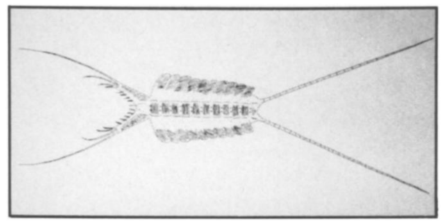
Evolutionary oddball surfaces in Greenland



Budd

Reconstruction of the 14-centimeter-long creature called Grasper shows gill-like flaps along the sides. Striations and bumps appear on the back.

Paleontologists prospecting in remote northern Greenland have discovered the remains of a bizarre creature dating from immediately after the evolutionary explosion that filled the seas with the first complex animals. Shaped a bit like a spiny postage stamp, this exquisitely preserved fossil may help make sense out of the menagerie of strange animals created during that critical evolutionary stage at the beginning of Earth's Cambrian period.

Discovered on an expedition led by John S. Peel of the Geological Survey of Greenland and Simon Conway Morris of the University of Cambridge in England, the ancient creature bears the unofficial name Grasper, for a pair of appendages sticking out in front. Paleontologists have collected 50 or so partial skeletons of the animal, but they have found only one complete specimen. In a stroke of luck, the researchers discovered one half of the complete specimen in 1989 and then found the matching half when they returned to the same site in 1991.

"We knew Grasper was something different and very special," says Peel, recalling the initial find. But scientists did not begin studying the animal until after the discovery of its second half. In Chicago last week, at the Fifth North American Paleontological Convention, Graham E. Budd of Cambridge described the preliminary results of his work on the fossil.

Grasper and the other creatures found at the Greenland site provide a glimpse of life roughly 540 million years ago, soon after the "Cambrian explosion," an evolutionary burst that created the major existing divisions of animal life. During Precambrian time, which makes up some 87 percent of Earth's history, animal life evolved simple, coral-like and jellyfish-like forms about as complicated in shape as a dinner plate. These forms persisted for tens of millions of years, only to be replaced over a very short span by the appearance of the first complex animals in the early Cambrian. Paleontologists have found spectacularly preserved fossils of early Cambrian animals at three sites: the Burgess Shale in western Canada, Chengjiang in southwestern China and Sirius Passet in northern Greenland.

At all three sites, rocks have preserved a number of bizarre animals that do not readily fit into any phylum defined by modern organisms. Budd has found several strange features on Grasper. Most obvious are the long spines protruding from the front and rear of the body; these do not appear on any other known Cambrian animal, Budd says. In addition, Grasper has gill-like flaps along its sides—a feature seen in only one other Cambrian animal, a weirdo called *Opabinia* that resembles a swimming vacuum cleaner.

But Grasper also has characteristics that may link it to some of its contemporaries. "The animal is bizarre; there's no doubt about it," says Budd. "But it's also important to look at the things that it appears to share in common with other animals, because that's the way you can try to classify it. It's quite easy to get bamboozled by the really bizarre aspects."

He points to several parts of Grasper's anatomy shared by animals called lobopods—worm-like creatures with legs that look as though they have been inflated with a bicycle pump. Ancient lobopods and their modern counterparts, in the phylum Onychophora, intrigue scientists because they may represent a link between two extremely successful phyla, Annelida (segmented worms) and Arthropoda.

Budd notes that Grasper has striations running across its back along with a double row of bumps — both features found on Cambrian lobopods. The remarkable preservation of this animal also allowed Budd to study its internal musculature, where he found signs of circular muscles resembling those of modern onychophores. Furthermore, indentations on the fossil's underside suggest that it had stubby legs, a characteristic of Cambrian lobopods.

Yet Grasper's unique characteristics prevent it from fitting squarely into the lobopod group. Budd speculates that Grasper may be a lobopod that sported arthropod features such as gills. Other scientists say they hesitate to judge Budd's preliminary analyses because they have not yet had a chance to exam-

Making big galaxies by merging smaller ones

Astronomers have gathered fresh evidence that millions of mini-galaxies merged to form today's collection of spiral and elliptical galaxies — including, perhaps, our own Milky Way.

The first hints of this cosmological drama came late last year, when astronomer Lennox L. Cowie and his colleagues at the University of Hawaii in Honolulu reported a baffling result: New infrared maps indicated that the vast majority of galaxies that existed when the universe was half its current age were small, amorphous blobs (SN: 11/16/91, p.312). Those galaxies lacked the familiar spiral or elliptical shape of galaxies common in the present-day universe.

