of them continued to enlarge slowly, but became a benign papilloma histologically, while the other 3 disappeared. The biggest to disappear was 2.3 cm. across and had extended through the ear when about one-tenth of it was taken for steeping. The bits steeped in Tyrode yielded no growth, whereas those exposed to virus gave rise to the large, malignant tumor just mentioned.

It is common knowledge that extraneous viruses[5] can flourish in tumors. Some induce no evident change, while others cause necrosis or the formation of inclusion bodies. The papilloma virus causes no inclusions, but it stimulates tar tumors to active growth, brings about morphological alterations in many of them, frequently acts as the determining factor in their survival, and makes some take on forthwith the character of carcinomas.

9628

Nutritional Myopathy of the Gizzard in Turkeys.

ERWIN JUNGHERR AND ALWIN M. PAPPENHEIMER.

From the Department of Animal Diseases, Storrs Agricultural Experiment Station, Storrs, Connecticut, and the Department of Pathology, College of Physicians and Surgeons, Columbia University, New York City.

This communication illustrates the fact that different species of animals may react in quite diverse fashion to the same abnormal diet. When growing chicks are given a simplified diet, lacking a still unidentified factor present in certain vegetable oils (Diet 108) extensive malacic lesions of the brain are produced.[1-4] The same diet fed to ducklings does not affect the brain, but leads to widespread degeneration of the skeletal muscles.[5] Pigeons appear to be refractory. We have recently found that the same diet given to turkey poults produces selective necrosis of the smooth muscle of the gizzard wall, unaccompanied by significant lesions in other or-

[5] Levaditi, C., and Nicolau, S., *Compt. rend. Soc. de Biol.*, 1922, **87**, 498; *Ann. Inst. Pasteur*, 1923, **37**, 443; Rivers, T. M., and Pearce, L., *J. Exp. Med.*, 1925, **42**, 523; Berry, G., and Syverton, G. P., *J. Bact.*, 1936, **32**, 356; Levaditi, C., and Haber, P., *Compt. rend. Acad. d. Sc.*, 1936, **202**, 2018.

[1] Pappenheimer, A. M., and Goettsch, M., *J. Exp. Med.*, 1931, **53**, 11.

[2] Pappenheimer, A. M., and Goettsch, M., *J. Exp. Med.*, 1931, **54**, 399.

[3] Pappenheimer, A. M., and Goettsch, M., PROC. SOC. EXP. BIOL. AND MED., 1934, **31**, 177.

[4] Goettsch, M., and Pappenheimer, A. M., *J. B. C.*, 1936, **114**, 673.

[5] Pappenheimer, A. M., and Goettsch, M., *J. Exp. Med.*, 1934, **57**, 35.

gans or tissues. In this preliminary report, these alterations are described in detail. Further experiments are planned in the hope of obtaining more definite information as to the nutritional factors concerned.

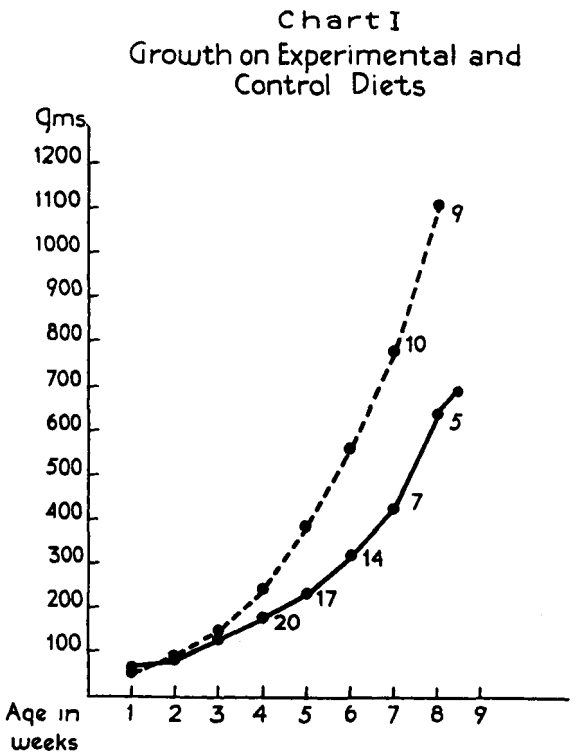
Thirty-one day-old Bronze and White Holland turkeys were kept in batteries for 6 days on a commercial turkey starter. They were then divided into two lots. Lot 1, (20 poults) was given Diet 108.* Lot 2 (10 poults) was maintained throughout the experiment on the original starting mash, and served as controls. On the experimental diet, the majority of the poults developed severe perosis within 18 days† whereas the controls remained free from this deformity. The growth rate of the experimental birds was inferior to that of the controls, but for the most part the turkeys were in good flesh, though of somewhat smaller size (Chart 1).

