X-Rays Speed Up Evolution Over 1,000 Per Cent.

By Frank Thone

Evolution, eugenics, the breeding of new varieties of crop plants and domestic animals: these three phases of science, vitally near to the interests and welfare of all of us, are now under the spell of a new magic. It is a magic that bodes both good and ill, for while it holds out the prospects of producing new forms of life a hundred times faster than has hitherto been possible by the best methods known so far, it also carries a warning that calls for severe caution in certain medical procedures that have become quite common in our modern world.

The wand of the new magic is not itself strictly new. It is our familiar friend the X-ray. The X-ray has been known for thirty years or some such matter, and what has been known for a generation is old stuff, in this day of mile-a-minute progress in science.

But the X-ray has found a new application—it is the new way of waving the old wand that has made the new magic. The new magic is as new as the newest front-page murder sensation or airplane record. It is only a short time since a quiet, soft-spoken professor from the University of Texas, Dr. H. J. Muller, stood up before a distinguished audience at the International Genetics Congress at Berlin, and in the most unsensational language imaginable broke the news of one of the most sensational researches ever conducted in the whole wide field of biology. It is hard to create a sensation in a scientific meeting nowadays, for professors have become too much accustomed to miracles of late; but Prof. Muller's address has been followed by a buzz of excited discussion that will be many months in dying out.

A Revolution in Evolution

Stated in three bald sentences, this is what Prof. Muller's experiments signify: Evolutionary changes, or mutations, can be produced 150 times as fast by the use of X-rays as they can by the ordinary processes of nature. This means that man can force the production of new and desirable plant and animal varieties far more rapidly than he has hitherto been able to get them. But X-rays affect the human hereditary cells too, and the reckless exposure of these cells to long and heavy doses of the rays is apt to inflict fearful penalties on our unborn grandchildren.

The full import of each of these three statements might well require a good-sized book for its explanation—and doubtless will fill more than one book in due time. But the gist of the business, the key to the whole situation, can be set forth very briefly and simply.

Mutations and What They Mean

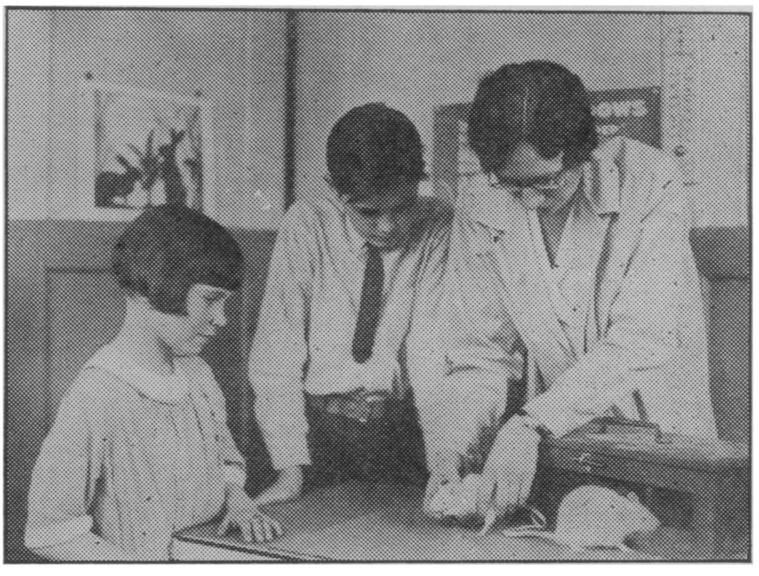
It all ties up with what the modern scientific breeder calls "mutations," which are the same things that the old-fashioned gardener called "sports." Mutations are what you get when a single-flowered plant suddenly produces offspring with double flowers, or when oranges that have always had seeds bring forth seedless progeny. Many of our choicest domestic plants and animals have originated in this way. The late Luther Burbank's reputation was built largely on mutations. He would plant millions of seeds and trust to luck to produce mutations, which his unfailing eye could pick out in a fraction of a second when he saw them in the field. Then he saved the mutations he wanted and wiped out everything else. With certain improvements and modernizations, Burbank's method is the one followed by all breeders.

