fact is that pitch levels for indifference, contempt and grief are in the neighborhood of C_2, while those for anger and fear are approximately one octave higher at C_3.

Indifference employs the narrowest total pitch range, about an octave, with grief using a range of one and one half octaves, and contempt, anger and fear approximately two octaves. The distribution of pitches used within these ranges is observed from the graphs of the effective readings in Fig. 1 to approximate a normal distribution.

The mean extent of inflections (*i.e.,* frequency modulations either upward or downward) is seen to vary from one third to approximately one half an octave in extent. Grief employs the narrowest inflectional range and anger the widest, with the other emotions falling within the interval which separates these extremes.

An additional means of distinction between emotions is afforded by a measure of the rapidity with which pitch changes per unit of time during inflections. An expression of the rate of this change is given in tones per second by dividing the pitch range in tones of a given inflection by its duration in seconds. As with inflectional range, anger and grief are the extremes, with anger using the fastest rate of pitch change and grief the slowest, the difference being ten tones per second. The speed of pitch change for contempt and indifference is slightly more rapid than for grief, while fear exceeds this value by approximately two tones per second.

Fig. 1 presents distributions of the pitches used by typical effective and ineffective actors. It is interesting to note that the ineffective actor deviates markedly from the effective performer in all but indifference, in which both were judged as being highly effective. Examination of the figure shows that pitch levels for the poor readings are not defined as clearly as those for the better readings. The median pitch levels in anger and fear are almost identical, as are those in grief and indifference, while contempt, contrary to the effective as well as average measures, employs a pitch level which is considerably lower than other attempts by this actor. The latter's simulation of contempt uses also an extremely narrow pitch range of less than one octave, and the extremely wide ranges of his fear and grief are due to the presence of a few very low pitches. The above deviations represent the typical differences between effective and ineffective portrayals. It is probable that the ineffectiveness is the result, to some degree at least, of these extreme deviations from the average and effective simulations.

One striking result regarding pitch in emotional speech was obtained by computation of the total pitch range employed by each actor in portraying all five emotions. It was found that five of the six actors used a total pitch range of over three octaves.

From the above data it is possible to characterize each emotion comparatively on the basis of pitch usage alone, as follows:

(1) Contempt. (a) Low median pitch level (124.3 c.p.s.), but (b) wide total pitch range (10.5 tones).

(2) Anger. (a) High median pitch level (228.8 c.p.s.), (b) wide total pitch range (10.3 tones), (c) widest mean inflectional range (2.6 tones), (d) most rapid pitch change (25.6 tones per second).

(3) Fear. (a) Highest median pitch level (254.4 c.p.s.), (b) widest total pitch range (11.2 tones).

(4) Grief. (a) Low median pitch level (135.9 c.p.s.), (b) narrow total pitch range (9.0 tones), (c) narrowest mean inflectional range (1.7 tones), (d) slowest pitch change (15.6 tones per second).

(5) Indifference. (a) Lowest median pitch level (108.3 c.p.s.), (b) narrowest total pitch range (7.8 tones).

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PHOSPHORUS METABOLISM OF CHICKS AFFLICTED WITH PEROSIS

PEROSIS (slipped tendon) in chicks was first described by Hunter and Funk.[1] It has been studied by a number of investigators, and recently Wilgus, Norris and Heuser[2] have shown that the affliction can be corrected by raising the level of manganese in the ration. This observation has been confirmed by a number of investigators.[3]

The disorder is characterized by a bowing of the legs in the tibia—metatarsal joint, enlargement with a tendency toward flattening of the joint and finally slipping of the Achilles tendon from its normal position. Perosis has been produced by the feeding of high levels of calcium phosphate—3 to 5 per cent. of the ration. Our ration[4] for producing this condition is given in Table 1.

The addition of 50 mg of manganese as $MnSO_4 \cdot 4H_2O$ per kilo of the above rations protects the chicks from perosis. Injection of 1, 3, 10 or 50 mg of manganese per week, in two equal doses, also protects on ration 604. No data involving injection are as yet available with ration 610. Rice bran fed at the level of 15 or 20 per cent. protected on ration 604. Auto-

[1] J. E. Hunter and E. M. Funk. *Proceedings* of the 22nd annual meeting of the Poultry Science Association, Macdonald College, Quebec, p. 45, 1930.

[2] H. S. Wilgus, Jr., L. C. Norris and G. F. Heuser. SCIENCE, 84: 252, 1936; *Jour. Nutrition,* 14: 155, 1937.

[3] V. G. Heller and R. Penquite, *Poultry Science,* 16: 243, 1937. M. Lyons, W. M. Insko, Jr., and J. H. Martin, *Poultry Science,* 17: 12, 1937. M. Lyons and W. M. Insko, Jr., *Ky. Agr. Exp. Station Bull.,* 371, 1937. P. J. Schaible, S. L. Bandemer and J. A. Davidson, *Poultry Science,* 16: 367, 1937.

