between the experimental and computed values of helium's so-called isotope shift.

"With a hundredfold improvement in precision [over previous experiments], this is the most precise isotope-shift measurement ever made for a multi-electron system," report physicists Ping Zhao, John R. Lawall and Francis M. Pipkin of Harvard University in the Feb. 4 PHYSICAL REVIEW LETTERS.

The team observed the same atomic transition in two different helium isotopes: helium-3 (whose nucleus consists of two protons and one neutron) and helium-4 (two protons and two neutrons). Theory predicts that the mass difference between the isotopes will have a small but noticeable effect on the specific wavelengths of light emitted or absorbed by a helium atom.

To measure this effect, Zhao and his coworkers constructed a special laser that produces light at an infrared wavelength of 1,083 nanometers, matching the wavelength of one particular helium-atom transition. A novel procedure allowed them to measure the wavelength difference, or isotope shift, between helium-3 and helium-4 without having to measure the exact wavelength corresponding to each transition.

"With this technique, the differences of [wavelengths] can be measured much more precisely than the [wavelengths] themselves," the researchers say.

The agreement between the theoretical calculations and experimental results provides by far the best confirmation yet that the computational techniques used to model a two-electron atom really work. "It would be straightforward to do more precise measurements, but we've already gotten to the point where we're past the theory," Pipkin says. "There's not much motivation [to go farther] at the present time."

– I. Peterson