Few of the small galaxies appear to reside within 60 million light-years of the Milky Way. Thus, Cowie speculated that clusters of the small galaxies may have served as seeds for today's elliptical and spiral galaxies, merging in the recent past to form these bigger galaxies. Alternatively, he noted, the tiny galaxies may have simply faded from view or even self-destructed as the universe grew older.

New observations by Cowie's team, made in the last six months with the Canada-France-Hawaii telescope atop Mauna Kea, strongly support the merger scenario, he says. Cowie reported the results this week in Paris at an astronomy workshop.

The findings show that as an observer views regions of space more than 2 billion light-years from Earth — the same as looking back in time — the number of small galaxies increases. Moreover, the number of spirals and ellipticals declines correspondingly. Peering into the past, it appears that "the population of large galaxies is replaced by the smaller ones," says Cowie. If a movie of the history of the universe were run in reverse, "it's clear that the large, present-day galaxies break up into smaller galaxies," he adds.

Cowie says it would take 10 to 100 of the small galaxies to form a single spiral. That may pose a problem, he notes, since current models indicate that the merger of so many mini-galaxies would form a fatter disk than spiral galaxies, such as the Milky Way, actually have. He suggests that theorists need to develop more detailed simulations of the motion of stars and gas in interacting galaxies.

"It's a tricky business once [a galaxy] is absorbed and gets mixed into the rest of a group of galaxies," Cowie notes.

Preliminary observations with the Hubble Space Telescope seem to support Cowie's merger notion. Richard E. Griffiths and Kavan U. Ratnatunga of the Space Telescope Science Institute in Baltimore and their colleagues used Hubble to resolve the shapes of a small sample of galaxies believed to lie between 3 billion and 10 billion light-years from Earth. The team found that more than half the roughly 300 galaxies in their survey were small and amorphous, and some appeared to be merging.

Though a definitive interpretation will require many more years of observations, Ratnatunga says the early data hint that small galaxies were the building blocks for today's galaxies. Griffiths reported the results last week at a Hubble workshop in Sardinia, Italy. — *R. Cowen* ine the new find. After viewing Budd's presentation last week, Desmond Collins of the Royal Ontario Museum in Toronto says he thinks Grasper looks more like an arthropod than a lobopod. Others don't know what to make of the beast.

The labels may seem of minor consequence, but the ultimate classification of the Cambrian oddballs will shape how scientists view patterns of animal evolution. If these creatures cannot fit into existing phyla, then the early seas held a great many more phyla than are recognized today.

In *Wonderful Life: The Burgess Shale and the Nature of History* (1989, Norton), paleontologist Stephen J. Gould of Harvard University argues that the Cambrian explosion created a great variety of fundamentally distinct body plans, most of which later disappeared, leaving the relatively few phyla found today. But a number of other scientists challenge that theory, saying that the number of phyla has remained relatively steady. Moreover, recent work has found homes for some of the most bizarre of the Cambrian animals, suggesting they do not represent unique phyla (SN: 5/18/91, p.310).

If Grasper is related to the lobopods, it may help scientists link other Cambrian oddballs, such as *Opabinia*, to existing phyla. Possessing characteristics of several phyla, the oddballs may represent intermediate forms that provide clues about how different body plans arose. Judging from Grasper's affinities with both lobopods and arthropods, Budd speculates that the arthropods may have developed from early gilled lobopods.

In the early Cambrian, he says, evolutionary forces apparently had great freedom to mix and match aspects of different phyla within a single organism. But soon after that period, the basic body plans emerged and the phyla grew distinct. "So the next challenge is to work out why it is that those changes could happen then, but don't appear to happen now," says Budd. *— R. Monastersky*

Hints of a chlorine-cancer connection

The chlorine added to drinking water in the United States has produced dramatic reductions in water-borne diseases such as typhoid fever. Yet this chemical's role as a public health hero may be tarnished if hints of a link with cancer prove true.

A new statistical analysis indicates that people who drink chlorinated water run a 21 percent greater risk of bladder cancer and a 38 percent greater risk of rectal cancer than people who drink water with little or no chlorine. There is no proof that chlorine itself actually causes cancer; however, investigators think something in chlorinated water may act as a carcinogen.

