CYTOLOGY

Subdivisions of Chromosomes Demonstrated by New Method

Making Hitherto Opaque Objects Transparent Lets in Light on the "Local Habitations" of Genes

See Front Cover

DEMONSTRATION of structural details within the chromosomes, considered by most biologists to be the bearers of the "genes" that control the inheritance of physical and physiological characters in animal and plants, compares in importance with the demonstration a few years ago of the divisibility of the atom into smaller electrically charged particles. Like the atom, the chromosome was suspected of being made up of distinct functional units on theoretical grounds for some time before the scientists' "hunch" was proved to be correct.

The brilliant work of Dr. Calvin B. Bridges of the Carnegie Institution of Washington, carried on at the California Institute of Technology and lately in the genetics laboratories of the Carnegie Institution at Cold Spring Harbor, N.Y., in making clearly visible the separate units of which the chromosome is composed, depends upon a paradox. For to see the chromosome-units distinctly it is necessary first to get out of the way the very stuff that gave the chromosome its name. The name "chromosome" is derived from the Greek for "color body," and was given to these small structures within the cell nucleus when it was observed that they became darker than the rest of the protoplasm upon the application of certain stains to make details of nuclear structure visible.

Banded Giant Chromosomes

The chromosomes were at first assumed to consist of a uniform substance, which was given the name chromatin. There was even developed a series of special chromatin stains for the purpose of making the chromosomes darker and more strikingly outstanding in the microscopic view of the cell.

A brilliant lead, to which Dr. Bridges acknowledges indebtedness, was developed during 1933 by Prof. T. S. Painter of the University of Texas. Prof. Painter worked with the "giant" chromosomes found in the salivary gland cells of fruit-fly larvae, which are seventy times the size of ordinary chromosomes.

He found on them numerous cross-bandings, which always had the same sizes and spacings on comparable chromosomes. He found also that with particular groups of these bands, groups of known genes could be correlated. This constituted the first truly quantitative, accurate gene-mapping ever accomplished.

When Dr. Bridges went to work, with Prof. Painter's results before him, he strove first to penetrate the veil of the chromatin. He developed a method to see right through it, so that he could get at what was inside. The chromatin, it developed, was not the important part of the chromosome at all, but only the matrix, the outside wrapping.

Now that the contents were visible, it could be seen that what Prof. Painter had first described as bandings on the chromosomes were really the edges of solid disks that ran clear through the chromosomes, strung together like beads on a thread. It was seen also that each gene locus corresponded with some special size or shape of "bead," always in the same relative position and always the same in all chromosomes examined.

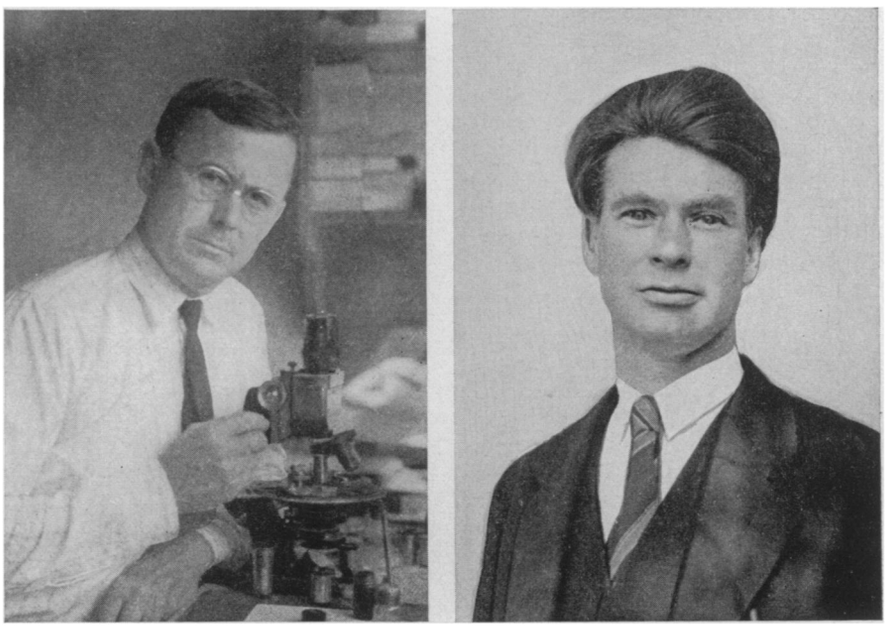
"As easily located as the houses on Main Street in the Old Home Town," is the vivid and homely characterization given by Dr. Bridges to the genes' places in the chromosomes.

The thick, somewhat snaky objects in the illustration on the cover are the chromosomes, thousands of times magnified. The many dark bands crossing them were invisible until Dr. Painter's and Dr. Bridges' work brought them out in sharp detail.

Chromosomes Divisible

But that was not the whole story. Not even the units of the now transparent chromosomes were the last words. They proved to be subdivisible also. Each disk is made up of a bundle of tiny rods, like a big handful of cigarettes; their ends are visible as dots on the faces of the disk. There is a continuity between these rods, from disk to disk; Dr. Bridges has likened them to segments of the strands in a twisted cable.

