tained with a glow discharge in mercury vapor using a hot tungsten cathode emitting 30 milliamperes. The conditions were such as to give a rather weak ionization, but the results are quite comparable with those observed in the portions of a mercury arc tube where similar ionization occurs.

ELECTRODE RADIUS 0.0635 CM. LENGTH 6.2 CM.

Volts	I obs. m.a.	β	$\frac{a}{r}$	I cal. m.a.
40	0.31	1.40	2.58	0.308
60	0.36	1.77	3.06	0.366
80	0.40	2.05	3.43	0.410
100	0.46	2.26	3.72	0.443
140	0.52	2.74	4.39	0.524

The last column gives currents calculated on the assumption that they are proportional to the values of a/r in the 4th column as they should be by the theory. It is seen that the agreement with the currents in the 2nd column is within the probable experimental error.

The positive ion currents flowing into the sheath in this case correspond to a current density of 49 microamperes per cm². With the more intense ionization in a five-ampere mercury arc rectifier, positive ion current densities of about 30–60 milliamperes per cm² are obtained and these currents, because of the small thickness of the sheath, are much more nearly independent of the voltage even if the electrodes are of small diameter.

This theory, for reasons which can not well be stated in a brief note, leads to the following conception of the positive column of the mercury arc (and of glow discharges in general).

The glass walls of the discharge tube become negatively charged and repel (or reflect) all but a very minute fraction of the electrons that move towards the walls. Since electrons in general make elastic collisions with mercury atoms, the motion of the electrons is in random directions, almost as many electrons moving against the potential gradient in the arc, as with it. Thus an apparent current density of one ampere per cm² in an arc is to be regarded as consisting of an electron current of perhaps 20 amperes per cm² in one direction and a similar current of 19 amperes per cm² in the opposite direction. The positive ion currents, because of the large mass of the ions, are many hundreds of times smaller (10 to 60 milliamperes per cm²). The positive ions, in general, lose a great part of their energy in each collision with the atoms, and thus behave as though all collisions were inelastic.

Few, if any, of the ions move against the potential gradient, but by collisions with atoms they are thrown against the glass walls before having travelled more than one or two free paths, these paths usually being comparable with the diameter of the discharge tube. Enough electrons pass to the walls to neutralize the charges of the positive ions and in doing so liberate in the form of heat, an energy corresponding to the ionizing potential 10.4 volts. Thus a positive ion current density of 10 milliamperes per cm² generates a heat of over 0.1 watt per cm². This accounts for the influences of the size of the tube on the voltage drop in the arc.

A more complete discussion of these conclusions will be published in the November number of the G. E. Review.

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LATE FERTILIZATION AND SEX-RATIO IN TROUT

THE experiments of R. Hertwig[1] and his pupils have shown conclusively that delayed fertilization in frogs will produce a preponderance of males, in some cultures 99–100 per cent. males being produced. It occurred to me that the trout would afford favorable material for seeing whether this phenomenon could be reproduced in other species. Accordingly, in 1921 and 1922, by the courtesy of the Midlands Fisheries Ltd., and in especial of their manager at Nailsworth, Glos., Mr. Stevens, I carried out some experiments on the matter.

I since discovered that Dr. Mrsic, in Professor Hertwig's laboratory at Munich, had also been working at the subject and had obtained more definite results than I. He had kindly sent me the proofs of his article due to appear shortly in the *Arch. Ent. Mech.*,[2] and allowed me to mention his results.

My own results were as follows:

	Total	Per cent. ♂♂ P.E.
Control '21	119	47.90 ± 3.09
Control '22	274	48.17 ± 2.04
Late-fertilized '21 (some 4, some 7 days late)	332	54.52 ± 1.83
Early-fertilized '22 (7 days early)	319	50.78 ± 1.89

Dr. Mrsic's were as under (I have calculated the probable errors for his figures, as these do not appear in his paper):

Control (I)	90	47.8 ± 3.55
4 days—7 days late (II–III)	199	39.7 ± 2.34
13 days late (IV)	77	50.6 ± 3.84
21 days late (V)	57	66.7 ± 4.21

[1] Hertwig, R., '05–'07, Verh. Dtsch. Zool. Ges.: '12, Biol. Zentr. 32; '21, Sitzb. Bayr. Ak. Wiss. 1921; Kuschakewitsch, '10, Festschr. f. R. Hertwig, 1910.

