berlain[2] discusses holders and implies that the commercial ones are not desirable.

The obvious need is a method of clamping the blade rigidly and yet permitting easy adjustment of the amount of blade projecting. It is also desirable that the angle which the bevel on the razor blade makes with the paraffin block is small so that a true cutting and not a scraping action is obtained. In Fig. 1 is

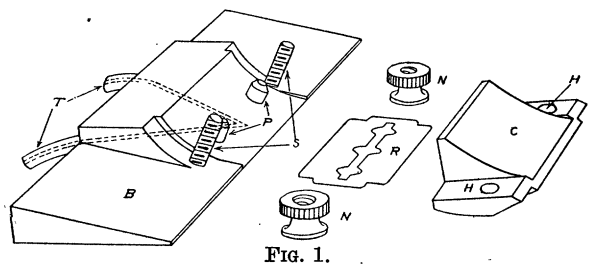

FIG. 1.

shown a blade holder which embodies these requirements.[3] The razor blade, R, fits over the pins, P, which project from a milled cylindrical surface in block B. The clamping block, C, is placed over the blade, the screws, S, passing through the holes, H, and is held down by the nuts, N. The bottom of the clamping block is a curved surface having a slightly greater radius of curvature than that in the block, B, to insure a tight clamping at the projecting edge. The pins, P, are eccentrically mounted so that by turning them the amount of blade projecting may be varied from 0.25 to 1.25 mm. The tubes, T, lead to a hole in the block lying just under the blade and are used for cooling the knife. For cutting thin sections in paraffin, cooling the knife by running cold brine through it will give a much better ribbon and less compression of the sections. The block is dimensioned to fit in the standard microtomes and is mounted so that the face toward the paraffin block is inclined 4°, which will give a clearance angle of about 8° to the cutting edge.

This holder has been in use for over a year and has proven entirely satisfactory. Using razor blades of several makes, it is possible to section whole insects, such as grasshoppers, butterfly pupae and insect eggs, when imbedded in paraffin. It is also possible to make 5 μ sections of plant material, such as insect galls, when imbedded in paraffin.

RODERICK CRAIG
CHARLES WILSON

INEXPENSIVE GREEN FILTERS

FILTERS which are quite satisfactory for the examination of tissues stained by the Feulgen method can be made by placing one or more thicknesses of green Cellophane between two large microscopic slides and binding the edges with lantern slide tape. Filters of different densities are obtained by varying the number of layers of Cellophane used.

ESTHER CARPENTER
SMITH COLLEGE

SPECIAL ARTICLES

HEREDITARY BRACHYDACTYLIA AND ASSOCIATED ABNORMALITIES IN THE RABBIT

DEFORMITIES of the hands and feet are among the oldest recognized hereditary variations in man. They have been reported in apparently unrelated families scattered throughout the world, and appear in a variety of forms ranging from minor brachydactylia to complete absence of hands and feet.

Investigations based on family histories have shown that these are dominant mutations, but the material available for study has been limited and not subject to experiment or control. The mating of individuals showing different forms of abnormality has not been recorded, and the genetic relation of this group of variations is uncertain.

Comparable variations have recently been encountered in the rabbit, and the occurrence of a series of deformities from brachydactylia to acheiropodia in a single line of animals indicates that in this instance they are expressions of a single primary mutation altered by modifying factors or of a closely linked group of genes. The appearance of the mutation in a laboratory animal naturally adapted to experimental procedures offers an approach to the study of the genetic relations of these abnormalities, and additional interest is attached to these affections because of a closely associated functional inferiority. The purpose of the present paper is to describe the variations as they occur in the rabbit and to report on the progress of genetic studies.

The first deformity of this order was discovered in the offspring of a brother-sister mating of apparently normal animals. These animals were hybrids derived from the crossing of a pure-bred English doe with a male of mixed breed for the purpose of studying the inheritance of a peculiar eye color. Both parental lines had been bred for generations, and there were instances in which matings had been made which should have disclosed the presence of the deformity in either line, but none occurred until the two lines were crossed as indicated above. Subsequently, the

[2] C. J. Chamberlain, "Methods in Plant Histology," University of Chicago Press.

