paraffin was raised until it was quite liquid, and then the cranium was removed and wiped clean. At the present the cranium has been exposed to such desiccation as would occur on my desk for quite some time, and there is absolutely no sign of shrinkage or alteration. This process would be applicable to the cartilaginous structure of any of the smaller elasmobranchian fishes, for there is an evident limit in the size of the cartilage to be impregnated; although the degree of infiltration necessary to preserve the cartilage would be below the standard required in microtechnical work. The cranium is in a condition for study far superior to cartilaginous material in liquid preservatives.

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## PERMANENT ACETO-CARMINE PREPARATIONS

THE following method has proven useful in accurately and permanently preserving the cytological details in aceto-carmine preparations. It is rapid and convenient and has been found more satisfactory for our purposes than previous techniques.[1]

The preparation is made in the usual way[2] and sealed with vaseline or preferably paraffin. When the stain is satisfactory the slide is supported face down by two thin glass rods in a petri dish of a mixture of equal parts of xylol, absolute alcohol and glacial acetic acid until the cover soaks loose. The action of the reagent is hastened by first cracking off most of the paraffin seal with a needle and also by gentle agitation of the slide.

When the cover comes off (5 minutes to ½ hour) the slide is rinsed in the solution for 5 minutes, drained carefully and wiped free from mounting medium. It is then passed through two changes of a mixture of equal parts of xylol and absolute alcohol (5 to 10 minutes each), then through xylol (10 to 15 minutes) and mounted in balsam. The xylol stage may be omitted with minute objects such as pollen-mother cells. Occasionally part of the preparation adheres to the cover slip in which case cover and slide are run up separately and recombined in balsam. Preparations in the balsam improve in clarity for a week or more. Smears of pollen-mother cells (*Lilium, Podophyllum, Hyacinthus, Tulipa*) made in this way are unaltered 10 months after preparation. The method has been used successfully on smear preparations of Dipteran salivary glands (*Drosophila, Sciara,* blowfly).

Professor C. W. Metz and Miss Elizabeth Gay find the following modification equally as good as the above for paraffin-sealed smears of *Sciara* salivary glands: Soak off the cover in equal parts of 95 per cent. alcohol, clove oil and glacial acetic acid; 2 changes of 95 per cent. alcohol up to ½ hour; absolute alcohol 5 minutes; clove oil 10 minutes; xylol 5 minutes; balsam.

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# SPECIAL ARTICLES

## THE SIMILARITY BETWEEN FASCIATIONS IN PLANTS AND TUMORS IN ANIMALS AND THEIR GENETIC BASIS

A COMMONLY recurring abnormality in plants is the irregular development of the growing points of the main stem or branches called fasciations. These peculiar formations occur in many plant families and are particularly noticeable in species having an indeterminate type of growth. In some cases fasciated plants are able to reproduce and all the progeny show the same abnormality. In these cases the teratological development is due to one or more specific genes for abnormal growth and is definitely inherited. In many other cases fasciations occur only in one part of a plant. Such variations occur so sporadically both in seed and vegetatively propagated plants that they seem not to have any basis in inheritance, yet they appear more frequently in some germinal lines than in others. Gall formations occur in plants, and many of these are clearly due to insect, fungus and bacterial parasitism. In some galls no infection can be found and these seem to be a form of unregulated growth for which no adequate explanation has been made.

The tumors in animals that assume many different forms and occur in many parts of the body are also a form of unregulated growth. This abnormal development frequently starts in traumatic tissue. In both plants and animals the injurious nature of unregulated growth comes mainly in later stages from a breaking down of cells due either to pressure or to a failure of normal metabolism, resulting in secondary infections in necrotic tissue. Plants differ from animals in that there is no migration of abnormal cells to other parts of the organism starting new centers of growth. In plants there is no circulatory system whereby this transfer could be brought about. Fasciations and galls in plants do not show the malignant features characteristic of many tumors in animals.

[1] B. McClintock, *Stain Tech.*, IV: 53, 1929; W. C. Steere, *Stain Tech.*, VI: 107, 1931.

