DISCUSSION

SPINDLE TWISTING IN THE GIANT AMOEBA

DURING a comparative study of the nutritional requirements and nuclear structure of *Amoeba proteus* and the giant amoeba, *A. carolinensis*,[1] observations of anaphase in the latter have revealed what appears to be a property of the spindle which has not previously been recognized. The giant amoeba is multinucleate and during mitosis all the nuclei in one individual are in approximately the same stage of division. During anaphase the half spindle regions do not appreciably change in length, but the spindle between the daughter groups of chromosomes elongates as these chromosomes (or early telophase nuclei) move sometimes as far as 62 μ apart. As this elongation progresses, the interzonal spindle undergoes a twisting such as would result in the rotation of the daughter groups of chromosomes in opposite directions. This twisting is easily seen until the chromosomes are up to 45 mμ apart. With further elongation a more complex distortion appears and dissolution of the fibers of the interzonal region occurs.

A single amoeba[2] was found with all its nuclei, 33 in number, at anaphase or early telophase. Of these 4 are at early telophase and the remainder at the anaphase stage. Twelve of the spindles are so elongated, contorted and in such a state of dissolution that they could not be properly resolved. Of the 21 spindles that lend themselves to analysis, one, with chromosomal plates 17 μ apart, shows no twisting of the interzonal region of the spindle (Table 1).

TABLE 1

Distance of daughter groups apart (μ)	Number spindles right	Number spindles left	Number not twisted
13–17	0	0	1 (17 μ)
18–22	9	0	0
23–27	3	0	0
28–32	4	0	0
33–37	1	0	0
38–42	2	0	0
43–47	1 (44 μ)	0	0
Total	20	0	1

The other 20 spindles, the chromosomal groups of which are 19 to 44 μ apart, have their interzonal regions clearly twisted, while the fibers of the half spindle region are straight. The direction of the twist in every one is clockwise or to the apparent right (Fig. 1, ×1660).

These observations, though limited, are of considerable significance. The fact that the spindles consistently twist in one direction indicates that this twisting which accompanies spindle elongation is not a chance phenomenon brought about by cytoplasmic movement or other external factors operating on the spindle. This interpretation is further strengthened by the fact that the spindles are oriented at random in the cell. The constancy in direction of the twisting would result from a property inherent in the spindle apparatus, possibly an uncoiling of spindle elements as elongation proceeds.

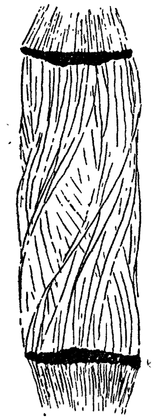

FIG. 1.

ROBERT B. SHORT

MILLER SCHOOL OF BIOLOGY,
UNIVERSITY OF VIRGINIA

[1] = *Chaos chaos* of some authors.
[2] Fixed in Carnoy and stained in Haidenhain's Iron-Haematoxylin.

ONE-PARENT PROGENY OF TUBIFICID WORMS

UNDER this title, is a recent article, Purdy[1] has reported the production of young by isolated tubificid worms of the genera *Tubifex* and *Limnodrilus*. This phenomenon was studied by Černosvitov[2] in *Tubifex tubifex* (Müller) and has been further investigated by Gavrilov[3,4] in several other species of oligochaets. Both these authors believe that some form of self-fertilization occurs, although the possibility of parthenogenesis does not appear to be completely excluded. In one case (*Limnodrilus udekemianus* Clap.) spermatophores were found in the spermathecae of isolated individuals, from which Gavrilov concludes that self-fertilization takes place by way of a process of self-copulation. However, in two other species of this genus (*L. hoffmeisteri* Clap. and *L. claperedeianus* Ratzel), as in *T. tubifex* and also in the lumbricid *Eiseniella tetraedra* (Sav.), the spermathecae never contain spermatozoa unless reciprocal copulation has occurred. If the production of uniparental progeny is the result of self-fertilization it must, in these species, be achieved by some other means than self-copulation. Gavrilov, supporting earlier findings of

[1] W. C. Purdy, SCIENCE, 102: 182, 1945.
[2] L. Černosvitov, *Biol. Zlb.*, 47: 587–595, 1927.
[3] K. Gavrilov, *Biol. Zlb.*, 51: 199–206, 1931.
[4] K. Gavrilov, *Acta Zool.*, 16: 21–64, 1935.

