SPECIAL ARTICLES

STRAINS OF THE DOG HOOKWORM, ANCYLOSTOMA CANINUM, SPECIFIC TO THE DOG AND TO THE CAT

IN another paper[1] experiments are described which demonstrated two strains of the dog hookworm morphologically identical but differing in their host specificity. One, originally recovered from a Baltimore dog, was highly specific to that species of host in that an average of 50 per cent. of the larvae matured in puppies while less than 1 per cent. matured in kittens. On the other hand a strain from a cat from Long Island was specific to the cat in that an average of 45 per cent. developed in kittens while less than 5 per cent. matured in puppies. On the basis of these findings and certain facts of distribution it was suggested that in a locality where this hookworm is common in cats a special strain specific to cats probably existed. It is now possible to present more definite evidence to substantiate this postulate.

A number of stray dogs from the streets of Baltimore which have come into the laboratory harbored the dog hookworm, *Ancylostoma caninum* Erc. 1859. Cultures were made from the stools of these dogs by stirring them into granulated charcoal, and the freshly isolated larvae used for infection experiments. The larvae were administered by mouth in double gelatin capsules following the technique described previously.[2] With the aid of Dr. N. R. Stoll similar cultures were obtained from the feces of cats in the vicinity of Princeton, N. J. Larvae from these were used for similar experiments as shown in the accompanying table.

All of the experimental animals used were young enough to be highly susceptible to the standard strains mentioned above. The average condition as shown in the table comes surprisingly close to the values for the standard strains when the length of the series and the variation is considered. It is evident that the strains harbored by these dogs in Baltimore are adapted to the dog and not to the cat. On the other hand the strains received from Princeton cats seem to be adapted to cats but not to dogs. Dr. Stoll has found eight of thirteen cats examined to be infected with these hookworms. As mentioned in a previous paper (*loc. cit.*) cats in Baltimore have never been found to harbor this species, but it was found in about 20 per cent. of more than a hundred stray dogs received.

Larvae from	Given to	Days infection to autopsy	Number larvae given	Number adults recovered	Per cent. developed
Dog 337	Dog 338	14	228	53	23.0
	Cat 349	20	316	3	1.0
Dog 340	Dog 357	24	700	314	45.0
	Cat 354	25	234	0	0.0
	Cat 357	28	880	0	0.0
Dog 341	Dog 345	23	460	199	43.0
	Cat 356	28	1,170	16	1.0
Dog 354	Dog 355	11	3,000	1,458	49.0
	Cat 375	14	600	0	0.0
Cat P1	Cat 323	40	287	215	75.0
Cat P2	Dog 350	21	724	2	0.3
	Cat 360	21	703	208	30.0
Cat P3	Dog 358	13	1,200	0	0.0
Average dog strains in puppies				40.0	per cent.
" " " " kittens				0.4	per cent.
Average cat strains in puppies				0.15	per cent.
" " " " kittens				52.0	per cent.

The following conclusions arise from experiments to determine the infectivity of larvae of various strains of the dog hookworm, *Ancylostoma caninum*. The dogs in Baltimore streets appear to carry strains to which puppies are susceptible but kittens are not, as indicated by infection experiments. Cats from the vicinity of Princeton, N. J., appear to carry strains to which kittens are susceptible but puppies are not.

J. ALLEN SCOTT
THE JOHNS HOPKINS SCHOOL OF HYGIENE

HETERO-FERTILIZATION IN MAIZE

THERE is abundant evidence that the endosperm and the embryo of the maize kernel regularly are genetically identical. Were they not, there would be no reason for selecting on the basis of endosperm characters among the individual kernels in genetic or breeding experiments. In connection with the writer's investigations on the inheritance of scutellum color, however, considerable data have been obtained which show that this usual condition is not universal.[1]

"Colored Scutellum" already has been described as a heritable character of maize (Sprague).[2] The development of scutellum color is dependent upon several factors, the interaction of which will be described later. Before purple or red color can

[1] J. A. Scott, 1929, "Experimental Demonstration of a Strain of the Dog Hookworm, *Ancylostoma caninum*, Especially Adapted to the Cat," *Jour. Par.*, in press.

[2] J. A. Scott, 1928, "An Experimental Study of the Development of *Ancylostoma caninum* in Normal and Abnormal Hosts," *Amer. Jour. Hyg.*, 8: 158.

[1] These investigations were conducted in the department of plant breeding, Cornell University, and at the North Platte Substation, North Platte, Neb.

[2] G. F. Sprague, *Jour. of Heredity*, 18: 41–44, 1927.

develop in the scutellum, the fundamental aleurone factors *A, C, R,* and *i* must be present. The *Pr pr* factor pair which differentiates purple and red aleurone has a similar effect on scutellum color. The scutellum is, of course, a product of the fusion of one sperm and the egg, whereas the aleurone (endosperm) results from the fusion of the second sperm with the polar nuclei.