[2] Lee, "Microtomist's Vade-Mecum," p. 142, 9th ed., 1928; J. Belling, *Am. Nat.*, 55: 573, 1921; *Biol. Bull.*, 50: 160, 1926.

Other differences in atypical growths in plants and animals arise from fundamental differences in development.

There are many transmissible lethal factors in both plants and animals that stop development at an early stage of embryonic growth when homozygous. In plants there are the numerous defective and germinating seeds that appear when naturally cross-fertilized species are self-fertilized. In some cases growth is stopped immediately after fertilization. In other cases the embryo and endosperm develop in a mass of abnormal tissue that finally breaks down and the resulting abnormal seeds fail to germinate. In many cases the embryos fail to go into their normal resting condition in mature seeds but keep on growing until they finally die with the maturity of the plant upon which they are borne. In animals there are lethal factors that result in the death of the embryo at various stages of development. In some cases the abnormal embryos survive birth resulting in monstrous forms. Not all these are due to single or multiple inherited genes, but many cases have been proved.

An individual heterozygous for these recessive genes may be normal throughout its entire life. But if anything should happen to the chromosome carrying the dominant allele, whereby the protecting gene is lost, abnormal development would be expected under certain conditions. If the change takes place in a critical place the death of the organism might result before the unregulated growth could attain a visible form. In many places unregulated growth would be held in check by surrounding tissues. But there are undoubtedly many places where there are actively dividing cells, and abnormal development starting from them could reach considerable proportions before serious injury resulted. An important point that seems to have gone unnoticed is that genes acting in restricted localities in somatic tissue may have an entirely unrecognized effect as compared to their action in embryos.

In plants unregulated growth can start only in the cambium and in growing points. In the first case the result would be gall formations and in the second, abnormal roots, stems, leaves or flowers which we see in fasciations. In animals similar growths could occur at many places where there are dividing cells. Particularly likely places would be in glands and in regenerating tissues resulting from injury.

Recent cytogenetic investigations have shown various ways in which recessive genes are allowed to appear in somatic tissue due to deletions, non-disjunction and other chromosomal aberrations. Any irregularity whereby a whole or part of one member of a chromosome pair is lost allows the latent genes in the corresponding chromosome to appear, provided there is enough subsequent growth from the deficient cell to become visible. Variable patches of colored aleurone in maize due to deficiency have been noted with a frequency of one in 30 seeds in some families and none in others. These frequencies fluctuate widely. Color variations in vegetatively propagated fruits and flowers are brought about in the same way. In many different animals mosaics of this type have been noted. These variations may be classed as somatic segregations due to *hemizygous* genes, that is, loci of which the corresponding section in the other member or members of the chromosome set is missing. In this way recessive genes become visible.

It is known also that missing segments may have a visible expression in modified characters as a direct result. Thus Notch wing in Drosophila results from a deficiency in the facet region. In this case the variation is not due indirectly to the uncovery of a recessive gene but directly to a loss of chromatin. Since somatic segregation occurs with a high frequency due to the uncovery of recessive genes resulting from a deletion in one chromosome there is the probability of a deletion in corresponding sections of two homologous chromosomes as a chance occurrence. This results in genes that are completely missing. A similar situation follows a viable deficiency in one chromosome and non-disjunction in the homologous chromosome, as shown by Demerec and by Ephrussi.[1] There is therefore the possibility that missing genes due to corresponding deficiencies in certain parts of both members of a chromosome pair result in a chromosomal unbalance and this brings about unregulated growth. Atypical growth in maize has been found associated with chromosome irregularities.

A most significant fact is found in the action of tar and aniline dyes. It has long been known that these substances induce abnormal development in animals in some cases and not in others. It has recently been found that the active principle of crude tar is dibenzanthracene. One of the noticeable effects of this substance when injected into living tissue is to bring about non-disjunction of chromosomes. Many other cancer-producing substances have a similar effect on chromosomes as well as x-rays and radium. If this induced chromosome aberration acts indirectly through the manifestation of hemizygous recessive genes or the total loss of genes necessary for normal growth or directly as a result of chromosome unbalance in particular regions we can understand why unregulated growths occur sporadically but with higher frequencies in some families than in others.

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[1] *Proc. Nat. Academy of Sciences*, 1934.