A Transmissible Lymphoid Tumor of the Chicken*  

Carl Olson, Jr., D.V.M.

(From the Department of Veterinary Science, Massachusetts State College, Amherst, Mass.)

(Received for publication March 27, 1941)

The first demonstrations of the transmission of neoplastic disease in the chicken were made by Ellermann and Bang (3) with fowl leukosis and Fujinami and Inamoto (8) and Rous (25) with sarcomas. Subsequently, many spontaneous neoplasms of connective tissue of the chicken have been shown to be experimentally transmissible and in nearly all transmissible neoplasms a cell-free agent has been shown to be the cause. Many of the tumors induced experimentally in the chicken by the use of tar or certain of its derivatives have been found to be transmissible and from some of these tumors (17, 18) a cell-free agent capable of producing the neoplasms has been isolated. Connective tissue neoplasms are relatively infrequent as spontaneous tumors of the chicken. The more common type of spontaneous neoplastic disease of the chicken is composed of lymphoid elements and has been described by such designations as lymphocytoma, lymphomatosis, lymphosarcoma, leukosis, "big liver disease," and others.

The great economic loss to the poultry industry caused by lymphoid neoplastic disease has stimulated much research work. In spite of considerable investigation much confusion exists as to the transmissibility of lymphoid tumors and the relation of lymphoid tumors of the chicken to fowl paralysis. Some investigators, Andersen and Bang (1), Mathews and Walkey (19), Engelbreth-Holm (4, 5, 6), and Fenstermacher (7) report that they have been unable to transmit lymphocytoma from affected chickens to healthy chickens. Some workers present data to indicate that lymphocytoma and fowl paralysis have a common etiological agent, Pappenheimer, Dunn, and Seidlin (23), anti Gibbs (12), Jungherr (5), Seagar (26), Jungherr (15), and Gibbs (12). Others, Patterson, Willeke, Murray, and Henderson (24), Johnson (14), and Lee, Willeke, Murray, and Henderson (16), believe that fowl leukosis, fowl paralysis, and lymphocytoma are all caused by a single agent. An interesting transmissible disease of the lymphoid cell system of the chicken has been described by Furth (9, 10, 11). He has called this disease lymphomatosis, but believes it different from the common type of spontaneous lymphomatosis which is associated with marked enlargement of the liver ("big liver disease," "hepatolymphomatosis"). The transmissible lymphomatosis of Furth is caused by a filter-passing substance that he calls the strain 2 agent. The agent of strain 2 produced myelomatosis and endothelioma as well as lymphomatosis and erythroblastic leukosis. Some other strains of the fowl leukemia agent have the ability to produce sarcoma and most of the strains become somewhat modified in their disease-producing power with successive serial passage, Olson (20).

This report describes a transmissible lymphoid neoplasm that has been developed and studied in experimental chickens during the past 3 years. The flock in which this tumor originated has been described (22).

Description of case 452 (transmissible lymphoid tumor).—The chicken was a crossbred, resulting from the mating of a Rhode Island Red female with a Barred Plymouth Rock male, purchased from a commercial hatchery and raised under the ordinary conditions for a small poultry flock. It first attracted attention at the age of 118 days when a small erosion of the skin on one toe was noted. A slow, persistent hemorrhage came from the lesion which healed without treatment. The bird was relatively light in weight. By October 30, 1937, at the age of 146 days, the chicken had become more emaciated and was brought to the laboratory. Its temperature was approximately normal (107.3° F.).

