and the cessation of all growth. The increased radiosensitivity appears to be chiefly associated, then, with the advanced developments induced in the partially germinated, dormant seeds. These developments may be identified with certain chemical and structural changes within rapidly dividing cells—namely, the initiation of nuclear divisions and the exposure to irradiation of enlarged and possibly oversensitized chromosomes, just prior to, or during mitotic activities.

Inasmuch as the water content of both lots of seeds was about the same, it would seem that increased seedling injury in the case of partially germinated, dormant seeds is related primarily to direct absorption of energy from ionizing radiations rather than to indirect chemical action of active radicles produced in the presence of water.

S. S. Ivanoff

Department of Plant Pathology and Physiology, Mississippi Agricultural Experiment Station, State College

References and Notes

1. L. J. Stadler, *Science* 68, 186 (1928); *Anat. Record* 41, 97 (1928).
2. E. Wertz, *Strahlentherapie* 67, 307, 536, and 700 (1940); 68, 136, 287 (1940); L. H. Gray, *Radiation Research* 1, 189 (1945); A. Gustafsson, *Hereditas* 33, 1 (1947); A. Gustafsson, *Acta Agr. Scand.* 4, 361 (1954); E. F. Riley, Jr., *Radiation Research* 1, 227 (1954); R. S. Caldecott, *Science* 120, 809 (1954); *Radiation Research* 3, 316 (1955); C. F. Konzak, *Science* 122, 197 (1955); L. Ehrenberg, *Hereditas* 41, 123 (1955).
3. This work is a part of a study to determine more effective ways of utilizing radiation techniques in connection with breeding oats for disease resistance and other qualities.
4. S. S. Ivanoff, *Botan. Rev.* 113, 90 (1951).
5. I am indebted to Seymour Shapiro of the Brookhaven National Laboratory for performing the irradiations.
6. The role of salts, oxygen, temperature, and other factors besides water on lowering or hastening the initial rate of development should be taken into consideration in interpreting radiation effects on biological material.

27 December 1955

Ability of Thais haemostoma to Regenerate Its Drilling Mechanism

The odontophoral process of the prosobranch gastropods is situated at the distal end of the proboscis, which is essentially a very extensible and maneuverable tube extending from the esophageal region, with the mouth at the end. The odontophore consists of a cartilaginous carriage, which licks back and forth while the radular band moves back and forth over it like a belt over a pulley (*1, 2*). Possibly the radula can also be held stationary at times, with the sole movement being made by the cartilaginous carriage. This may account for the differences in observations made by some famous zoologists in the past century (*1*). With its attendant muscles and nerves, the odontophore is a very complicated mechanism (*2*) and efficiently operates in drilling as if it were a small rotary drum covered with spikes (*1*).

Hundreds and possibly thousands of species of predatory gastropods drill holes through the shells of other mollusks and extract the meat. It is generally stated that this ability is possessed only by the Naticidae and Muricidae. It should be noted, however, that the Thaisidae have been separated from the Muricidae. In addition, Moore (*3*) has shown that three species of the Cassidae bore through the calcareous tests of sea urchins and sand dollars.

The odontophore is certainly mechanically efficient, but whether it functions in this manner alone (*4*) or is sometimes assisted by acids or enzymes is not yet settled (*5*). Furthermore, *Thais haemostoma,* the Gulf oyster borer, which is at times a very serious oyster pest, can open oysters without leaving any sign of shell damage whatsoever. This raises the question of whether the animal makes use of some paralytic agent.

In an attempt to answer this question, we cut off the proboscis of several *Thais* with a razor blade. This was done after the hungry animals had been induced to extend the proboscis through a small hole in a plate of plastic to reach a piece of oyster meat placed to one side. The cutting movement had to be swift, for the proboscis is very sensitive and can be retracted with the speed of a rubber band. It was noted that "conchs" that had the proboscis cut cleanly survived, while those suffering jagged cuts did not. Only the distal portion of the proboscis containing the odontophore was cut off. These were preserved in formalin. The supposition was that these "aradulate" gastropods might open oysters by use of a paralytic agent, if they possessed one.

The planned experiment was a complete failure, but the results were nonetheless startling. Within 3 weeks, the surviving gastropods all regenerated the complete odontophoral process, as good as new, and without abnormalities as far as we can determine. The odontophore, consisting as it does of muscle, nerves, cartilage, and chitinous teeth in a band, which undergo a complex but coordinated set of movements, may well be the most complicated organ any animal is able to regenerate. The complexity of the odontophore has been shown best by the detailed anatomical studies of Carriker (*2*) on *Urosalpinx.* The anatomy of *Thais* has not been described, but it is very similar.

The morphogenetic processes involved in the regeneration of this complicated organ may or may not yield easily to analysis. The apparatus lies in a tube, but it probably will not be extruded by the animals while healing. In any case, some interesting questions are raised and other workers may wish to take advantage of this type of material.

William J. Demoran
Gordon Gunter

Gulf Coast Research Laboratory, Ocean Springs, Mississippi

References

1. G. Gunter, *J. Wash. Acad. Sci.* 26, 361 (1936).
2. M. R. Carricker, *J. Morphol.* 73, 441 (1943).
3. D. R. Moore, *Nautilus* 69 (1956).
4. A. S. Jensen, *Vidensk. Medd. Dansk Naturh. Foren.* 113, 251 (1951).
5. G. Gunter, *Nature* 169, 630 (1952).

30 January 1956

New Evidence for Reversal of the Geomagnetic Field Near the Pliocene-Pleistocene Boundary

It has been shown (*1*) that, almost without exception, undisturbed Cenozoic lava flows are magnetized roughly in the direction of the present geomagnetic field or at 180° to this direction, termed normal (N) and reversed (R), respectively. There are two conflicting interpretations of how this thermoremanent magnetization was acquired.

1) The geomagnetic field has two stable configurations, those of an axial geocentric dipole of either polarity. Change from one polarity to the other happens in a time of the order of some thousands of years and occurs a number of times in the Cenozoic period, the last occasion being about the Pliocene-Pleistocene boundary. The total time during which the field was reversed in Cenozoic times appears to be roughly the same as that during which the field was normal.

2) In about 50 percent of the lava flows, the iron oxide minerals responsible for the magnetization possess the anomalous property of spontaneously reversing the magnetization acquired during the first stages of cooling below the Curie point. This occurs either during the final stages of cooling or slowly through the time between the eruption and the present day. In the former case, certain interactions between two lattice sites or two phases must be assumed; in the latter case, diffusion of ions between lattice sites or chemical changes or exsolution must be postulated.

No simple decisive test of these hypotheses has so far been proposed. Geologic time correlation is not sufficiently good to allow the magnetization of lava flows of the same age in different places to be compared, nor can any laboratory tests entirely exclude the possibility that the anomalous properties required for the second hypothesis were not pres-