What the breeders do in field and pen, nature does on a grander scale, both as to space and time, in the process of evolution. Mutations arise among animals and plants in the wild as well as among their domesticated kindred. The common double golden glow, for instance, is such a wild mutant; it just came of its own accord, without any invitation from a gardener. Later on some one saw it growing in the field and dug it up to take home. And nature acts the part of a super-Burbank in looking over these wild mutants and weeding out the undersirable ones with the drastic hoe of the struggle for existence, as Charles Darwin pointed out long ago. But though drastic, this weeding-out process is very slow, and that is why natural evolution is so much more deliberate a process than the hurry-up selection and destruction practised by the breeder.

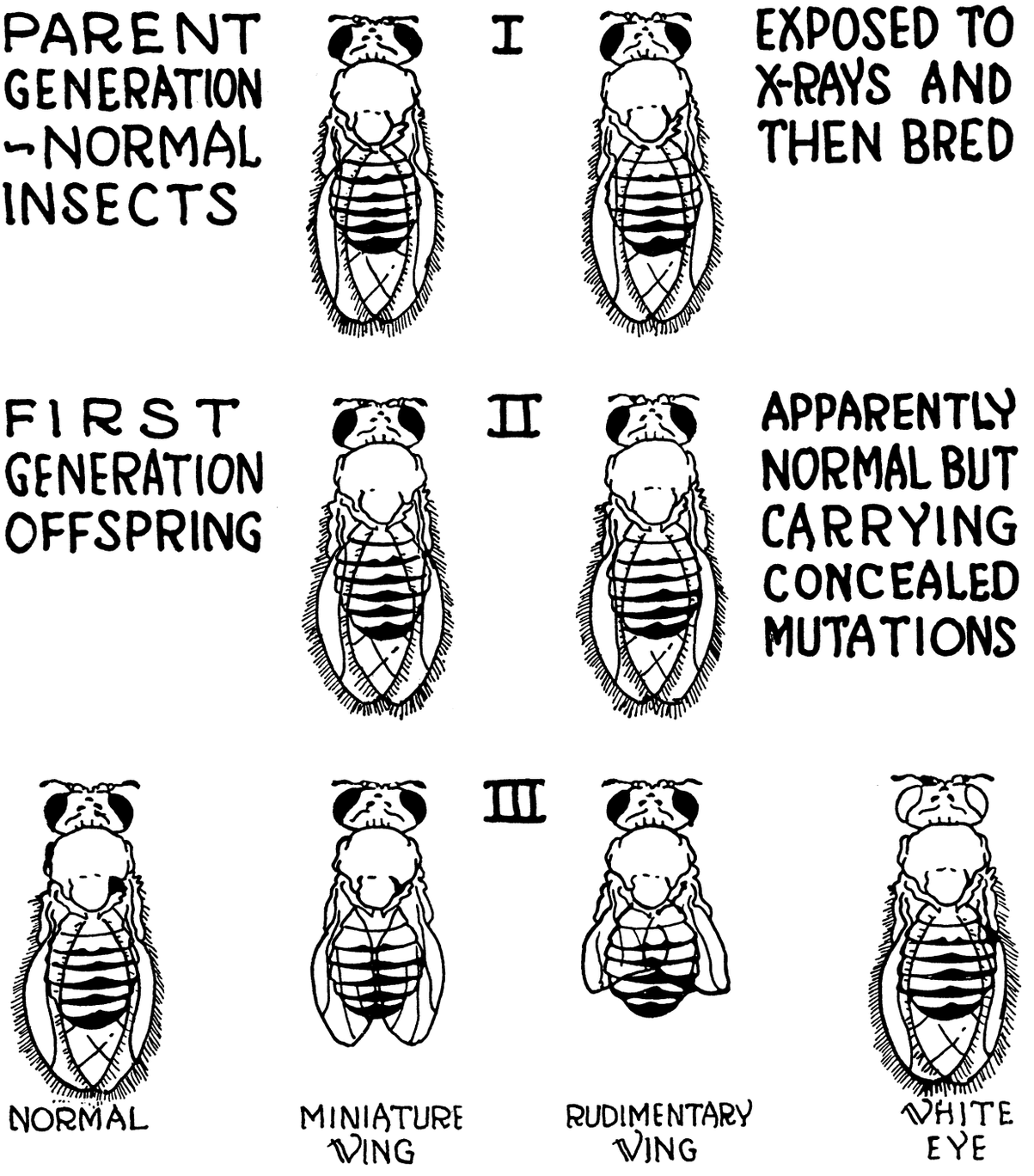
Natural Mutation Too Slow

While man can select the new forms he wants to keep much more rapidly than nature can, he has hitherto enjoyed no such advantage in the rate at which he can get new forms from which to do his selecting. In the long run, mutations in the garden or pasture do not occur any oftener than mutations in the forest. But man is an impatient creature, and does not like to sit down and wait for something to happen, on which he can then go to work. He wants to *make* something happen. He wants what he wants when he wants it—and that includes

(*Just turn the page*)



EXPERIMENTS ON RATS AND MICE will eventually tell much of what the new discoveries may be expected to mean to future generations of children



WHAT X-RAYS DO TO GRANDCHILDREN: a simplified family tree of Professor Muller's experimental insects showing in diagrammatic form how the "curse" is handed down

X-Rays Speed Evolution

(*Continued from page* 243)

mutations. Assisting or forcing nature in some way, so that new things will be produced faster than at the old, poky rate, has for centuries been the breeders' dream.

The Mechanism of Mutations

Until recently, however, there was not even a hint of hope that this dream might be realized, because nobody knew what made mutations happen. Nobody knew their mechanism. And until that was known, man lacked a handle to take hold of in his effort to push nature along a bit.