Numerous examinations of the blood were made during the illness of the bird. The results of the blood counts are given in Table 1. Only differential blood counts were made before the chicken became ill and the counts were found to be within the range of normal variation. A résumé of the studies on the blood follows. The number of erythrocytes and the amount of hemoglobin in the blood decreased slightly during the illness of the chicken. No pathological forms of erythrocytes were observed. The thrombocytes were normal. The number of eosinophils and basophils varied slightly around the normal values for these cells. The total number of leukocytes was greater than normal at the time the chicken was first ill. This marked increase persisted for 10 days and then the number dropped to a more nearly normal value. The number of heterophils (pseudoeosinophils) was originally very high, then dropped, later increased, and finally fell to a nearly normal level. Lymphocyte numbers were normal at first, increased markedly during the early part of the illness, and near the terminal stage of the disease were again at a normal level. The number of monocytes was higher than normal at all stages of the disease and their total value was in general parallel to the number of heterophils. No immature cells were noted in the blood smear preparations, with the possible exception of the group designated as
monocytes. Included in the classification of monocytes were a few cells somewhat atypical yet possessed of certain characteristics of the monocyte. These atypical cells were considered to represent immature monocytes. In no instance did they constitute the bulk of cells designated as monocytes, but were rather relatively scarce.

Twelve days preceding death the chicken became so weak that it was unable to stand. From this time it was fed a mixture of ground feed and water by means of a bulb syringe. The chicken died November 24, 1937 at the age of 205 days. Necropsy was done immediately after death and was conducted in an aseptic manner, so that material for the inoculation of experimental chickens could be obtained reasonably free of contamination.

The carcass was markedly emaciated. The liver was moderately enlarged and contained a number of gray-white tumor masses. These tumor masses varied in size from a few millimeters to 2.5 cm. in diameter. They were discrete although some masses tended to be confluent. The spleen was of normal size and color and contained 4 small foci similar to those seen in the liver. Immediately dorsal to the cloaca was a solid rounded mass about 4.5 cm. in diameter composed of soft gray tissue. On one side of the large mass was a nodular protuberance which had a hollow center filled with dry, yellow, necrotic material which probably represented the lumen of the bursa of Fabricius. The larger solid tumor mass apparently arose from the wall of the bursa. The kidneys were dark red in color and small in size. The ovary was quiescent and normal in appearance. The marrow of the distal end of the left femur was replaced by a mass of gray tumor tissue; that of the right femur was red-brown in color and hyperplastic.

Microscopically the tumor was composed of large, round lymphoid cells. These cells had a relatively

<table>
<thead>
<tr>
<th>Date</th>
<th>Erythrocytes</th>
<th>Hemoglobin</th>
<th>Leukocytes</th>
<th>Total</th>
<th>Lymphocytes</th>
<th>Eosinophils</th>
<th>Basophils</th>
<th>Monocytes</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/26/37</td>
<td>2.52</td>
<td>8.35</td>
<td>47,000</td>
<td>46,950</td>
<td>76.5</td>
<td>13.5</td>
<td>4.0</td>
<td>1.5</td>
</tr>
<tr>
<td>9/2/37</td>
<td>2.46</td>
<td>8.04</td>
<td>41,000</td>
<td>50,305</td>
<td>76.0</td>
<td>16.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>9/9/37</td>
<td>2.52</td>
<td>8.10</td>
<td>36,750</td>
<td>48,747</td>
<td>77.0</td>
<td>16.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>9/16/37</td>
<td>2.38</td>
<td>7.88</td>
<td>30,200</td>
<td>38,800</td>
<td>81.0</td>
<td>11.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>10/30/37</td>
<td>2.44</td>
<td>8.04</td>
<td>43,500</td>
<td>55,363</td>
<td>76.5</td>
<td>13.5</td>
<td>4.0</td>
<td>1.5</td>
</tr>
<tr>
<td>11/1/37</td>
<td>2.38</td>
<td>7.58</td>
<td>43,100</td>
<td>55,148</td>
<td>77.0</td>
<td>16.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>11/3/37</td>
<td>2.47</td>
<td>7.50</td>
<td>28,900</td>
<td>30,214</td>
<td>71.5</td>
<td>14.8</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>11/5/37</td>
<td>2.50</td>
<td>8.32</td>
<td>36,400</td>
<td>41,900</td>
<td>75.0</td>
<td>12.6</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>11/6/37</td>
<td>2.44</td>
<td>8.09</td>
<td>43,500</td>
<td>55,363</td>
<td>75.0</td>
<td>12.6</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>11/8/37</td>
<td>2.51</td>
<td>7.58</td>
<td>43,100</td>
<td>55,148</td>
<td>75.0</td>
<td>12.6</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td>11/12/37</td>
<td>2.32</td>
<td>7.58</td>
<td>30,200</td>
<td>38,800</td>
<td>76.5</td>
<td>13.5</td>
<td>4.0</td>
<td>1.5</td>
</tr>
<tr>
<td>11/19/37</td>
<td>2.58</td>
<td>9.70</td>
<td>38,800</td>
<td>52,207</td>
<td>72.5</td>
<td>27.5</td>
<td>0.2</td>
<td>3.0</td>
</tr>
</tbody>
</table>