Ordinarily, kernels with white aleurone have no scutellum color and, when their progeny are selfed, produce either white aleurone kernels or kernels segregating for aleurone color in ratios characteristic of the action of an inhibitory factor. Many aberrant kernels which possessed white aleurone and colored scutellums have been found and tested for breeding behavior. In spite of the colorless aleurone of the parent kernels, the progeny segregated for aleurone color in ratios characteristic of those generally obtained only from hybrid kernels with colored aleurone. This points clearly to a difference in genotype between endosperm (aleurone) and embryo (scutellum).

The term hetero-fertilization has been applied by the writer to the process resulting in those exceptional cases in which the endosperm and embryo differ genetically. These may occur because (a) the egg and polar nuclei are of different genetic constitution and fuse with identical sperms or, conversely, (b) the egg and polar nuclei have the same genotype but fuse with sperms having unlike genotypes during syngamy. Either of these phenomena would give rise to hetero-fertilized kernels.

It is obvious that hetero-fertilized kernels may be produced and escape detection because of phenotypical identity with their normal sibs. Hetero-fertilized kernels of this kind undoubtedly occur unnoticed in much maize material. For the ready identification of hetero-fertilized kernels, the embryo and endosperm must be of different phenotypes. The relation of aleurone and scutellum factors provides an ideal combination for detecting hetero-fertilization. The ease of identifying a particular kind of hetero-fertilized kernel, namely, those having a colorless aleurone and colored scutellum, has been taken advantage of in studying this phenomenon genetically. There is some evidence that hetero-fertilization may occur only in the presence of a certain gene or complex of genes. Some strains show no hetero-fertilization among several thousand kernels, whereas other strains show as many as 10 per cent. of hetero-fertilized kernels, and individual ears have shown much higher percentages of this anomaly.

It is conceivable that hetero-fertilization may be brought about in various ways. Dispermy, non-disjunction of one or more chromosome pairs when the generative nucleus divides to form the sperms, the persistence and functioning of the four megaspores, or mutation of one of the aleurone or scutellum factors might result in hetero-fertilized kernels. The genetic tests applied have failed so far to distinguish with certainty between the possible causes of hetero-fertilization. The occurrence of the phenomenon, however, is abundantly proved.

GEORGE F. SPRAGUE
BUREAU OF PLANT INDUSTRY,
U. S. DEPARTMENT OF AGRICULTURE

THE NATIONAL ACADEMY OF SCIENCES. II

Production of X-rays according to wave mechanics: A. SOMMERFELD (by invitation). Twenty years ago the author published a paper on the production of X-rays, especially on the angular distribution of X-rays, produced by high speed cathode rays. This work was done entirely on the basis of classical electrodynamics. New experiments taken with very thin anti-cathode by Kulenkampff and D. L. Webster make it desirable to treat the same question from the standpoint of wave mechanics. The general radiation emitted by the cathode particles in the process of stopping is computed from the matrix element of the coordinates. The initial and final state of cathode particles are treated as plane electronic waves. The forward shift of the maximum of the emitted intensity is calculated from a factor depending on the arithmetical mean of the initial and final velocity of the electron. The use of parabolic coordinates is proved to be convenient for expressing the distribution of the incident as well as the emergent electronic wave.

New studies of X-ray spectra from ruled gratings: J. A. BEARDEN and C. E. HOWE (introduced by Arthur H. Compton). One of us (J. A. B.) has been making precision measurements of the X-ray spectrum lines from copper (K series), trying to establish a more reliable standard of X-ray wave-lengths than that resulting from crystal measurements. A glass grating of 600 lines per millimeter and a glass and a speculum metal grating, each with 50 lines per millimeter, were kindly ruled for this work by Professor Michelson. Every one of the thirty-one plates obtained from these three gratings gave wave-lengths greater than those calculated from crystal diffraction data. The weighted mean value of the wave-length for the Kα line of copper is 1.5439 $\pm$ .0002 A, and for the Kβ line, 1.3940 $\pm$ .0002 A. These values are .35 per cent. higher than the wave-lengths of these lines given by Siegbahn from crystal measurements. Using these wave-lengths, the grating space of calcite is calculated to be 3.039 A, Avogadro's number as 5.999×10^{23} per gram molecule, and the electronic charge as $e = 4.825 \pm .005 \times 10^{-10}$ e.s.u. The last result differs so greatly from the usually accepted value, $4.774 \pm .005 \times 10^{-10}$ e.s.u. as to suggest a hidden error. The other one of us (C. E. H.) has been studying the spectra of very soft X-rays, especially the L series, whose wave-lengths lie between 10 and