Most of the birds showed no definite signs of disease apart from the leg deformity and retardation of growth. Three, however, became weak and prostrated and acquired coarse tremors of the head—symptoms which could not be attributed to the perosis. At autopsy, the only significant lesion was found in the gizzard wall. The corneous lining was intact on gross and microscopic examination. There was nothing abnormal in the external conformation or tonus of the organ, but one could observe irregular greyish patches through the transparent serous covering. These were very conspicuous on section of the gizzard, appearing as rather circumscribed grey areas of firmer texture than the normal muscle (Fig. 1). Some of the patches had a pearly greyish luster, suggesting scar tissue. Others were more opaque. The lesions were not always sharply demarcated and conspicuous, but sometimes merged gradually into the healthy muscle, and were detectable only on close examination. The histological changes were in essence, hyaline necrosis of the smooth muscle fibers, with secondary inflammatory reaction, and later disappearance of fibers and replacement fibrosis. Individual fibers were swollen, lumpy and fragmented, staining more deeply with eosin than the normal elements (Fig. 2). The nuclei, instead of

*Diet 108

Skimmed milk powder	15.0	Salt mixture (McCollum and Simmonds)	6.5
Casein, commercial	20.5		
Corn starch	20.0	Paper pulp	10.0
Lard	21.0	Cod liver oil (Meade Johnson)	2.0
Yeast (Bakers')	5.0		

† The severe perosis was probably due to the deficiency of Diet 108 in manganese (Wilgus, H. S., Norris, L. C., and Heuser, G. S., *J. Nutr.*, 1937, **14**, 155). Analysis showed merely a trace of manganese present.



being pale and vesicular, became shrunken and pycnotic, later undergoing karryorrhexis, and eventually disappearing completely throughout the necrotic areas. In Masson trichrome preparations, the necrotic fibers could be sharply mapped out by virtue of their mauve color, which contrasted with the orange-red staining of the healthy fibers.

An acute inflammatory reaction was noted in and about many, but not all of the necrotic areas. The inflammatory cells consisted predominantly of pseudo-eosinophiles, with a varying proportion of large mononuclear cells. These were scattered amongst the necrotic fibers, and tended to accumulate also in the intermuscular septa and perivascular connective tissue (Fig. 3).

With the development of the lesions, the degenerated fibers gradually disappeared, and the supporting stroma of collagen and reticular fibers became condensed into scar-like tissue (Fig. 4).

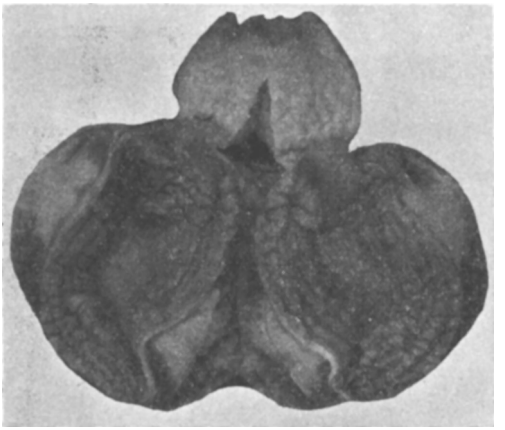


FIG. 1.
Gizzard, showing large patches of necrosis and fibrosis in muscle. The mucosa is intact.

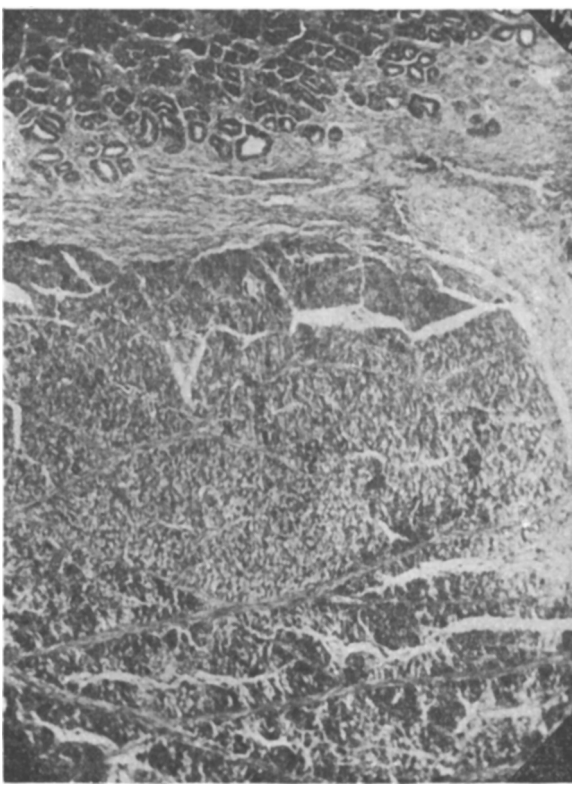


FIG. 2.
Section through lower portion of mucosa and portion of muscularis. The necrotic areas are more deeply stained. (Masson trichrome stain. × 110.)

FIG. 3.
Necrosis of smooth muscle fibers. Inflammatory reaction, with pseudoeosinophile and mononuclear leucocytes. (H.E. × 1050.)

No changes were found in the blood vessels, and the ganglion cells and larger nerve trunks of the gizzard appeared normal with the non-specific staining methods used. Further study will be made of the neurites and nerve endings.