[3] These holders may be obtained from J. R. Dempster, 2204 Glen Ave., Berkeley, Calif.

male was backcrossed to his mother and mated to a number of related females, and while the variation did not appear in the resulting litters, tests of representative animals derived from these matings showed that some were carriers. Unfortunately, the doe of this pair and her sire died before similar tests could be made, but in several matings with the same buck, the doe produced young showing the deformity. Three litters containing 19 normal and 6 deformed animals were obtained in this manner, but despite continued efforts, including the use of foster mothers, only one deformed animal, a female, was raised to maturity.

In typical cases of brachydactylia in the rabbit the toes of affected feet are shortened in the manner characteristic of the deformity in man, and x-ray examination shows that the shortening is due to loss or shortening of the middle phalanx. Minor deformities also occur in which shortening or loss of the terminal phalanges is the only alteration, but as a rule, the abnormality is more extensive than in typical cases of human brachydactylia. There is usually shortening of the metacarpal or metatarsal bones, and the complete absence of all bones except those of the tarsal and carpal groups is of common occurrence. Frequently, the entire foot is absent or composed only of irregular fragments of tarsal or carpal bones. These conditions are present at birth, and definite deformities have been found in embryos during the third week of pregnancy. The feet of these embryos were in a normal position and there were no adhesions or abnormal relations which would suggest intrauterine amputation.

An especially important feature of this mutation is the influence exerted upon the long bones of the leg. In all cases of marked abnormality of the feet so far observed, the bones of the corresponding leg, including proximal and distal segments, are markedly shortened and their diameters irregularly diminished as compared with those of unaffected members. This condition is also present from birth and appears to be an integral part of the variation.

Any one or any combination of the conditions described may be present in a given animal and any one or all feet may be affected. Moreover, the progeny of given parents differ as widely in these respects as the progeny of different parents, so that at present there appears to be no relation between the location or character of the deformity presented by parents and by progeny.

As mentioned above, there is evidence of a constitutional inferiority in the stock transmitting this abnormality. The deformity itself offers no serious obstacle to a normal, healthy cage life, but losses of affected and unaffected animals during the first few weeks of life have been exceptionally high. At birth they frequently show signs of retarded development or prematurity, such as deficient pigmentation and delayed growth of hair; others are obviously nonviable. Most of the females are poor mothers, and unless the young are fostered, they die shortly of starvation or exposure or are eaten by the doe. Even with good foster mothers, the animals show an increased susceptibility to ordinary disorders and only a small proportion reach maturity.

These animals also display reproductive abnormalities. Thus, the fertility of females and of heterozygous males is considerably lower than the general level of the colony, and less than 30 per cent. of matings result in pregnancy. Only two affected males have been reared to maturity. One of these, a semicryptorchid, has been mated repeatedly with does known to be fertile without a single pregnancy resulting. The other possesses normal testicles but is an extremely pugnacious animal. While numerous attempts have been made to secure matings, he has never manifested a desire to render service, but on the other hand viciously attacks the female.

So far, genetic studies have been based largely on the progeny derived from the affected female mentioned above by crossing with an unrelated male. Tests of three sons obtained in this manner have shown that all of them transmit the abnormality. Eleven females were raised from the matings of one son with unrelated does and were backcrossed to him and to the other males. Of these six proved to be transmitters and five produced only normal young in numerous litters, indicating that the male in question was heterozygous.

Matings between heterozygous males and females have given 145 normal and 48 abnormal animals, which corresponds with the expected values of 144.75 and 48.25 for a simple recessive character.

Backcross matings between affected females and heterozygous males have given a total of 50 young, of which 31 were normal and 19 abnormal. This is an approximation to the expected ratio of normal and affected individuals, and the difference is not significant.

The mutation described is apparently a simple recessive character which originated with the crossing of the two animals mentioned. One of the parental lines was adequately tested for the prior existence of the mutant genes after the character was detected and the other was sufficiently investigated by an examination of breeding records and by test of closely related members of the line to render the previous existence of the mutation highly improbable. The mutant character is of especial interest because of its close resemblance to well-known human affections with the

implication of a genetic relation in the series of abnormalities affecting the hands and feet and the definite extension of the developmental disturbance well beyond the site of obvious deformity. The connection between the anatomical abnormalities and the functional disorders in these animals is uncertain. Further studies may clarify these several relationships.

HARRY S. N. GREENE

THE ROCKEFELLER INSTITUTE
FOR MEDICAL RESEARCH
NEW YORK, N. Y.

