11 soils from the 3 disease areas. Only soils of comparatively high alkali concentration have been shown. In Fig. 2, mgm. of each group of ions per 10 gm. of soil are plotted against per cent total soluble salts.

The amounts of nitrate ions from disease and non-disease areas alone show a marked difference, being practically zero in non-disease areas studied, while from 50-250 mgm. per 10 gm. of soil were found in all but 2 of 11 samples from the 3 disease areas examined. This observation is particularly significant in view of the marked toxicity noted in ducks as a result of artificial feeding with salt mixtures of sodium chloride and sodium sulphate, containing nitrate ions and also magnesium or bicarbonate ions.

Two additional factors indicate that nitrate may play an important role in the incidence of "duck disease". Sodium nitrate is several times more soluble than the corresponding chloride and sulphate. One may therefore expect nitrate to become an appreciable factor in the surface alkali only at the hottest and driest time of the year. In addition, nitrate is also increased at this time through bacterial decomposition of organic matter. These considerations correspond to the usual incidence of the duck malady in late summer and fall.

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An Experimental Method for the Radiographic Demonstration of the Bronchial and Pulmonary Arteries.

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In a previously described series of experiments[1] it was found that the introduction into the venous circulation of an embolus infected with pyogenic organisms may be followed by widely differing pathological changes in the parenchyma of the lung. To determine the exact conditions present within the pulmonary and bronchial circulations following the introduction of such emboli a method for the radiographic demonstration of the two circulations was developed.

Anatomically the bronchial arterial system usually arises as one

[1] Holman, E., Chandler, L. R., and Cooley, C. L., *Surg. Gyn. and Obs.*, 1927, xliv, 328.

or more branches from the first portion of the descending aorta anteriorly. Occasionally branches may arise from the first or second intercostal, the internal mammary, or the right subclavian arteries. They enter the lung at the hilum and course along the bronchi and their branches up to the *ductus alveolaris*.[2]

The bronchial artery is best injected with the lung *in situ*. Under chloroform or ether anaesthesia the chest is opened avascularly by splitting the sternum exactly in the midline. Just before entering

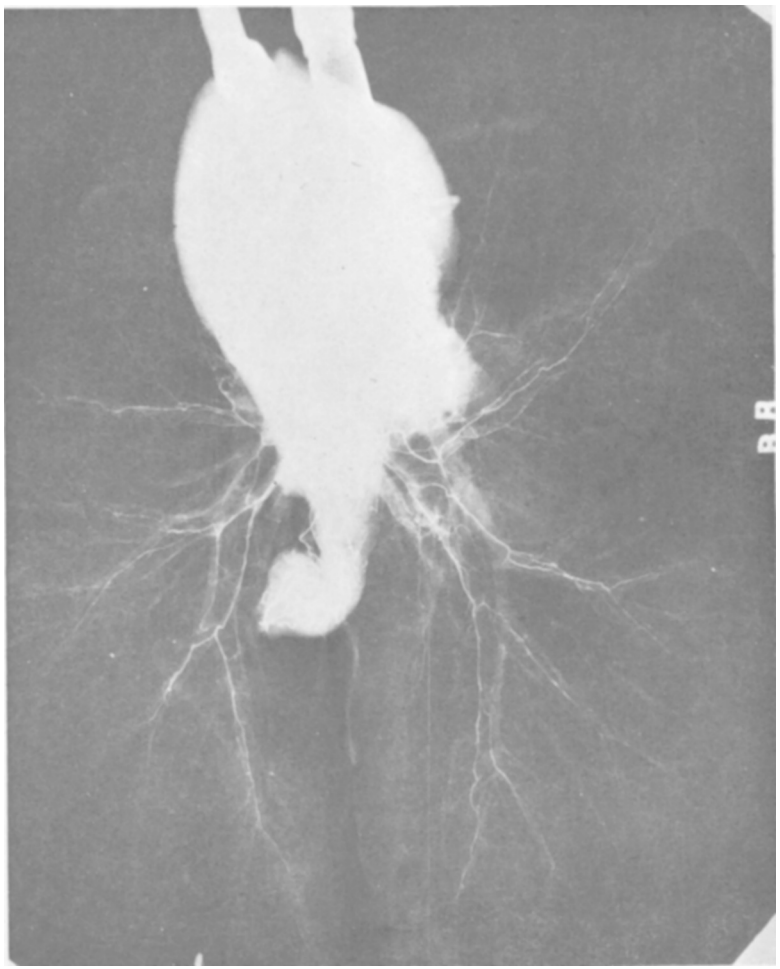

FIG. 1.
Roentgenogram of a normal lung after injection of the bronchial arterial system with Hill's bismuth mass.

