CLXXVII. A NOTE ON THE EFFECTS ON PIGEONS OF AN EXCLUSIVE DIET OF RICE MEAL, BRAN AND POLISH.

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MOORE [1914] has described a condition in swine closely resembling beriberi, which, however, ensued from diets consisting largely of the outer coats of rice known as rice meal¹. This product is, of course, rich in its content of anti-beriberi vitamin. This led the writer to test the effects on pigeons of exclusive diets of the several commercial by-products of rice milling. The products tested were rice bran, a coarse material consisting largely of the outer bran coats, rice meal, which is the material next removed from the grain in the milling process and rice polish, a fine relatively light coloured product containing a large percentage of starch as well as the last portions of the bran coats. A mixture of the products was also made in the proportion of 14 of bran to 10 of meal to 3 of polish, which is approximately the proportions in which the three products are obtained from the grain.

Exp. 1. It was desired first to prove the presence of adequate amounts of anti-beriberi vitamin in each of the several products mentioned above. Accordingly, four groups of four pigeons each were fed on polished rice *ad lib.*². In addition each bird in one group was fed daily by hand 3 g. of rice polish; in another 3 g. of the meal; in the third the same quantity of bran, and in the fourth an equal amount of the mixture of the four products. The birds were weighed twice a week. All maintained their initial weights or made slight gains and continued to show a healthy and vigorous condition at the end of 60 days when the experiment was discontinued.

Exp. 2. A group of four pigeons was fed *ad lib.* on an exclusive diet of rice bran in the form of a stiff mash which was freshly prepared each day. No. 471 died after 32 days, having lost 49 % in weight; No. 472, at the end of 22 days with a loss of 42 % and No. 473 on the 22nd day having lost 41 %. The symptoms in these birds were not very characteristic, consisting of loss of appetite, a mild diarrhoea and steady decline in strength and weight. On examination of the sciatic nerves after staining by the Marchi method, a distinct fatty degeneration was readily detected in the fibres of all. No. 470

¹ Mr Moore in a private communication has verified this interpretation of the term rice meal and kindly submitted a small sample for inspection.

² Water was furnished from the Washington City water supply in all the feeding experiments described in this paper.

in the course of 40 days lost 26 % in weight, after which its weight remained stationary for an additional 80 days. At the end of this time the bird was killed, having exhibited no characteristic symptoms of disease. On examination, the fibres of the sciatic nerve were found to be extensively degenerated.

Exp. 3. An experiment precisely similar to the above was conducted, using rice meal instead of bran. All four birds lived for 120 days and, except for two instances of temporary decline, maintained their initial weights. At the end of this time, they were killed. The sciatic nerve fibres in all these birds appeared normal.

Exp. 4. Rice polish was fed under the same conditions to four pigeons. All four birds declined slightly during the second or third week but later recovered the loss in large part and lived throughout the 120 days of the experiment. No. 477 remained stationary at about 85 % of its initial weight throughout the latter half of the feeding period, but the remainder maintained approximately their initial weights and all were free from serious outward symptoms of disease. The fibres of the sciatic nerves of birds 475 and 476 showed no lesions, but those of 477 and 478 were found to be moderately degenerated.

Exp. 5. A mixture of 14 parts of bran, 10 of meal and 3 of polish was fed to four birds under similar conditions. No. 467 slowly declined to 64 % of its original weight and on the 65th day was found in a condition of complete paralysis, with severe neck retraction precisely similar in appearance to the condition of polyneuritis induced by feeding exclusively on white rice. Death followed on the same day. No. 468 declined to 76 % of its initial weight but lived for 120 days at this lower level without other evidence of disease. Nos. 466 and 469 retained weight and strength throughout the feeding period. After 120 days the birds remaining were killed as in the previous experiment. The sciatic nerve fibres of No. 467 were slightly degenerated but those of the remainder betrayed nothing abnormal.

Exp. 6. Six pigeons were fed in the same manner on another sample of commercial rice polish which, however, was identical with the first in appearance. These birds all declined fairly rapidly, losing from 30 to 40 % in weight. Nos. 328 and 329 died in 23 days; No. 330 in 10 days; No. 331 in 36 days; No. 332 in 13 days, and No. 333 in 15 days. No. 328 showed a slight ataxia and 333 a moderate neck retraction on the day previous to death. Degeneration of the sciatic nerve fibres was fairly pronounced in 328; slight in the remainder, being especially slight in 333.

It seems evident from the above experiments that rice mill by-products are distinctly harmful to pigeons when fed as the exclusive diet. Apparently there is a great variation in the harmfulness of different samples, an observation which is in entire accord with that of Moore as to the effects of rice meal on swine. It also seems likely that pigeons are more resistant than swine to the harmful factor, although there appear to be extremely wide individual variations in pigeons in this respect.

McCollum, Simmonds and Pitz [1916] have recorded evidence of the presence of a toxic substance in wheat germ and Hart *et al.* [1916] have noted a nervous disorder resembling beriberi in swine, ensuing from a diet rich in wheat products. Rommel and Vedder have also called attention to the marked resemblance between so-called cotton-seed poisoning in swine and human beriberi. That the condition resulting from excessive feeding of cotton-seed is in reality due to poisoning seems to rest on excellent evidence. Taking all these facts into consideration, the most plausible hypothesis by which to account for the harmful effects of large amounts of rice offal on pigeons and swine is that there is present in the outer coats of rice a variable quantity of a more or less distinctly toxic substance. This hypothesis should be tested by further experiment.

These considerations are of especial interest in the suggestions they offer regarding the nature of the "deficiency diseases." How does it happen that what appears to be essentially the same type of nerve lesions is found in beriberi, pellagra and in a mild form in scurvy [McCollum, Simmonds and Pitz, 1916] as well as in animals fed largely on wheat germ, cotton-seed meal or rice offal? Not only are these nerve lesions found in dietary disorders but they have been reliably reported as resulting from oxalic acid [Mauer, 1907], alcoholic and arsenical poisoning [Ross, 1900, 1902].

The writer believes that these facts constitute evidence sufficient to demand consideration that in the "deficiency diseases" there exist toxæmias consequent or incident to dietary disturbances which may play no small rôle in determining the pathology and symptomatology of these diseases. This does not necessarily imply that the foods productive of these diseases are toxic in the ordinary sense. Nor is the opposing argument, that in the case of beriberi the hypothetical toxæmia is corrected by addition to rather than by a subtraction from the diet, necessarily contrary to the view suggested. Hart *et al.* [1916] have shown that effects of the toxic element in wheat which are serious when the diet is otherwise poor disappear almost completely when other dietary defects are corrected.

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