Then, about a generation ago, a few years after the discovery of X-rays, biologists made a re-discovery of the lost work of Gregor Mendel, and the science of genetics suddenly came of age. Men with microscopes looked critically at all kinds of reproductive cells, to see whether they could learn what carried from parent to offspring the "unit characters" of heredity, such as red in hair or blue in flowers, and they saw some very curious things. Not only in the dividing

(*Turn to page* 245)

X-Rays Speed Evolution

(*Continued from page* 244)

reproductive cells but within every living cell that divided, there were numbers of special, dense bits of the living substance, that looked rather like microscopic sausages of assorted sizes and shapes. Because these special bits of protoplasm stained especially deeply with the dyes used to color the cells in preparation for the microscope, they called them "chromosomes," which is simply Greek for "color bodies."

Chromosomes and Genes

If chromosomes were to be named over again, modern biologists would probably call them "genophores," or "gene-bearers," because they think of them as the things in which, or on which, roost and ride the genes, or chemico-physical carriers of hereditary qualities. Nobody ever saw a gene, and probably nobody ever will, for they are conceived of as being too small to be visible under even the highest powers of the microscope. Indeed, even the chromosomes are so small that it takes a very powerful instrument to see them, and the genes they carry are ever so much smaller than that. Scores, probably hundreds, of genes ride on each chromosome.

But if the genes are so small, and no one has ever seen them, how do we know that they exist? Some scientific skeptics maintain that they don't, but perhaps a majority of geneticists, who are the special students of this subject, believe that they do. They declare that every time a mutation occurs, like the production of a wingless insect from a winged parent stock, a certain particular bit of a given chromosome shows up missing, or at least is in an unaccustomed place, when they look at it through their lenses. Every time there is a mutation, they say, they can show a chromosome that has had an accident. This parallelism between mutations and chromosomes gone wrong has been traced in hundreds, even thousands, of cases. The defenders of the gene have plenty of data to back up their case.