[4] L. E. Clifcorn, C. A. Elvehjem and E. B. Hart, *Poultry Science,* 17: 28, 1938.

TABLE 1

	Ration 604	Ration 610
(Dried beef kidney 15)		
(Dextrin .... 48)	71	69
Crude casein	14	14
Brewer's yeast	2	2
Salts I	5	5
$Ca_3(PO_4)_2$	3	5
Alcoholic extract rice bran	5	5
Percomorph oil—3 drops twice weekly		

claved rice bran failed to protect. The ash of rice bran or the manganese equivalent to that of 15 or 20 per cent. of rice bran also failed to protect when fed with ration 604.

These observations led to an investigation of the phosphorus distribution in the blood of normal and perosis birds as well as the phosphatase content of the blood and bone. It was found that the inorganic phosphorus of the blood remained constant in both normal and slipped tendon birds and at a level of approximately 4.7–5.6 mg per 100 cc of blood. The ester phosphorus was approximately 26–30 mg per 100 cc of blood in the case of perosis, while the total phosphorus ranged from 100 to 141 mg per 100 cc of blood. In normal birds produced by feeding or injecting manganese, the ester phosphorus ranged from 32–44 mg per 100 cc of blood, while the total phosphorus varied from 100–132 mg per 100 cc of blood. The most characteristic feature of the phosphorus distribution in the normal and afflicted birds was a higher ester phosphate in the blood of the normal birds.

In respect to the phosphatase content of bone and blood of normal and slipped tendon birds, there was also a clear-cut difference. On ration 604—which produced 100 per cent. slipped tendon—the phosphatase content of the blood ranged from 2.1–3.1 units per 100 cc of blood and from 3.6–7.7 units per gram of green bone. In the birds protected by manganese feeding or injection at different levels, the phosphatase content of the blood varied from 15.9–51.3 units per 100 cc of blood and from 8.5–10 units per gram of green bone. It is apparent that in the complex process of normal bone formation, a high inorganic calcium phosphate ingestion had depressed the phosphatase content of blood and bone, and at the same time there had occurred a lowering in the ester phosphate level of the blood.

It is possible that the autoclaving of rice bran, which is then rendered ineffective as a protective agent, is linked with a destruction of the phosphatases of the bran. Since rice bran is rich in phytin—the calcium-magnesium salt of phytic acid—we raised the question as to whether there was a possibility that inositol (a constituent of phytic acid) might be concerned in the ester phosphate increase observed in normal birds as compared with those afflicted with slipped tendon. Feeding inositol on ration 604 at a level of 5 grams per kilo did not protect against perosis. Injection of inositol at the rate of 50 mg per week did not protect with ration 604. However, we have observed that with ration 610—containing 5 per cent. of calcium phosphate—and supplemented with 20 mg of manganese per kilo, there is no protection against perosis. The manganese level is not high enough. The ester phosphorus remains below 30 mg per 100 cc of blood and the phosphatase at 30 units per 100 cc of blood and 6.4 units per gram of green bone. When the chicks receiving ration 610 supplemented with 20 mg of manganese per kilo were injected with 100 mg of inositol per week, there was complete protection against perosis. The ester phosphorus rose to 34 mg per 100 cc of blood and the phosphatases of the blood to 40.5 units per 100 cc. With the same ration injection of 10 mg of inositol or of 100 mg of glucose per week did not protect. We hesitate at this time to state definitely that the increase in ester phosphorus of the blood by injection of adequate manganese or inadequate manganese plus inositol resulted in the formation of inositol esters of phosphoric acid, but such a possibility may well exist. So far as we know, no one has isolated from animal tissue phosphoric esters of inositol, although they are known to exist abundantly in the seeds of certain plants. Free inositol itself is known to occur in muscle and brain; however, its function has not been disclosed.

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THE GROWTH OF LEPTOSPIRA ICTEROHEMORRHAGIAE ON THE CHORIO-ALLANTOIC MEMBRANE OF THE CHICK EMBRYO

A WIDE variety of bacteria and viruses has been successfully grown in the tissues of the chorio-allantoic membrane of the chick embryo by a number of workers.[1] Up to the present time, however, no one has described the cultivation by this method of any member of the family *Spirochetales*. The purpose of the present note is to report the use of chorio-allantois of the chick embryo for the successful cultivation of *Leptospira icterohemorrhagiae,* the causative organism of Weil's disease (infectious spirochetal jaundice or *spirochetosis icterohemorrhagica*).

The strain of *Leptospira icterohemorrhagiae* employed was isolated at autopsy from the kidney of a man who died of Weil's disease at Rochester, N. Y., on February 19, 1937. The strain was maintained by passage in guinea pigs and by cultivation in Fletcher's

[1] See reviews by F. M. Burnett, *Med. Res. Council, Sp. Rept. Series,* No. 220, 1936; also, E. W. Goodpasture, *Amer. Jour. Hyg.,* 28: 111, 1938.