* Expressed in millions per cu. mm.
† Expressed in gm. per 100 cc. of blood.
‡ Values are averages of two or three counts and are number of cells per cu. mm. of blood.
Figures in italics are per cent values.
large vesicular nucleus and their basophilic cytoplasm was confined to a narrow rim at one edge of the cell. Mitotic figures were numerous. The neoplastic lymphoid cells were extravascular in location, although in some organs, as the liver, some such cells were found intermingled with the elements of the blood within the vessels. The tumor masses in the liver were diffuse and tended to compress the liver tissue rather than to infiltrate it (Fig. 1). Tumor cells were actively multiplying in many of the periportal areas of the liver. Several small microscopic foci of neoplastic lymphoid cells were found in the spleen and there was also a rather generalized hyperplasia of the reticulum of the splenic pulp. An accumulation of the tumor cells on the visceral aspect of the splenic capsule penetrated the latter at some points and encroached upon the substance of the organ. The tumor in the wall of the bursa of Fabricius and in the bone marrow was composed of lymphoid cells. The myeloid tissue, where not replaced by tumor cells, was active, especially in granulopoiesis, and a normal relationship existed between erythropoiesis and granulopoiesis. The ovary was infiltrated with tumor cells. The kidneys, lungs, lumbar spinal cord, spinal cord in the region of the brachial plexus, and adjacent dorsal root ganglia were normal in microscopic appearance.

**Transmission of the Lymphoid Tumor**

**Methods**.—In the first passage of the lymphoid tumor the trocar and cannula method of implanting tissue into the recipients was used. The usual precautions to prevent contamination were observed in obtaining the tissue, during the process of mincing with scissors, and while implanting tissue into the experimental chicken. This technic was found to be quite laborious, particularly when large numbers of birds were used. An instrument, called a tissue mincer (21), was devised which subdivided the tumor tissue to such a size that it could be injected with a syringe using a needle with a large bore (15 gauge). Handling of the minced tumor was facilitated by dilution of the tissue with an equal volume of modified Ringer's solution (13). The standard dose of such a mixture was 0.5 cc. The site of implantation of the inoculum was usually the breast muscle on one or both sides. In instances where several sites were used, inoculations were made into the musculature of the thighs, as well as into the breast muscle. The implants were placed deep in the muscle tissue and in some experiments in the subcutaneous tissue as well.

**Source of experimental chickens**.—The chickens used in the first 30 passages of the lymphoid tumor were obtained from three sources, all unrelated to the flock contributing the bird from which the tumor originated. The principal source of supply was a small flock of laying hens maintained in the laboratory for the purpose of producing inbred chickens for experimental work. These Rhode Island Red hens were sisters and were mated to a brother. The other two sources of birds were another breeding stock of the laboratory and stock from a commercial hatchery.

**First passage of the lymphoid tumor**.—The first attempt at transmission of the disease found in case 452 was made at the time the bird was brought to the laboratory, October 30, 1937. Blood was taken from the wing vein in sodium citrate solution and inoculated intravenously in 1 cc. doses into 4 experimental chickens 46 days old. These chickens remained normal and the experiment was terminated 73 days after inoculation.