Apart from these lesions of the ventriculus, no constant or significant alterations were noted. The smooth muscle of the proventriculus, and of the intestine, of the aorta, and of the bronchi was not affected. The heart muscle also was unaltered, and the skeletal muscle showed no changes save occasional necrosis of individual fibers—possibly attributable to trauma associated with hock disease. The central nervous system, in contrast to the reaction in the brain of chicks maintained on this diet, showed no alterations. Focal necrosis of the pancreas was seen in one bird and of the liver in another. These were the only visceral lesions found in this series—

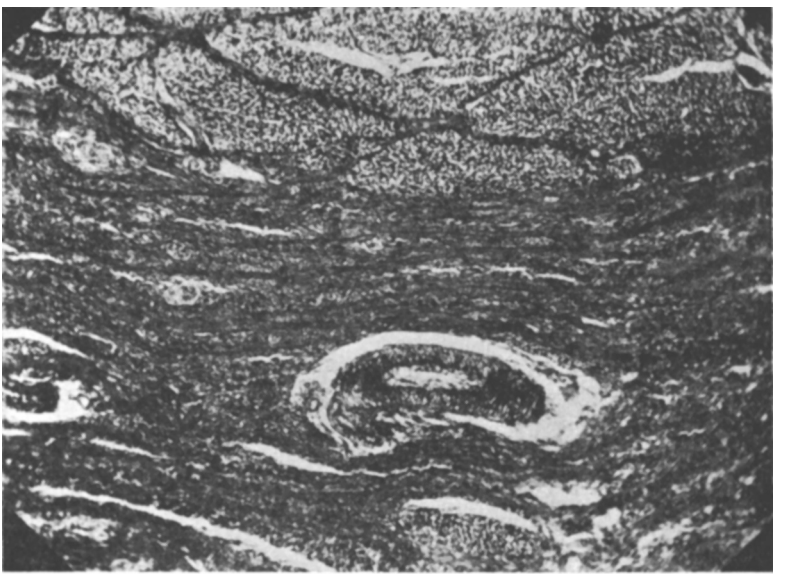


FIG. 4.
Large area of collapse fibrosis in gizzard wall. (Masson trichrome stain. × 110.)

except those described in the gizzard, and they were regarded as incidental.

Gross lesions like those described have never been observed in over 150 routine autopsies of turkeys. Three carefully studied controls on the commercial mash, showed no comparable gross or histological lesions in the gizzard, and the other viscera were normal. The other controls showed no evidence of illness, and are still under observation. Cultures were made from heart-blood and liver from 6 cases on liver infusion agar, and meat extract agar. No pathogenic organisms were recovered. No bacteria were seen in the stained sections.

An analysis of the data given in Table I shows that gross lesions of the gizzard wall were present in 11 of 14 turkeys which survived for 30 days or longer upon the experimental diet, and 2 additional positive cases were detected on microscopic examination. The incidence was thus almost 93%.

We have found in the literature no reference to similar lesions of the gizzard. Inflammatory foci of the gizzard wall which grossly resemble those here described, do occur in pullorum disease of chicks,[6] the predominant cell type being mononuclear. In a case

[6] Van Heelsbergen, T., *Hdbch. d. Geflügelkrankheiten, etc.*, F. Enke, Stuttgart, 1929, p. 116.

TABLE I.

No.	Days on Diet 108	Final Weight	Gizzard Lesions			
				Microscopic		
			Gross	Necrosis	Inflammation	Fibrosis
1	K 30	308+	+++	++	+	—
2	K 39	304	++++	++	+	—
3	D 33	420+	+	++	+++	—
4	D 18		Found dead and decomposed—no tissues			
5	K 50	528	—	+	—	—
6	K 21	190	Not examined			
7	K 50	571	±	+	—	+
8	K 33	268+	Not examined			
9	K 37	352+	+++	+++	+	+++
10	K 50	961	+	++	—	+
11	K 50	660	+++	+	+++	—
12	K 50	658	++	+	—	+++
13	K 39	330	++	+	—	+++
14	K 36	183+	+++	+++	+	—
15	D 24	239	Not examined			
16	K 23	190+	,,	,,		
17	K 37	272+	+++	+	+	—
18	K 32	305	±	—	—	—
19	K 36	275	+	+	—	+
20	D 18	108	Not examined			

recently seen bacilli were easily demonstrated in the lesions.

Under the title of lymphoblastoma, Adamstone[7] has recently described lesions of the gizzard, liver and other organs observed in chicks reared on a diet in which vitamin E was destroyed by ferric chloride treatment. It is not possible to decide from the photographs or description whether these lesions resemble those found in our turkeys. Chicks on Diet 108, which is lacking in vitamin E, have not, in our experience, shown similar lesions of the gizzard wall, although erosions of the corneous lining are frequently seen. It would seem then, that we are dealing with a previously unrecognized nutritional disorder of turkeys characterized by a specific lesion of the gizzard muscle.

[7] Adamstone, F. B., *Am. J. Cancer*, 1936, **28**, 540.