furnishes evidence that the Y-chromosome type of inheritance occurs in man as well as in fishes.

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JUNE 3, 1922

THE VOCABULARY OF METABOLISM

I wish to suggest in the columns of SCIENCE the following new terms in the vocabulary of metabolism: (1) *Eubolism,* a condition of normal bodily metabolism; (2) *Pathobolism,* a condition of perverted metabolism of a diseased nature, as, for example, diabetes; (3) *Dysbolism,* a condition of disturbed metabolism not necessarily of a diseased nature, as, for example, alkaptonuria. I believe that these terms will supply a want in the terminology of metabolism.

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SALARIES OF PROFESSORS IN POLAND

I TAKE the following item from the weekly news release of June 7 of the Polish Bureau of Information:

Because of the importance attached to their rôle in the life of the nation, the university professors of Poland have been granted salaries greater than those to which their official rank would entitle them. [The official rank of full professors in Polish universities is considered equivalent to that of major generals.]

If they have been in service fifteen years and are supporting families, they are to receive monthly salaries of 139,000 marks. This approximates the salaries of cabinet ministers, who receive about 160,000 marks monthly, and is slightly in excess of those of vice-ministers, who receive, including representation funds, about 137,000 marks.

These salaries for professors have been made possible by a special provision in the state budget, appropriating 357,906,966 marks for professors' salaries and 87,625,761 marks for the salaries of assistants, a total of nearly half a billion marks. [For the value of a Polish mark in American money to-day, consult the morning newspaper.]

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SPECIAL ARTICLES

THE SPIRAL TREND OF INTESTINAL MUSCLE FIBERS

IN the *Anatomical Record* for May, 1921 (Vol. 21, pp. 189-215), Professor Carey published his "Studies on the Structure and Function of the Small Intestine." These were reprinted, in part, with the title, "Studies on the Anatomy and Muscular Action of the Small Intestine," as the opening article of volume 1 of the *Journal of Gastro-Enterology* (July, 1921). The first conclusion, and the only one on which comment is here to be made, is this:

> The inner muscle coat of the small intestine is not composed of circular or annular rings contiguously placed, but is a continuous muscular sheet wound into a close helix. One complete turn is made in every 0.5 to 1 mm. or less (*Anat. Rec.*, p. 193; *Journ. Gastro-Ent.*, p. 9).

Professor Carey characterizes the conception that the inner muscular coat is composed of discrete muscular rings with a certain degree of connection, as "a faulty anatomical heirloom"—an "erroneous idea which arose with the inception of the microscope and has since been accepted unchallenged." There is, however, a neglected anatomical heirloom, with which perhaps the author was unfamiliar, in the form of "A Discourse concerning the Spiral, instead of the supposed Annular, structure of the Fibres of the Intestins; discover'd and shewn by the Learn'd and Inquisitive Dr. William Cole to the Royal Society" (*Phil. Trans.*, 1676, Vol. xi, pp. 603-609). This discourse, not now readily accessible, is so admirably confirmed by Professor Carey's repetition of the work as to repay examination.

At the time of Dr. Cole's studies, Willis, in his *Pharmaceutice rationalis,* published two years previously, had described the interior fibers of the muscular coat as "annular, everywhere girdling in close-set ranks the cavity of the intestines, and inserted into the edge of the mesentery as in a tendon." Overlying these, and "crossing them at right angles," he found straight or longitudinal fibers, and believed that the sinewy outer layer wrapped around them served them in place of tendons. (Earnest efforts were made by the early anatomists to

find tendons for smooth muscle!) From the mesentery and from the fibers of the outer coat, the circular and longitudinal muscles, respectively, received the animal spirits or nervous energy whereby they were at first inflated and distended, thereafter becoming shorter and more contracted. As to the action of the two sets of muscle fibers, he wrote:

Indeed the circular fibers, having contracted successively and seriatim, constrict the diameter of the intestine; and at the same time the longitudinals, inflated and distended, narrow it still more and produce a downward movement, so that the contents of the intestines, thus compressed from behind, must constantly be driven forward.

With such a description current, Dr. Cole begins his paper as follows:

Discoursing (near two years since) with a very ingenious Person, concerning the Mechanical reason of the Peristaltick motion of the Intestines, which is by Anatomists deduced principally from *Annular* fibres, constituting, according to the received doctrine (with the right fibres immediately investing them, though, by the by, I take these to make a distinct coat) one of the coats of them; his sence was (which he told me was that likewise of some others of his acquaintance) that they might be rather numerous, though small, Sphincter-muscles, than single fibres, to which that motion is to be attributed.

For four theoretical considerations Dr. Cole dissented, namely (1) that on the supposition of circular sphincters there would be no continuous lengthwise channel for the propagation of motion, and (2) lateral transmission seems not to be agreeable to nature's methods. Moreover, (3) lateral exits would tend to prevent distension of the fibers by the influent matter; and (4) circular muscles lack two tendons by the approximation of which all muscular work is accomplished. He therefore offered the following solution:

Viz. That those fibres which have been esteemed *annular*, might perhaps be *spiral*, and so be continued down in one tract to the lowest extremity of the intestines; . . . their declination being not easily discernible. . . But . . . I consider'd 'twas too unphilosophical to acquiesce in bare speculation, when *autopsy* might be consulted; and therefore I set upon the experiment, first in the upper intestines of an Ox, afterwards in those of Sheep and Calves. . . .