At the time of necropsy of case 452, blood from the heart chambers and liver tissue infiltrated with tumor was obtained for the purpose of inoculating chickens. A portion of liver infiltrated with lymphoid tumor was cut into small pieces with scissors and implanted in chickens with a trocar and cannula. Four chickens 13 days old received the inoculum in the peritoneal cavity. One died of an unrelated disease 30 days after inoculation and the others were killed 93 days after inoculation. The implants did not develop or produce disease in any of the chicks.

Six chickens 121 days old received implants of the diseased liver in the pectoral muscles of one breast. No reaction was noted at the site of implantation of lymphoid tumor tissue in 4 chickens and 48 days after inoculation they were considered negative and used for other purposes. One of the birds considered negative (M 34) was killed 139 days after inoculation.
and found at necropsy to have a markedly enlarged liver infiltrated with lymphocytoma associated with foci of the tumor in the spleen and kidneys. This case of lymphocytoma has been considered spontaneous in origin. Two other birds of the group were killed 130 days after inoculation and were negative. Two of the chickens (M 31 and M 35) had detectable swelling at the site of implant 9 days after inoculation. This swelling continued to increase in size in each bird until at the time of necropsy the major portion of the pectoral muscles was replaced by a huge mass of neoplastic tissue. A biopsy of M 35 was made 10 days after inoculation to obtain tissue from the tumor in the breast muscle for study and implantation in other experimental chickens. The tissue had a marked infiltration with large, actively multiplying lymphoid cells between atrophic muscle fibers. Chicken M 35 died 49 days after it had been inoculated. The tumor mass in the right breast muscle measured roughly 15 x 7 x 6 cm. and was relatively firm and composed of gray tissue (Fig. 2). A discrete, disc-shaped mass of tumor, 23 mm. in diameter and 11 mm. thick, was found on the surface of the left liver lobe. Except for this, the liver and the rest of the visceral organs were normal. Histologically, the breast tumor was composed of large, neoplastic, lymphoid cells having the appearance of those described in case 452, from which the tumor was derived. A microscopic, metastatic focus was found in the spleen and a small embolus of tumor cells was noted in a blood vessel of the liver. Repeated examinations of the blood of M 35 were made during the course of the experiment. Sixteen days after the implant of the lymphoid tumor, a moderate leukocytosis of heterophils was noted, but this did not occur again. Chicken M 31 was killed 51 days after inoculation with the lymphoid tumor to provide material for inoculation of other chickens. No gross pathological change was noted except for the large tumor mass of the pectoral muscle. Upon histological examination several small, discrete metastatic foci of tumor cells were found in the spleen. Repeated examinations of the blood of the bird during the period of experiment were made and no pathological changes were noted.

The blood obtained from the heart chambers of case 452 at the time of necropsy was kept from clotting by the addition of sodium citrate solution and was injected into the right wing veins of 4 chickens aged 13 days. The blood of these birds was examined periodically after their inoculation, but no abnormality was observed. Three of the chickens were negative at the time the experiment was terminated 96 days after inoculation. The remaining bird, M 78, was noted to hold its right wing in an unnatural position 82 days after inoculation. Upon closer examination a large irregularly shaped tumor mass was found in the region of the right humerus (Fig. 3). A biopsy was made and the tumor was found to consist of large, neoplastic lymphoid cells. Another biopsy was attempted, 99 days after inoculation, during which the bird died. The tumor of the wing measured approximately 7 x 6 x 5 cm. and it completely encircled the humerus by infiltration of the soft structures. It was yellow-gray in color and well vascularized. Portions of the tumor were used for inoculation of other experimental chickens and it was through this bird that serial passage of the lymphoid tumor was maintained.