[2] Since published while the above was passing through the press.

It will be noticed that all the controls give approximately the same figure. It is probably legitimate to add them together, when we get: Total, 483: per cent. ♂ ♂, 48.0 ± 1.55.

The differences between Dr. Mrsic's control and (a) II–III and (b) V are: (a) — ♂, 6.31 per cent. ± 4.26. (b) + ♂, 18.9 per cent. ± 5.20. Between (c) his II–III and his V, + ♂, 27.0 ± 4.52. The differences (b) and (c) are significant, (a) is not; however, if the normal sex-ratio be taken as 48:52, to which it clearly approximates, the difference becomes 8.3 per cent. ± 2.34, which, being over 3.5 times the P.E., is significant.

Of my results, the difference caused by the early fertilization is obviously not significant. That caused by late fertilization is not significant, unless the normal sex-ratio be taken as 48:52 ± 0, when the difference is 6.52 per cent., which is over 3.5 times its P.E. of ± 1.83.

Thus, what Dr. Mrsic's figures indicate is that a moderate degree of delay in fertilization causes a preponderance of females, while a considerable degree causes a preponderance of males. He has definitely clinched this by careful histological examination. He finds that sex is undifferentiated to about 120–130 days. Then all individuals show some ova in their gonads; later some gonads continue this female development, but in others the germ-cells divide rapidly, the ova disappear, and the male histological arrangement results. For one short period the gonads appear undetermined and usually mixed ♂ and ♀; but differentiation soon sets in, and is much clearer than in the frog.

Development is similar in all the cultures up to and beyond this point. But in the "21 days late" culture, at about 250 days (when in all controls the gonads are large, sex is obvious even to the naked eye, and the histology of the gonads is normal) many gonads are extremely small and show various stages in the degeneration of ova and a caudo-cranial redifferentiation in a male sense. The samples which he took at intervals from this culture before this point gave an approximate equality of males and females, whereas those which he took after it showed an excess of males as did the final count at 337 days. From this and other reasons, he judges, I think rightly, that he has excluded the idea of differential mortality. He appears to have shown definitely that some gonads which were female-differentiated could no longer continue their development in this phase, but changed over to maleness.

As it appears that all 250-day fish with mixed gonads are in process of sex-transformation to males, I have included seven such as ♂ ♂ in the figures of Dr. Mrsic's culture No. V (above). If my figures have any significance, they imply that 4–7 days' delay causes a slight excess of males, whereas a similar amount of delay in his experiments led to an increase of females. If this is a real discrepancy, it may be accounted for by the fact that whereas he worked with rainbow trout, I used brown trout. Since he found no histological abnormalities in these "excess female" cultures, one presumes that simply more fish than usual enter upon the female path of development at the time of sex-differentiation, and that there is in this case no true reversal of sex later.

Other extremely interesting points which he establishes are that late fertilization leads to a progressive (a) increase in mortality, especially in early stages, (b) decrease of growth-rate, (c) increase in monstrosities and especially slight shortening of the gill-cover, (d) affecting of the males in these respects more than the females. The retention of the eggs within the body for long periods leads to their partial resorption in many cases, and he believes this interference with their cytoplasm acts unfavorably on general metabolism later.

It is interesting to note that R. Hertwig has recently found by histological examination that the excess of males in late-fertilized frogs is also due to a transformation operating during development, not to an interference with chromosome number as he at first surmised.

It seems, therefore, to be established: (1) that changes in sex-ratio, on the whole similar to those obtained by similar means in frogs, can be produced by delayed fertilization in trout; (2) that the alteration of sex-ratio is never nearly so profound as in frogs (21 days' delay is the utmost so far obtainable, and this is very bad for the female parents); (3) that in both cases there is a transformation of sex during development; (4) that the trout, in which normal sex-differentiation is less variable and uncertain than in frogs, affords excellent material for histological studies on the subject; (5) that many problems of developmental physiology could be advantageously approached in conjunction with this problem in trout.

If laboratory facilities were available at a commercial hatchery, a great deal of very important work could be readily undertaken.

Those who are interested should consult the very full paper of Dr. Mrsic. I hope myself to report shortly on the effects of delayed fertilization on eggs kept outside the body of the fish, instead of, as in these experiments, in the coelom. The expenses of my work were borne out of a grant from the Royal Society.

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