[2] Miller, Wm. Snow, *Am. Rev. Tbc.*, 1925, v, 87.

the pleural cavity the animal is killed with the anaesthetic to prevent injury to the inflated lung.

The innominate and left subclavian arteries are ligated as they leave the aortic arch. The first intercostal arteries should be clamped laterally to avoid occlusion of the bronchial artery which may arise from one of them. The thoracic aorta is tightly clamped distal to the fifth intercostal arteries so as to limit the injection to the thorax.

The pericardium is opened longitudinally and a large cannula inserted into the aorta through an incision in the left ventricle, all air is excluded from the system by filling the cannula and the attached tube with warm water before insertion into the ventricle. A heavy ligature passed around the base of both the aorta and pulmonary artery holds the cannula firmly with less danger of rupture of the aorta by cutting through of the ligature.

The most satisfactory injection mass is that of Hill[3] using a suspension of 20% bismuth oxychloride in an 11% solution of gum acacia. The bismuth mixture, preferably warm, must be repeatedly shaken to prevent settling. In our experiments Berlin blue has been added to distinguish the bronchial from the subsequent pulmonary arterial injection. The injection is begun by bringing the pressure immediately to about 160 mm. of mercury, which is the normal arterial pressure in the dog. To aid in complete filling of the bronchial vessels the lung is very gently manipulated during the injection, taking care to prevent injury to the pleura. Fifteen to twenty minutes are required to secure complete injection. The lungs and heart are removed by severing the vessels of the neck, the trachea, oesophagus and thoracic aorta. The intercostal vessels may be ligated and cut, but less trauma to the lung is produced when the intercostal vessels are carefully avulsed a centimeter or so distant from the aorta by passing the hand along the aorta dorsally. The vessels remain plugged with bismuth and no leakage occurs with careful handling.

After the lung is removed the intercostal arteries and the thoracic aorta are ligated, if the bronchial artery arises from the intercostal artery it may be torn in removing the lung and must be ligated.

A tube and cannula are tied into the trachea and the lung inflated so as to distend all atelectatic areas, care being taken never to inflate beyond a pressure of 40 mm. of mercury when the air sacs are ruptured. The lung is then deflated to an intrabronchial pressure of 10

[3] Hill, E. C., *Johns Hopkins Univ. Bull.*, 1929, xliv, 248.

mm. of mercury which is the optimum respiratory distention of the canine lung. Inflation of the lung and maintenance of normal pressure relations are points of greatest importance in any observations on the lung.

Stereoscopic roentgenograms of the injected lung are made at this time. These enable one to study accurately the size and distribution of the bronchial artery.

After roentgenograms of the bronchial artery have been taken the pulmonary artery may be injected in the excised lung by inserting a cannula through the right ventricle into the pulmonary artery. Hill's mass is again injected this time at a pressure of 20-40 mm. of

