here are pieces of cheese-cloth, pieces of glass tube, open on both sides and with smooth edges so as not to cut the cloth, and pieces of rubber tube, also open on both sides, which just fit around the glass tubes and around the faucet used for the water current.

First, the faucet above the sink is provided with a long piece of rubber tube. Then a piece of cheese-cloth is put over one end of a glass tube, and this end is connected with the long rubber tube on the faucet. Now the free end of the glass tube is held upward and a gentle flow of water allowed to expel all air bubbles. Then the material and a label is transferred into the glass tube and its other end covered with a piece of cheese-cloth kept in the right position by another piece of rubber tube. This in its turn may be connected with a second glass tube containing another piece of material, and this may be repeated any number of times. The result is that a long series of glass tubes separated by cheese-cloth and rubber tubes and each containing a piece of tissue are connected in a series with the faucet (see Fig. 1).

Intercalation of one or more Y-shaped tubes allows one faucet to serve more than one series of tubes containing material fixed in different reagents. In this way substances washed away from one piece of tissue can never touch material fixed in a different way.

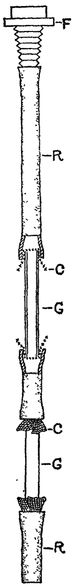

FIG. 1. Semi-diagrammatic drawing, showing the arrangement of the tubes. F, faucet; R, rubber tube; G, glass tube; and C, cheese-cloth.

Abstract: As a simple way of washing more than one piece of tissue at the same time in running water, it is suggested to put them in glass tubes separated by cheese-cloth and connected by rubber tubes to one another and to the faucet.

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ELASTIC FATIGUE AND CREEP OF COILED SPRINGS

THE writer tested springs of two types to obtain information on the rate of increase in length when loads were applied for long times. One type was made of steel piano wire. This type had turns of uniform size. The other type was the ordinary jolly balance spring, made of phosphor bronze and tapered.

During the 365 days that the 50 gm load was on the steel spring there was a gradually subsiding increase in length. This is not surprising, but the writer was surprised at the magnitude of the creep. It was about 3.5 cm (5 per cent. increase in length). At the end of the year the load was removed and replaced after a few weeks. During this rest period the spring became 1.2 cm shorter. Within six days after it was reloaded it had regained most of its loss in elongation (0.8 cm). Then the creep proceeded at a much slower rate, the displacement-time curve soon reaching about the same slope as it had shortly before the load was removed. The load was left about 6 months longer, but the creep was still noticeable at the end of this time. Such a spring would be entirely unsuited as a balance spring for many purposes, such as slow evaporation measurements.

The two phosphor bronze springs showed very little creep. With the load applied for six months the length increases 0.03 cm with one spring and 0.23 cm with the other, the former being about 0.08 per cent. The uncertainty of the readings was about 0.04 per cent.

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SPECIAL ARTICLES

EFFECTS OF ENVIRONMENTAL CONDITIONS ON LONGEVITY

IN line with a recent article in SCIENCE by Dr. C. M. McCay[1] some of the writer's experiments, planned to test the effects of environmental conditions on longevity, may be of interest. For the past year the writer has been working with the effects of certain environmental conditions on the duration of life in Cladocera. The animals used in the experiments to be mentioned here were Cladocerans from the

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[1] C. M. McCay, "Is Longevity Compatible with Optimum Growth," SCIENCE, 77, 410, 1933.

stock of Dr. A. M. Banta. These animals are in many respects ideal for this purpose, chiefly because they reproduce parthenogenetically, and as pure lines (clones) exclude the probability of influence of any heritable factors for longevity.

The results presented are based on experiments with *Daphnia longispina* and *Moina macrocopa,* both of which have been reared in Banta's laboratories for many generations. They were cultured in manure infusion medium[2] which had been brought to a temperature of 25° C. previous to the introduction of the animals. This temperature was maintained throughout the course of the experiments.

