A study of the bone marrow in these animals shows an effect comparable to that of benzol. There is early destruction of the cells of the granulocyte series and in some animals an extraordinary depletion of the bone marrow. Animals which partially recovered from the initial injection and were then killed, showed active regenerative changes in the bone marrow.

There is a possibility that these effects may have been due to the chlor-benzine or nitro-benzine used as a solvent in German gas shells, and carried over in the distillate used for injection. In view of the small amount of such impurity present, this does not seem likely, but there was no opportunity to repeat the experiments with dichlorethylsulphide completely freed from this solvent.

The experiments were carried out in collaboration with Capt. Morgan B. Vance, M.C., at Hanlon Field, Chaumont, France.

54 (1429)

Developmental rate and the formation of embryonic structures.

By CHARLES R. STOCKARD.

[*From the Department of Anatomy, Cornell Medical School, New York City.*]

The eggs of different species develop at specifically characteristic rates. These rates vary for a given species within certain limits. Variation in the direction of increased rate is far more limited and more difficult to bring about experimentally than is the opposite variation towards a decreased or slower rate.

The slight acceleration of developmental rate that may be induced in early embryos does not seem to cause any marked deviation from the normal course of development, on the contrary such embryos are unusually well developed. It might be said that the ideal rate of development is probably somewhat faster than the so-called normal average usually followed. In other words, the normal conditions of development are not entirely the best possible conditions.

The limits of retardation in developmental rates are extremely wide. The rate may be slowed down to almost zero or development may actually be to all appearances stopped for long or short

periods of time in many species without noticeably injuring the embryo. Such an interruption normally occurs during the development of certain eggs as those of birds and some mammals. In eggs having a continuous development, such as those of fish, the rate of development may be slowed to apparent stoppage at many stages and held in such a condition for some time without injury to the embryo which results after the inhibiting influence has been removed. However, when the rate of development is retarded but not entirely stopped at certain critical periods and development is allowed to proceed at this diminished rate for some time, most serious structural anomalies are induced.

Double monsters of varying degrees of doubleness may actually be produced by slowing the rate at a time when the primary embryonic bud should arise. Normally the initial appearance of the primary embryonic bud probably suppresses the appearance of other buds which potentially exist, but when the primary bud is delayed in its appearance it becomes possible for more than one bud to arise, usually two. The distance apart of these two buds on the blastodisc determines the degree of doubleness of the resulting individual. Buds arising close together give two-headed monsters, while buds arising at opposite points on the periphery of the disk, 180° apart, each give rise to a complete individual, in such a case twins result.

When the two buds arise simultaneously they have equal chances in development and symmetrical double monsters result. If, however, one bud obtains the start over the other bud this start constitutes a supremacy which almost invariably makes it possible for the leading bud to develop into a perfectly normal specimen, and invariably defeats the possibility of normal development on the part of the slower bud.

An investigation of a large series of such double fish embryos lends strong support to the interpretation that the late bud is inhibited in its rate of development on account of the presence of the leading bud, just as the first bud to grow out from a notch on the leaf of *Bryophyllum* inhibits the growth of other buds as Loeb has so strikingly shown. The inhibited rate of development in the lesser component tends to suppress and interfere with the normal origin and development of certain organs, especially the

eyes and other head parts. Organs may entirely fail to arise, or develop abnormally after they do arise.

In the series of double fish when both individuals or both heads, as the case may be, are of equal size they are both normal, but whenever one component is larger than the other, the larger one is almost invariably normal and the smaller is *invariably* defective. This is not only true in the present series of specimens but also in all illustrations and descriptions of double monsters which I have been able to collect from the literature.

These embryos furnish material for an analysis of the causes of many common structural defects about which there has been considerable discussion, a consideration of this phase of the subject will be given in the complete review of the experiments.

55 (1430)

A semi-lethal in Drosophila funebris that causes an excess of males.

By **O. L. MOHR** and **A. H. STURTEVANT** (by invitation).

[*From the Zoölogical Laboratory of Columbia University, New York City.*]

In the course of the genetic work on *Drosophila melanogaster* cases have been found rather frequently in which the sex ratios showed marked deviations from the usual approximate equality. Those cases in which there is a deficiency of males have been the most frequent, and the explanation of many of these has been worked out by Rawls, Morgan, Bridges, Stark, and others. They are now known to be due to sex-linked lethal genes. Less frequently cases have been noted in which there was a deficiency of females (see Quackenbush, Science vol. 32). In none of these has the explanation hitherto been discovered.

From a culture of *Drosophila funebris* we obtained one female and 87 males. This female, mated to a few brothers, produced 60 females to 103 males. Descendants of this mating have been inbred for many generations, and have given sex ratios ranging from 0 ♀ : 76 ♂ up to approximate equality. There is no obvious