"I am quite convinced, based on this study, that there is an association between cancer and chlorinated water," says Robert D. Morris of the Medical College of Wisconsin in Milwaukee, who directed the new study. Previous investigations showed no clear link between chlorinated drinking water and bladder or rectal cancer, but those efforts may have lacked the statistical power to find a connection, Morris says.

He and his colleagues turned to a formidable statistical method called meta-analysis. They began their inquiry by using a computer to comb the medical literature for studies on chlorinated water and cancer. Their search turned up 22 studies, but only 10 met certain quality standards. In these 10 studies, for example, investigators had determined whether subjects consumed chlorinated water and then used that information to define control groups. Some of the 10 studies indicated that people drinking chlorinated water had an elevated risk of cancer; others showed no excess risk.

Meta-analysis enabled Morris' group to pool the data from the 10 studies, far surpassing the statistical power of any single study. The analysis turned up a significantly increased risk of developing rectal and bladder cancer for people who drank chlorinated water — a risk that went up as the dose increased. In the July AMERICAN JOURNAL OF PUBLIC HEALTH, the researchers suggest that at least 4,200 cases of bladder cancer and 6,500 cases of rectal cancer in the United States each year may trace to consumption of chlorinated water.

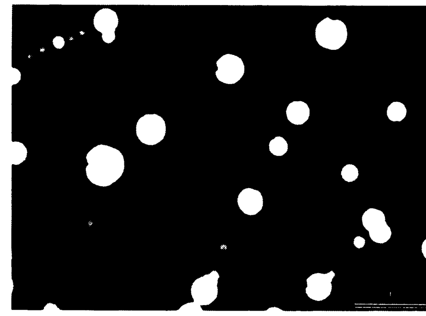
Animal studies have suggested that chlorine forms cancer-causing by-products when it interacts with organic compounds in water. Morris speculates that the rectum and bladder, which act as holding tanks for concentrated human waste, may be especially vulnerable to such chemicals.

"We recognize that there could be an association between exposure to chlorination by-products and cancer," says Fred S. Hauchman at the Environmental Protection Agency's health effects lab in Research Triangle Park, N.C.

However, he and Morris emphasize that the public health benefits of clean water far outweigh the potential health risks of chlorination. At the same time, researchers continue to study other methods of disinfecting water, including a process called chloramination, which adds both chlorine and ammonia to water. Chloramination may prove safer than simple chlorination because it yields fewer dangerous by-products, Morris says. *— K.A. Fackelmann*

Speeding the spread of helium bubbles

Irradiation can have a deleterious effect on metals in a nuclear fission or fusion reactor. Alpha particles captured by aluminum, for example, readily pick up electrons to form helium atoms, which collect into gas bubbles that grow, migrate and coalesce. Such bubbles weaken the material and sometimes initiate crack formation.



Van Siclen et al.

This electron micrograph, taken after the sample was slowly cooled to room temperature, shows small indium particles attached to the surfaces of helium bubbles embedded in aluminum.

Now researchers have discovered that at sufficiently high temperatures, helium bubbles diffuse at least 100 times faster through solid aluminum containing traces of lead or indium than through pure aluminum. This suggests that these "impurity" atoms may partially coat a bubble's surface to form a thin liquid layer, which somehow facilitates a bubble's movements through the surrounding array of aluminum atoms.

Clinton DeW. Van Siclen and Richard N. Wright of the Idaho National Engineering Laboratory in Idaho Falls describe their results in the June 29 PHYSICAL REVIEW LETTERS.

The researchers initially came upon this effect when impurities accidentally contaminated an aluminum sample during the course of another experiment. They videotaped the behavior of helium bubbles in thin films of irradiated aluminum alloyed with either lead or indium after heating the samples for several minutes to temperatures ranging from 723 to 743 kelvins — higher than the melting points of lead and indium but lower than that of aluminum.

"It was really striking to actually watch the bubbles diffuse," Van Siclen says. Measurements confirmed that the presence of trace amounts of lead and indium greatly increases the rate of bubble diffusion.

These findings add to the list of factors nuclear engineers must consider in selecting materials for reactors. They also suggest a novel means of enhancing the diffusion of atoms within materials when that seems desirable. *— I. Peterson*