The "normal" series was composed of animals reared in medium at a temperature which provides conditions as favorable as possible for growth and reproduction. The "retarded" series was composed of animals treated in every way exactly as were the normal animals except that their culture medium was diluted from 24 to 36 times with pond water so that growth was very slow and their reproductive rate low. The young selected as experimental animals were taken from large broods (20 to 35) produced by vigorous mothers, and were distributed evenly between the normal and retarded groups. Hence, all members of the series were either sibs or daughters of sibs. Each animal was confined to a wide-mouthed bottle containing approximately 100 cc of medium and was transferred to new medium after the release of each clutch of young. The young were counted and discarded. The summarized data for three such series are given in the table.

	No. mothers	Ave. no. young per mother	Ave. repr. life in days	Ave. no. broods per mother	Ave. no. young per brood	Repr. index	Average longevity in days
			SERIES I *Daphnia longispina*				
Normal	46	208.8	22.48	10.54	19.09	9.04	32.30 ± .401
Retarded ...	40	92.0	31.0	13.25	6.99	2.96	36.13 ± .490
			SERIES II. *Daphnia longispina*				
Normal	78	250.90	22.55	10.54	23.85	11.19	27.60 ± .356
Retarded ...	75	107.73	38.36	16.42	6.10	2.63	46.75 ± .503
			SERIES III. *Moina macrocopa*				
Normal	98	102.81	6.24	3.73	27.09	15.95	9.01 ± .125
Retarded ...	94	71.46	10.65	6.72	10.95	6.78	13.84 ± .240

Series I was started late in September, 1932, and consisted of 46 normal and 40 retarded animals. The retarded mothers produced fewer young and lived 3.83 (11.8 per cent.) days longer than did the normal mothers. A more significant analysis of their relative reproductive rates is obtained from the reproductive indices. The reproductive index is the average number of young per mother per day of reproductive life. The reproductive life is measured from the time at which the first clutch of eggs passed into the brood chamber until the last brood was released. In this series the normal animals produced on the average 6.08 more young per day than did the retarded of the same series.

Series II, started in November, 1932, and consisting of 78 normal and 75 retarded animals, gave similar results with an even larger differential between the two groups. The retarded mothers released 8.46 fewer young per day than did the normal. Their duration of life was 19.15 (68.4 per cent.) days longer than that of those reared under favorable conditions. The increased longevity of the retarded over the normal may in part have been due to reproductive exhaustion since Series II normal mothers produced more young per brood than did those of Series I. Even though the duration of life of the normals of Series II was shorter, they showed very nearly the same length of reproductive life and exactly the same average number of broods per mother as did those of the first series.

Series III, of *Moina macrocopa,* a much shorter lived Cladoceran than *D. longispina,* was started during March, 1933, and was composed of 98 normal and 94 retarded mothers. Here again, animals living under poor food conditions have a lower rate of reproduction and a longer life than those under favorable conditions.

Lowered reproductive rate is not the only result of inferior environmental conditions. Mothers in diluted medium do not reach sexual maturity as soon nor do they release clutches of young as frequently as those in undiluted medium. The growth increment is especially decreased, the retarded animals never attaining the same size as do the normal.

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[2] A. M. Banta, "A Convenient Culture Medium for Daphnids," SCIENCE, 53, 557, 1921.

McCay cited evidence which he believed indicated that longevity in the rat is increased by limited diet. The present controlled experiments with Cladocera seem to demonstrate (1) that poor environmental conditions influence rate of development and reproduction in several different ways and (2) that longevity is influenced by environmental conditions. In the present case it is greatly influenced by suboptimal conditions. The writer's experiments are being continued.

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ARTIFICIALLY INDUCED CROSSING-OVER IN MALES OF DROSOPHILA MELANOGASTER

SOME of our previous work on the artificial induction of breaks in somatic chromosomes in *Drosophila melanogaster* by means of x-rays[1] makes it highly probable that breakage of chromosomes in the somatic tissues of males occurs less easily than in those of females. On the supposition that this peculiarity of the male is also present in spermatogenesis, it may be expected that crossing-over is not absolutely impossible in the male, and that its absence is merely due to this low liability of male chromosomes to breakage. There is reason to expect, therefore, that crossing-over might be brought about in males by applying the same agents that increase crossing-over in females. We know that for females, temperature extremes[2] and x-rays[3] considerably increase crossing-over in the central region, *i.e.,* near the attachment point of the spindle fiber, of the long autosomes (chromosomes II and III). If our supposition that crossing-over is possible in males is correct, we may expect that these same agents will induce crossing-over in the central region of the chromosome in spermatogenesis also. In my experiments heterozygous males of *Drosophila melanogaster* in the second day of the pupal stage were placed in test-tubes and subjected to the action of x-rays (dosage – 4000 r.). About 4½ to 5 days later the adult males were crossed with homozygous females suitable for crossing-over tests. The multigenic second and third chromosome heterozygotes were chosen for the experiment.