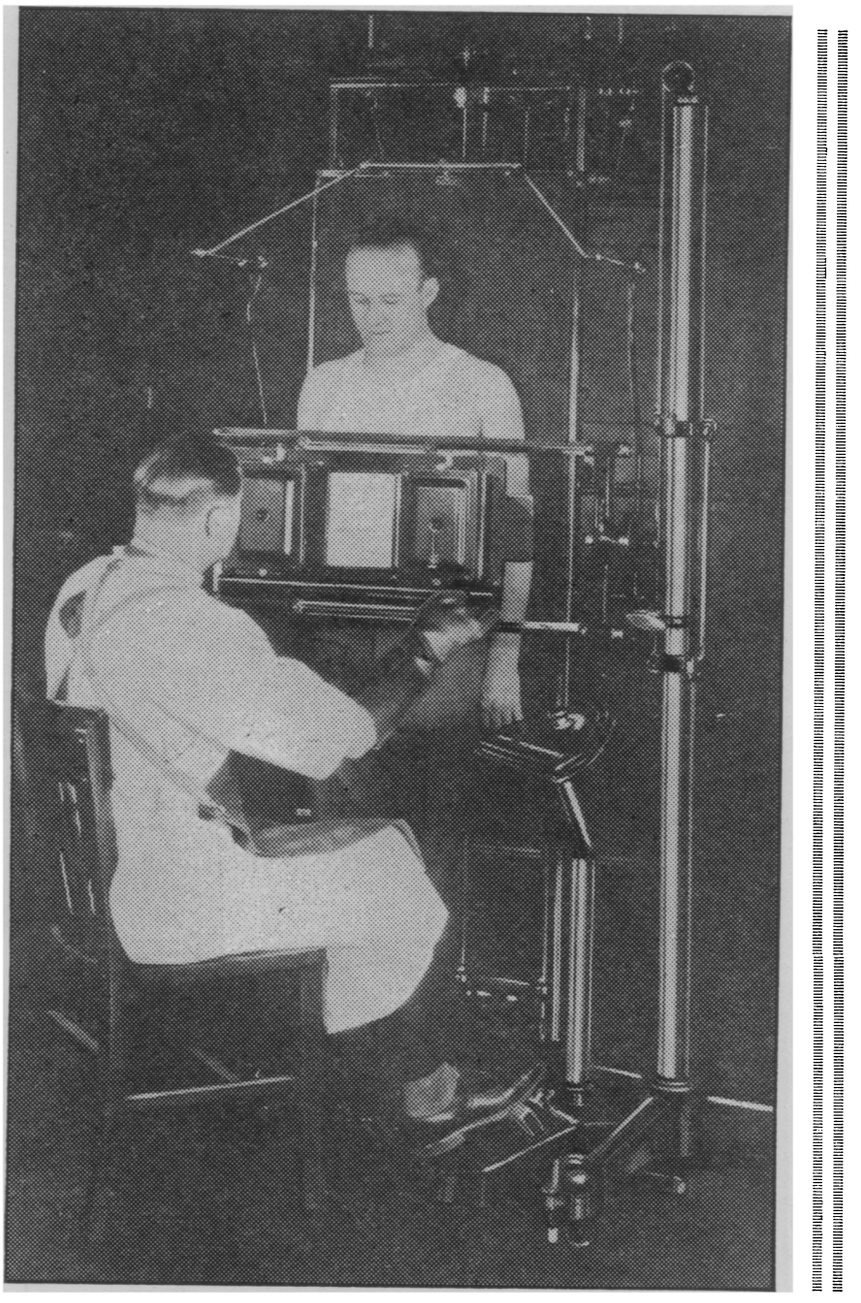
Arranging Accidents

If mutations always follow when accidents happen to the chromosomes in the course of nature, why not arrange a few such accidents, and thus get your desired hastening of the mutation process? Chromosomes are a bit hard to get at, and seem to be stubborn things anyway. Several means were attempted: ultraviolet rays, serum treatments, mechanical whirling, extremely rapid sound waves, even light doses of X-rays, but the results were all either negative or somewhat equivocal. Prof. Muller decided, in spite of the unpromising reports of other workers, to make one more try at it. He would use heavier doses of X-rays.