So small are these sub-units that many of them are hardly larger than single molecules of one of the more complex proteins. They may, indeed, be single molecules, or they may be small



HAVE FOUND THE HOME OF THE GENES

Following the lead of Prof. T. S. Painter (left), Dr. Calvin B. Bridges (right), has demonstrated subdivisions of chromosomes, bearers of hereditary units. This research is comparable with the demonstration a few years ago of the divisibility of the atom.

groups of molecules acting together.

Whether these tiny units are the genes themselves, or only the "genophores" or gene-bearers, is a matter of relative unimportance. The important thing is that they have now been unveiled, so that the searching finger of science may probe a little further into the secrets of life.

The principal milestones in the development of modern genetics may be listed as four: Gregor Mendel's proof, three generations ago, that genetic units determine the inheritance of characters; Otto Bütschli's demonstration of the existence of chromosomes; Thomas Hunt Morgan's concept of the gene; Painter and Bridges' separation of the chromosome into its finer structural units and their correlation with the location of the genes.

Science News Letter, September 29, 1934

MARINE ENGINEERING

Science Aided the Endeavour In Her Race for the Cup

"New-Fangled Gadgets," Including a Triangular Boom And Instrument Board With Stress Meter Helped

SCIENCE and mechanics can claim their share of credit for the showing of the British yacht *Endeavour* in the races for the America's Cup off Newport, R. I.

Old salts may shake their heads over instrument boards for yachts, triangle booms and all the other "gadgets," but both cup contestants have their share of them. A large part of the job of the scientists in the afterguards of both cup racers is devoted to the perfection and maintenance of "new-fangled" mechanical helpmates to the art of sailboat navigation.

To any yachtsman a boom is—or perhaps it is better to say, used to be—a piece of wood to which the lower edge of the mainsail was attached with rings. The boom rotated about the mast and by setting it at different angles the maximum velocity through the water was obtained.

Not on Endeavour

But on the *Endeavour* the boom is not just a cylindrical length of wood; it is triangular in cross-section. Such a triangular boom is a three-sided structure of wood with a flat side just under the edge of the mainsail. Rings attached to the "foot" or bottom of the sail slide along metal rods on the boom and set in it at right angles to its axis.

As the yacht tacks the rings slide along the rods and allow the foot of the sail to assume the best aerodynamic curve. Said another way, the sail takes a "set" which brings about the least "spilling" of air from it and hence the maximum driving force.

Convenient to the helmsman on the *Endeavour* is the instrument board of the vessel containing instruments for telling wind velocity and wind direction, and a mechanical log, or speed indicator of the yacht relative to the water.

Hot Wire Anemometer

The wind indicator is known technically as a hot wire anemometer, working on the Wheatstone bridge principle. Its workings are not as complicated as its name. Two equal resistance wires have a given electrical current passing through them. One resistance wire is shielded from the wind; the other is exposed to it. The cooling of the exposed wire changes its current-carrying capacity and throws the hitherto balanced Wheatstone bridge circuit out of balance. The out-of-balance current registers on a meter whose dial is before the helmsman. The out-of-balance current varies in proportion to the wind velocity.

The wind direction indicator is a rigid racing pennant acting as a weather vane high up on the peak of the main mast. Variations in its position control an electrical circuit acting on a voltmeter on the instrument board which is calibrated in wind direction.

Still another device is a stress meter giving the helmsman continuous knowledge of the forces acting on important bracing cables in the rigging. When the forces reach a point where there is a possibility of their breaking vital stays in the rigging the suitable ropes may be "eased off."

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ARCHAEOLOGY

Prehistoric Java Race Had Tools Like Neandertaler's

HOMO *soloensis*, a prehistoric race that lived in Java 40,000 years or more ago, had tools and weapons resembling those of Neandertal Man in Europe. This is the conclusion of Dr. P. V. van Stein Callenfels, based on a study of a large collection of such implements of stone, bone and horn collected on a terrace of the River Solo. This terrace was apparently formed during pleistocene or Ice Age times. The animal bones found associated with the relics of human occupation included an extinct elephant, a hippopotamus, and other animals no longer known in Java.

Striking among the implements found on the Solo terraces are a notched bone harpoon, showing a high degree of workmanship, and several of the barbed spines from stingray tails, which apparently were used as dart or arrow points, as they still are used by some island tribes. These spines argue the existence of trade between the hill-dwellers on the river terraces and the shore-dwellers of the coast, far back in cave-man times.

The stone tools and weapons include no flints, for flint is not found on the island of Java. Instead, this ancient race used chalcedony, chipping and flaking at least the better pieces with as much skill as did Neandertal man in Europe, at the culture level known as Mousterian.

Although *Homo soloensis* and his handicrafts are known from specimens found along the same river whose gravels yielded the much-discussed skull, teeth and thighbone of *Pithecanthropus erectus* something over forty years ago, Solo man is considered a far more advanced race than *Pithecanthropus*, and probably much later in time. His head was much larger and more highly domed, although still possessing the very heavy eyebrow ridges characteristic of Neandertal man in Europe and Peking man on the Asian mainland.

As yet, no artifacts assignable to *Pithecanthropus* have been found, so that a culture comparison between these two ancient Javanese races is not possible.

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Rainfall may wash 21 times as much plant food from the soil as growing crops would consume.