Gathy, Černosvitov and others, claims that there are the same number of chromosomes on the first and second maturation spindles as during segmentation and that, in this respect, there is no difference between normal and uniparental eggs. The interpretation of this remarkable situation is obscure and the facts themselves require fuller investigation. Against the occurrence of parthenogenesis, Gavrilov believes that he has found evidences of spermatozoa in the uniparental eggs.

Uniparental production of progeny is probably quite general among the Oligochaeta. Gavrilov quotes unpublished observations of Černosvitov on *Enchytraeus albidus* Henle and of Janda on *Eisenia foetida* (Sav.); in both these forms reproduction can occur in the absence of reciprocal copulation. On the other hand, isolated specimens of *Rhynchelmis limosella* Hoffm. showed reduction of the sexual organs and produced at most only a few uniparental eggs which failed to develop beyond the segmentation stages. According to Kobayashi[5] there are as many as ten species of the oriental genus *Pheretima* which frequently or even usually lack male pores. This author was able to demonstrate the production of viable young by individuals of the Japanese-Korean species, *P. hilgendorfi* (Michaelsen), which were without male pores and which had been isolated before reaching sexual maturity. As in the case of the species discussed previously, parthenogenesis is not excluded, but the presence of testes argues in favor of some form of self-fertilization.

GRACE E. PICKFORD
OSBORN ZOOLOGICAL LABORATORY AND
BINGHAM OCEANOGRAPHIC LABORATORY,
YALE UNIVERSITY

HAMSTER SEXUALLY MATURE AT TWENTY-EIGHT DAYS OF AGE

SHEEHAN and Bruner[1] have summarized our limited knowledge of the care, breeding habits and estrous cycle of the golden hamster (*Cricetus auratus*). Their published data on the development of the hamster pups and on the gain in weight through the sixth week of growth have been substantially corroborated by the writer.

Our records show that the newly born young averaged 1.9 grams instead of 2.23 and 2.49 grams for the females and the males as recorded by Sheehan and Bruner, and our young hamsters did not show a failure to gain weight during the fourth week as they reported.

The females will breed only during the early evening hours. During November copulation began about 7 P.M. (Pacific war time) and during March and April about 7:30. On December 5th a female refused to copulate at 5 P.M., again refused at 6 P.M., and at 7 P.M. copulated repeatedly with all four of the males in the cage. When not in heat the females usually attack the males and occasionally inflict wounds of varying degrees of severity.

The estrous cycle of the hamster recurs every four days. During the morning following an evening when the female was receptive for copulation, a white mass of vaginal fluid containing leucocytes and epithelial cells appears at the orifice of the vagina. Upon application of slight pressure with the finger it can be expressed readily. The evening of the third day following the appearance of the vaginal exudate the female will again be in heat. We found this to be a very simple and satisfactory way of keeping track of the cycles in the different females.

In addition to water, the hamsters were fed daily a standard laboratory pellet for dogs and liberal amounts of fresh bur clover (*Medicago hispida*) of which they were exceedingly fond. What special part, if any, the bur clover had in stimulating early breeding can not be stated by the writer; however, stockmen have long recognized bur clover as being a highly nutritious forage plant.

Hamsters are said to breed at eight to twelve weeks of age.[1] Upon several occasions the writer observed young females from 42 to 45 days of age copulating with mature males. Two of these females, one that copulated on the 42nd day, gave birth to eight young, and the other (45th) contained fourteen fetuses when she was killed on the fourteenth day of gestation.

In order to determine the minimum age at which the female hamster will breed, ten 21-day-old females from two litters were selected on April 25th. Each evening for an hour they were placed in a cage with seven sexually experienced males. They copulated at the following ages in days: 27, 28, 29, 29, 30, 31, 31, 38, 42. The tenth female never copulated during the experiment and was the only one of the ten that did not become pregnant during the two months that the experiment was in progress.

The female that copulated when she was 28 days old gave birth to five young when she was 44 days of age! She successfully raised and weaned all five of them. Another female, the one that copulated on her 31st day, had nine young when she was 47 days old and raised them all. The two next youngest females were 54 and 58 days of age when their litters of four and nine young were born. In these experiments the young were usually born on the sixteenth day of gestation; however, on several occasions young

[5] S. Kobayashi, *Sci. Rep. Tohoku Imp. Univ., Biol.*, 11: 473–485, 1937.

[1] John F. Sheehan and Joyce A. Bruner, *Turtox News*, 23: 65, 1945.