The Handy Fruit Fly

It didn't really matter much what animal or plant he used. It was cells he was interested in, and though living things differ vastly in size and shape, the cells out of which we are made are so much alike that in many fundamental things what holds true for a toadstool is true for an oak, and what can be done to a tiny insect can be done to a horse or a man. So Prof. Muller chose the little flying creature we find on fruit when it begins to spoil, known variously as fruit-fly, vinegar-fly and pomace-fly. It has the advantage that it breeds very rapidly—maturing in twenty-one days, as against twenty-one years in man. Furthermore, it

(*Just turn the page*)



X-RAY EXAMINATIONS AND TREATMENTS ARE NOT DANGEROUS under normal conditions; only when the hereditary cells are exposed to heavy raying do we take chances with the welfare of our grandchildren

X-Rays Speed Evolution

(*Continued from page 245*)

is cheap to maintain, demanding only a pint milk bottle as its cage and a bit of blotter soaked in banana juice for its whole rations. Finally, it has been studied intensively, and its mutations are probably better known than those of any other living thing.

The faintly buzzing little creatures were exposed to heavy doses of X-rays, and then allowed to breed. Presently the new generation hatched from their eggs. They were less numerous than might have been expected, but otherwise apparently all right. But that did not fool the researcher. There are such things as "recessive" characters, which appear not in the children but in the grandchildren; most mutations, indeed, are of this recessive nature. So Prof. Muller bred the first generation offspring and got a second.

Results of the Raying

Here he began to see results aplenty. Mutations such as he had often seen in un-X-rayed stock turned up, together with a number of brand new ones. All told, he figures that he has produced at least 100 distinct gene mutations, and that the raying has speeded up the process over 1,500 per cent. Some of the insects turn up with wings only half size, others with no wings at all, still others with wings of normal length but abnormally wide, or notched at the end, or splotched with odd patterns. Instead of their normal dark eyes, some of the little flies have white ones. Many of the new mutations must have been natural impossiblities, for the flies never hatched at all. Such mutations are known as "lethals," and their existence can be detected only by counting the offspring of normal, unrayed insects and comparing numbers. Male and female insects respond alike to the raying.

What It All Means

The obvious thing to do next is to try similar treatments on the larger, slower-breeding animals and on plants, with an eye to turning to agricultural advantage the numerous mutations this speeding-up process may be expected to produce. Prof. Muller says that this will be done "eventually." Further work on his fruit flies will probably come first, then experiments with rats and mice, which are cheap and can be wasted without regrets. But in the end, in an "eventually" not too remote, the rays will be applied to sheep and cattle and wheat and apples. The simplest of arithmetic will show that if the mutation-producing process can be speeded up even a tenth as much with these larger organisms as it is with the little fruit-flies, the gain to plant and animal breeding will be enormous.

A Menace in Birth Control

The production of mutations by X-rays comes home to the human species even more intimately than in its effects on his crops and livestock. There are such things as human mutations. When they arise in the course of nature, a family may be blesed with a Lincoln or an Edison, or it may be sickened and saddened with a child born mentally or physically defective. Most of us would rather forego the chance of a genius to escape the chance of a cripple among our descendants. Obviously therefore, X-ray doses of high intensity and long duration are things to be shunned so far as they concern the physical basis of human heredity, and this point is especially stressed by Prof. Muller.

There is no danger in ordinary X-ray examinations anywhere on the body, nor in properly regulated therapeutic treatments that do not come too close to the generative system. But the danger zone is now clearly indicated, and the warning has been unmistakably sounded.

X-rays have been more or less resorted to by persons desiring to limit the number of their children. The treatment results in temporary sterility, which afterward passes, permitting the production of offspring. But Prof. Muller's work indicates that while the first generation following such treatment may be apparently normal, they will carry concealed within them recessive mutations that may crop out as a horror and a curse to the third and fourth generations and to all succeeding posterity. As a means of birth control, therefore, X-rays are to be most severely shunned.

Science News-Letter, October 15, 1927

Mercury poison in the air, even so little as one part in 20,000,000 parts of the atmosphere, can be detected by a new device.

Weather records from all parts of the earth are gathered together in an important new publication by the Smithsonian Institution.

Bones of an ape which had been kept in a temple at Thebes about 2000 B. C. show that rickets was a malady of that ancient time.

WHAT CHROMOSOMES LOOK LIKE: three figures from the dance of life every living cell performs when it divides to produce new cells