In one of the series, the males carried in one of the second chromosomes the recessive genes atrura (a gene inducing a dark brown coloring of the eye, locus 18), plexus (inducing a plexus in the wing-veins, 100.5) and speck (inducing a black speck at the base of each wing, 107), and in the other one the normal allelomorphs of these genes. The 561 flies produced from this experiment gave 22 (3.9 per cent.) cross-overs between atrura and plexus (11 atr and 11 px sp). Another similar experiment, differing from the first in the structure of the males $\frac{\mathrm{S}\ +\ \mathrm{Br}\ +\ \ +}{+\ \mathrm{atr}\ +\ \mathrm{px}\ \ \mathrm{sp}}$; S = Star, rough eyes, dominant and lethal in homozygous state, locus 2; Br = Bristled, extra sternopleural bristles, dominant and lethal in homozygous state, 21), was carried out with 830 offspring, including 17 (2 per cent.) crossovers between Bristled and plexus (9 atr and 8 S Br px sp). The control series, consisting of 1,756 flies, did not give a single case of crossing-over. In a third experiment, producing 988 flies, the x-rayed males had the structure $\frac{\mathrm{S}\ \mathrm{Br}\ +}{+\ \ +\ \mathrm{bw}}$ (bw = brown eyes, recessive, 105) and 2 cases of crossing-over between Bristled and brown (1 S Br bw and 1 wild type) were obtained. In a fourth experiment with the second chromosome, the structure of the male being $\frac{\mathrm{S}\ \mathrm{Br}\ +\ +\ +}{+\ \ +\ \mathrm{b}\ \mathrm{cn}\ \mathrm{c}}$ (b = black body, recessive, 48.5; cn = cinnabar eyes, recessive, 57.5; c = curved wings, recessive, 75.5) 142 flies gave two cases of crossing-over between black and cinnabar (2 S Br cn c).

In one experiment with a six-gene third chromosome, yielding 834 flies, (structure of the males = $\frac{\mathrm{ru}\ \ \mathrm{h}\ \ \mathrm{st}\ \ \mathrm{p}^{\mathrm{p}}\ \ \mathrm{ss}\ \ \mathrm{e}^{\mathrm{s}}}{+\ \ +\ \ +\ \ +\ \ +\ \ +}$; ru = roughoid, irregular eye facets and hairs, recessive, 0; h = hairy, extra hairs on scutellum, recessive, 26.5; st = scarlet, cinnabar eyes, recessive, 44; p^{p} = peach eyes, recessive, 48.4; ss = spineless, bristles very short, recessive, 58.5; e^{s} = sooty, dark body, recessive, 70.7) there was not a single case of crossing-over. But in a second experiment with the same chromosome, yielding 257 flies, the sires were males from the line atr px sp, which had given a high percentage of crossing-over in the second chromosome (see above), and 5 cases of crossing-over between scarlet and peach were obtained (2 ru h st and 3 p^{p} ss e^{s}). It may be that in the first experiment with this third chromosome certain conditions obtaining in the other experiments were absent. Nevertheless, it would seem, from a comparison of all the experiments, that the artificial induction of crossing-over in the male is accomplished with unequal ease in different lines. This problem must be investigated further.

A genetic analysis has shown that the observed crossing-over in males is not imaginary and is not the result of chromosome aberrations, *e.g.,* translocations, duplications, deficiencies or mutual translocations between two homologous chromosomes in non-homologous points. A cytological examination, for

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[1] Friesen, 1932, *Biol. Jour.* (Russian), I, Nos. 5–6.

[2] Plough, 1917, 1921.

[3] Mavor and Svenson, 1924, and Muller, 1925.