To effect a [illegible]e disjunction of the membranes and fibres (wh[illegible] I found 'twas hard, if not impossible, for n[illegible] to make while 'twas raw), I was fain to caus[illegible] the intestine of Oxen to be boiled 5 or 6 hours, of Sheep 4; whereby the compages of the parts was so loosned, that the two outward coats were easily separated from that to which my search was destined, and left those reputed annular fibres naked.

The results of attempting to follow, through separation, the course of the bundles of these muscle fibers—single fibers being found too small to isolate—Dr. Cole records in numbered paragraphs, from first through "eighthly." The following are selected statements, abbreviated (as were previous citations):

When, beginning at the top, I attempted the separation of one of these clusters of fibres towards my right hand (on that side of the intestine, I mean, which was turned towards me) a whole ring would come off together . . .; but endeavouring it towards my left, I found, for the most part, I could easily enough unravel that cluster to a considerable length, *viz.*, that of sometimes more than two or three spans, before ruption, which yet at last 'twould be subject to.

If I began at the lower part of the intestine, and try'd to unravel *upwards*, there was not much more difficulty in so doing . . . [But] the operation, I observ'd would not succeed, unless I attempted it on the contrary order, *viz.*, towards my right hand.

When before boiling I caused the inside of the intestines to be turned outward, as I did in two tryals, . . . and endeavoured to unravel the fibres, I found they would come off in the contrary order . . . the intestine being inverted, the order of separation must be so too.

Other observations are that the obliquity of the spiral may vary; that the spiral is less well-defined in the cæcum; and that everywhere some fibers deviate from the main trend, being in the opposite order, or forming intercommunications between the turns of the spiral. But the general conclusion reached is that the fibers altogether form "one concave helical muscle."

Where the tendons of it are fixed is not evident; but if I may have the liberty of conjecture, I should think the upper of them to be radicated at the pylorus (if not as high as the sphincter gulæ); and the other at the anus.

Whether the supposed annual fibres of the veins

and arteries may not have the same fabrick as those of the Intestines . . . I propose to be considered and examined by persons of more acute hands and judgment; as I do all what I have here delivered, nor daring too much to trust even the informations of my own hands and eyes, till I find them confirmed by those of others, more judicious as well as more dextrous in making experiments.

After two centuries Professor Carey has supplied the needed confirmation *except in one particular;* he finds that the spiral winds in the opposite direction! Carey describes a "left-handed helix,"—a spiral which reverses the direction of the rotation of the embryonic stomach and goes counter to the twisting of the œsophagus. But Dr. Cole recorded the type familiar in dextral gastropod shells, which accords with the rotation of the stomach. Although it often happens in nature, as noted by Thompson, that two opposite systems of geodetic spirals exist together, and interfere with one another, forming a criss-cross pattern[1] (and indeed such a condition has been recorded for the œsophageal muscles of ruminants[2]), it can not be invoked to reconcile the conflicting statements regarding the direction of the intestinal spiral, since both Cole and Carey agree that there is but one well-defined cleavage. Under these circumstances, the question has been referred to Professor Sykes, who, during the past season, while studying in the Harvard Laboratory, has frequently unwound the circular muscle of the intestine. Although his results are to be published elsewhere, I am permitted to report that he has verified the early work of Dr. Cole in regard to the direction assumed by the spiral; it is dextral. If this is so, Dr. Carey's explanation of that primary torsion of the embryonic intestine which determines the disposition of small and large bowels in the adult, though very ingenious, must be considered illusory, for it depends on sinistral coiling and tension.[3]

The origin of the spiral trend of the muscles is ascribed by Dr. Carey to "the rotating spiral growth of the epithelial cells,"[4] but this is a phase of the problem which invites further study.

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[1] *Growth and Form,* 1917, p. 489.

[2] Owen: *Comp. Anat. of Vert.,* 1868, Vol. 3, p. 470.

[3] *Journ. Gen. Physiol.,* 1920, Vol. 3, p. 76 *et seq.*

[4] *Anat. Rec.,* 1920, Vol. 19, p. 220.

NEARCTIC PROTURANS

THE Protura—the most primitive of all the insects, if indeed they are insects—were first reported from the Nearctic Region in 1909. In that year the eminent Italian zoologist and entomologist, F. Silvestri, collected and described under the name of *Eosentomon wheeleri,* a single species from New York. For the next twelve years no record was added from the vast area of the Nearctic.

The second record from this region was obtained in 1921 from the vicinity of Washington, D. C., the first specimen being found by H. S. Barber, who accidentally came across it in some leaf mold in which he was rearing beetle larvæ. Other specimens of the same species, which proved to be new, were soon taken, and the species described by the writer as *Acerentulus barberi.*[1]

Following the initial discovery at Washington the writer has been fortunate enough to encounter Proturans in large numbers and in considerable diversity at Takoma Park, Maryland. Here during the spring of 1921 no less than twelve species, representing six genera, were found, ten of them proving to be new. These have been described in a paper presented at a meeting of the Entomological Society of Washington.[2]

To these records obtained in the vicinity of Washington are now added several more from widely separated localities, and in some instances from different life zones of the Nearctic Region. These localities are as follows: Chesapeake Beach, Md.; top of Blue Ridge Mountains, near Bluemont, Va. (elevation 1,200 feet); near Prospect Hill, Va.;

[1] "A Second Nearctic Species of Protura, *Acerentulus barberi,* new species." *Ent. News,* Vol. XXXII, pp. 239-241.

[2] "New Genera and Species of Protura," *Proc. Ent. Soc. Wash.,* Vol. XXIII, No. 9, pp. 193-202, Pl. XVI.