THE REDUCING POWERS OF PHYSIOLOGICALLY IMPORTANT CARBOHYDRATES

IN view of the increasing attention paid to the rôle of the physiologically important sugars in body economy, it seemed worth while to determine the relative and actual reducing values of these sugars, using the newer techniques devised for the determination of glucose.

The sugar methods employed were: Folin's modification of the Folin-Wu method[1]; Somogyi's modification of the Shaffer-Hartmann technique[2]; the revised Folin-Malmros micro-sugar method[3]; the Hagedorn-Jensen ferricyanide method[4]; and the new copper-iodometric method (reagents) of Shaffer and Somogyi.[5]

In this paper are presented a comparison of the reducing values of d-glucose, l-arabinose, d-fructose, d-galactose, lactose (hydrate) and maltose (hydrate).

The sugars employed were all of the highest purchasable purity (Pfanstiehl brand). All the sugar samples were dried in a vacuum desiccator to constant weight and the purity checked by means of the polariscope. All pipettes, sugar tubes and boiling tubes were calibrated. Stock sugar solutions were made by accurately weighing out 75 milligrams of sugar and diluting in retested 50 milliliter volumetric flasks with one-half saturated benzoic acid as a preservative. From these 0.15 per cent. solutions the proper dilutions for the techniques were made.

The determinations were carried out for each method exactly as described for glucose, the glucose reference standard being made up to contain the same weight of material as the solutions of the other sugars.

Since the sugar methods employed were designed primarily for the determination of glucose, the reducing powers of the other sugars are expressed in terms of this carbohydrate as unity.

In Table I is presented a comparison of the relative reducing values of equal weights of the carbohydrates studied, while in Table II are given the results on the basis of equimolecular solutions, as calculated from Table I.

TABLE I

A COMPARISON, TO GLUCOSE AS 1, OF THE RELATIVE REDUCING POWERS OF EQUAL WEIGHTS OF THE CARBOHYDRATES

	Method	Glucose	Arabinose	Fructose	Galactose	Lactose*	Maltose*
Weinbach and Calvin	New Folin-Wu	1	0.65	1.05	0.75	0.41	0.40
	Somogyi-Shaffer-Hartmann	1	0.80	1.03	0.70	0.40	0.38
	Folin-Malmros	1	0.96	0.98	0.82	0.47	0.39
	Hagedorn-Jensen	1	0.87	1.02	0.74	0.67	0.75
	Shaffer-Somogyi, Reagent 50, 1 gm KI	1	0.85	0.96	0.75	0.46	0.34
	Shaffer-Somogyi, Reagent 50, 5 gm KI	1	0.87	1.00	0.76	0.46	0.35

* One molecule water of hydration.

TABLE II

A COMPARISON, TO GLUCOSE AS 1, OF THE RELATIVE REDUCING POWERS OF EQUIMOLECULAR CARBOHYDRATE SOLUTIONS (AS CALCULATED)

	Method	Glucose	Arabinose	Fructose	Galactose	Lactose*	Maltose*
Weinbach and Calvin	New Folin-Wu	1	0.54	1.05	0.75	0.82	0.80
	Somogyi-Shaffer-Hartmann	1	0.67	1.03	0.70	0.80	0.76
	Folin-Malmros	1	0.80	0.98	0.82	0.94	0.78
	Hagedorn-Jensen	1	0.73	1.02	0.74	1.34	1.50
	Shaffer-Somogyi, Reagent 50, 1 gm KI	1	0.71	0.96	0.75	0.92	0.68
	Shaffer-Somogyi, Reagent 50, 5 gm KI	1	0.73	1.00	0.76	0.92	0.70

* One molecule water of hydration.

The order of reducing power in general, for all

[1] O. Folin, *Jour. Biol. Chem.*, 82: 83, 1929.
[2] M. Somogyi, *Jour. Biol. Chem.*, 86: 655, 1930; 70: 599, 1926.
[3] O. Folin and H. Malmros, *Jour. Biol. Chem.*, 83: 115, 1929.
[4] H. C. Hagedorn and B. N. Jensen, *Biochem. Zeitschr.*, 135: 46, 1923.
[5] P. A. Shaffer and M. Somogyi, *Jour. Biol. Chem.*, 100: 695, 1933.