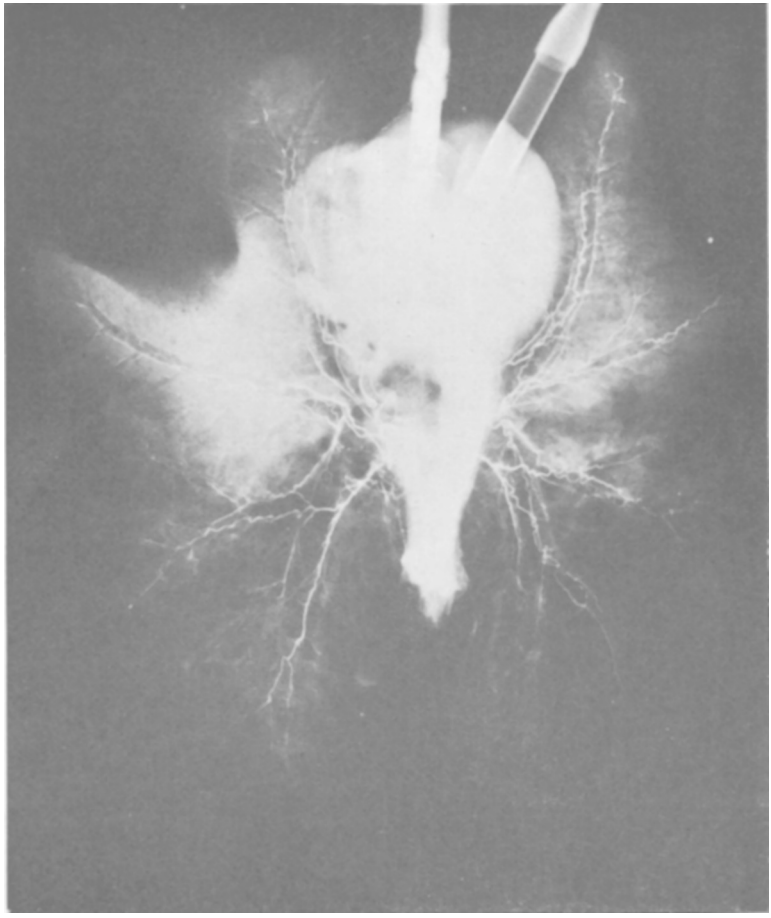

FIG. 2.
Roentgenogram showing a generalized dilatation of the bronchial arterial system in distemper pneumonia which involves the entire lung.

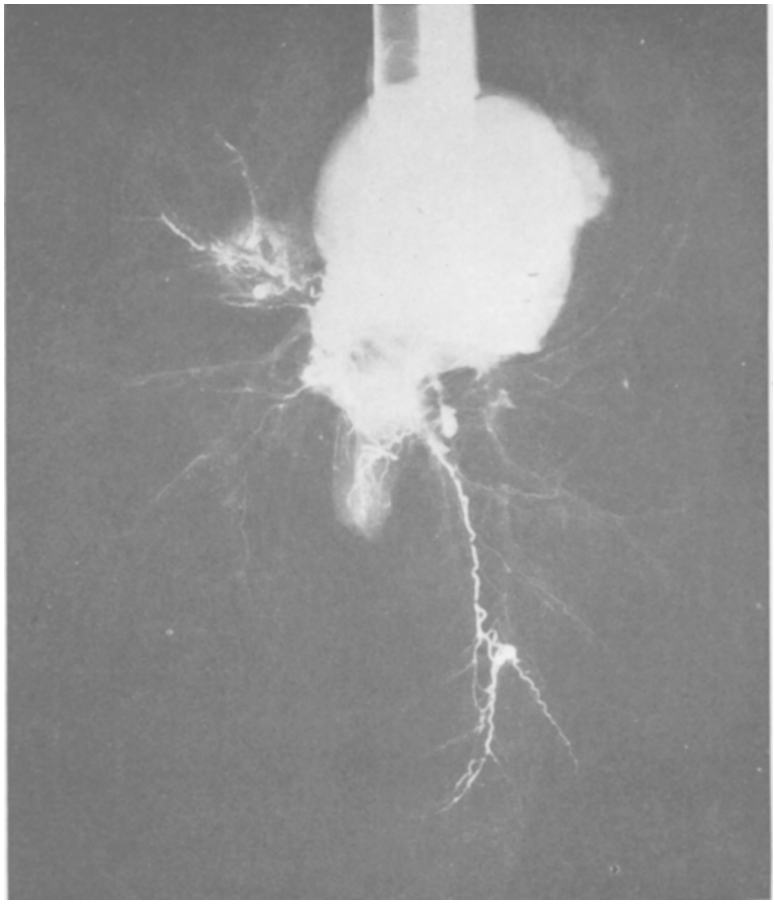

FIG. 3.

Roentgenogram demonstrating enlargement of the bronchial arteries to the lobes which contain emboli. The left upper lobe shows an abscess cavity while the right lower lobe contains a sterile embolus.

mercury, the lung being maintained in a state of inflation by an intrabronchial pressure of 10 mm. of mercury. Stereoscopic roentgenograms are made showing the relationship between the two arterial systems.

Injections are preferably made immediately after sacrificing the animal but may be successfully carried out from one day to several weeks after death if the animal is kept on ice. In such a case the chest should be repeatedly filled with warm water during the injection.