Clues to how lead impairs growth, vision

For at least 2,000 years, societies have recognized lead as a potent toxicant while remaining mystified as to how it poisons. But as more and more researchers address the question, an understanding is beginning to emerge. Now, in a pair of animal studies, scientists have identified important new clues to how the heavy metal retards growth and damages visual processing areas of the brain.

Researchers at the University of Cincinnati conducted a series of rat experiments probing what lies behind one of lead's most subtle effects: a stunting of children's growth (SN: 11/22/86, p.333). A 1987 report on lead-intoxicated children hinted that the metal might shorten stature by suppressing the thyroid's production of growth hormone. However, even when the Cincinnati team supplied extra growth hormone, rats drinking water contaminated with high lead levels grew more slowly than companions on lead-free water. Nor did stunting result from less efficient metabolism of food. When the researchers restricted lead-free rats to the same amount of food as the lead-treated rats chose to eat, both groups grew at the same rate.

It appears lead-intoxicated animals grow more slowly simply because they eat less, conclude Paul B. Hammond and his co-workers in the July TOXICOLOGY AND APPLIED PHARMACOLOGY. Whether they received the toxic metal in drinking water or through tiny controlled-release pumps implanted in their shoulder muscles, lead-exposed rats ate 11.5 to 16.4 percent less than lead-free counterparts when both groups could eat all they wanted. Follow-up work now suggests lead's effects on brain neurotransmitters or hormones probably account for at least some of the appetite suppression observed, says coauthor Robert L. Bornschein.

Lead also appears capable of disturbing the brain's processing of visual signals, according to a second report in the same journal. Researchers with Health and Welfare Canada, in Ottawa, administered lead daily to seven macaques, beginning in infancy. At age 6, the monkeys were killed and their visual systems examined.

None showed evidence of damage in either the optic nerve, which receives visual stimuli from the retina, or the region where the optic nerve relays its messages to the brain. However, the three monkeys in the high-dose group—receiving 2,000 micrograms of lead per kilogram of body weight (μg/kg) daily—showed a marked reduction in the volume of nerves within two areas of the visual cortex, compared with the monkeys in the very-low-dose group (receiving 25 μg/kg lead daily). Both brain areas are important in interpreting visual stimuli.

"We don't know if the [observed volume reduction] reflects fewer neurons or just smaller ones. But either would be a toxic effect," says Deborah C. Rice of the Ottawa team. Moreover, the two groups of monkeys had structurally different dendrites—tree-like structures at the ends of nerve cells, responsible for taking in messages from other nerve cells. Rice says the reduced dendrite branching in the high-dose group suggests these monkeys "may not be able to take in as much information from surrounding cells."

EPA neurotoxicologist David A. Otto of Chapel Hill, N.C., says the Canadian results suggest lead may not affect the transmission of visual information so much as the brain's integration and processing of it. Neurotoxicologist Donald A. Fox agrees, but adds he has demonstrated in several species that the brain is not the only lead-sensitive organ in the visual system. "We've found lead is a selective poison for rods [light receptors] responsible for night and form vision," says Fox, of the University of Houston's College of Optometry. In his own study of lead-poisoned monkeys, which is scheduled to begin soon, Fox will look for rod changes and other visual-system effects.

—J. Raloff

Envisioning arcs of moondust at Neptune

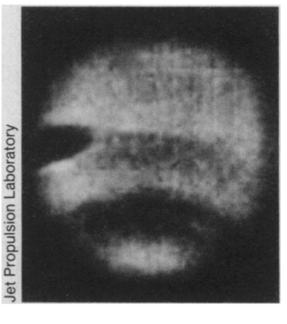
As Voyager 2 approaches its Aug. 24 rendezvous with Neptune, scientists wait eagerly to see whether the spacecraft will confirm that the planet possesses the strangest set of rings known in the solar system.

About a decade ago, in studying the way a star's light blinked off and on as Neptune got in the way, Peter Goldreich and Scott Tremaine of the California Institute of Technology in Pasadena concluded that the planet has rings—but that unlike the rings of Jupiter, Saturn and Uranus, Neptune's might consist of short, unconnected arcs. Now Goldreich heads a research group proposing that if the arcs actually exist, as Voyager's photos should show, they may consist of debris left over from the destruction of some of Neptune's moons.

The source of this moon wreckage would be Neptune's big satellite Triton, say Goldreich and Caltech colleagues Norman Murray, Pierre-Yves Longaretti and Donald Banfield in the Aug. 4 SCIENCE. They propose that Triton originally formed in an orbit around the sun and was later gravitationally captured by Neptune as the result of a collision with another of the planet's moons. This left Triton in an orbit that gradually became more steeply tilted. In such an orbit, Triton circled Neptune and collided with a number of the planet's smaller satellites.

Triton could have gone around this path as many as 100 million times, picking off lesser moons all the while, says Goldreich. As a result, the researchers calculate, Triton "cannibalized" most of the satellites then orbiting Neptune at distances between about five and 200 times the planet's radius, which spans approximately 15,000 miles.

"Close to the planet, in the region where Triton never penetrated, regular satellites might still survive," the group concludes. "If comparison with the satellite systems of other giant planets is an accurate guide, several satellites must have formed in this region."



Jet Propulsion Laboratory

No ring-arcs show up in this Voyager 2 photo of Neptune, taken July 16 from about 35 million miles away, but detail accumulates in the clouds.

By Aug. 1, Voyager 2 scientists had identified only one moon other than the pair (Triton and Nereid) detected from Earth. But the craft had discovered no more moons at the other giant planets while at a similar distance from them.

The debris resulting from Triton's collisions would be confined in individual arcs, rather than a continuous ring, by "resonances" located at the balance points of the gravitational attractions of Neptune, Triton and perhaps several other satellites, say Goldreich and his colleagues. They base this whole idea on observations of stellar light blockages, or occultations, during only two occasions. Nonetheless, the group estimates from the limited data that Neptune may possess 10 to 100 arcs. The arcs would measure from a few tens of miles to thousands of miles long, laid out like segments of what would otherwise be a continuous ring. Holding them in place might require "a large number" of additional satellites, the researchers suggest.

On the other hand, the group also suggests that all the arcs might be held in position by resonances associated with a single moon, which they call Satellite X. If one Satellite X is indeed responsible, they speculate, its orbit is most likely tilted or elliptical. Tides caused on Triton by Neptune could have made Triton almost entirely molten during most of its unusual orbital evolution, they conclude.

—J. Eberhart