**Second passage of the lymphoid tumor.**—The tumor material secured from chicken M 35 at biopsy 10 days after inoculation was implanted in the peritoneal cavity of 4 chickens aged 16 days. One died 4 days later and was negative, except for a localized peritonitis. The other 3 remained negative and the experiment was terminated 83 days after inoculation. The tumor was also inoculated with a trocar and cannula into the pectoral muscles of 4 chickens aged from 218 to 235 days. In only one bird did the implant develop. It attained a maximum size at the end of 20 days, and then regressed. All 4 birds were negative when killed 83 days after inoculation.

A portion of the tumor from chicken M 31 was implanted in the breast muscle of 4 chickens, 57 days old. All the birds remained negative and were killed 42 days after inoculation. Another portion of the tumor from M 31 was ground into a heavy emulsion with a modified Ringer's solution (13) and was injected in 0.5 cc. doses into the breast muscles of 6 chickens aged from 43 to 57 days. No indication of growth of implant was observed and the experiment was concluded after 42 days.

Intramuscular and subcutaneous implants of the tumor from chicken M 78 grew in all of the 6 birds so inoculated. In four instances the growth of the tumor reached a maximum size about 14 days after inoculation and then regressed. One bird died at 28 days with a large tumor at the site of inoculation and infiltrative metastases in the ovary, adrenals, and proventriculus. The remaining chicken had a large tumor of the breast muscle when it was killed 28 days after inoculation to provide material for further passage of the neoplasm.

**Third to thirtieth passages of the lymphoid tumor.**—During the course of the subsequent serial passages various factors such as age of the chickens at time of inoculation, intervals between passages, and mode of inoculation were varied to study their effect on the results obtained.
PATHOLOGY

A total of 442 chickens was inoculated in the intramuscular or subcutaneous tissues with the lymphoid tumor, during its first 30 serial passages. Growth of the implant was observed in 300 birds or 67.7 per cent of those inoculated (Table II). After the growth of the implant had become established in some animals the tumor regressed, in others it continued to grow but remained localized, and in still others it grew and metastasized to visceral organs.

Regression of the tumor growth was observed in 133 birds or 44.3 per cent of the chickens in which the implants took root and developed. Growth of an implant was usually apparent about 7 days after inoculation, and in a few instances it began to regress shortly after it could be detected. On the average the maximum growth was observed in these birds 13.6 days after inoculation. In one bird the tumor attained its maximum growth 34 days after implantation and then completely receded. Most of the chickens in which the implant of tumor regressed were killed on an average of 40.8 days after inoculation. The remainder of the birds (6 birds only) died from unrelated causes from 17 to 74 days (average 54 days) following inoculation.

The lymphoid tumor remained localized at the site of inoculation in 116 or 38.7 per cent of the birds in which growth took place. In this group 48 died and 68 were killed. Of the birds killed many were in extremis, others were killed to furnish material for transmission experiments, and still others to end the experiment of which they were a part. The duration of life during the experiment was 11 days in the shortest instance and 66 days in the longest. The average duration for birds that were killed was 22.5 days and for birds that died was 24.7 days. In many cases the tumor grew to a large size and weighed approximately one-fifth the total body weight, which

### Table II: Summary of Thirty Serial Passages of a Transmissible Lymphoid Tumor (Intramuscular or Subcutaneous Implants)

<table>
<thead>
<tr>
<th>Passages</th>
<th>Number inoculated</th>
<th>Number of Growth</th>
<th>Number of Regression</th>
<th>Number of Local only</th>
<th>Number of Local and metastases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 10</td>
<td>120</td>
<td>31.6</td>
<td>68.4</td>
<td>37.8</td>
<td>48.8</td>
</tr>
<tr>
<td>11 to 20</td>
<td>154</td>
<td>32.7</td>
<td>66.3</td>
<td>37.2</td>
<td>37.2</td>
</tr>
<tr>
<td>21 to 30</td>
<td>169</td>
<td>31.4</td>
<td>68.6</td>
<td>55.2</td>
<td>32.8</td>
</tr>
<tr>
<td>21 to 30</td>
<td>169</td>
<td>31.4</td>
<td>68.6</td>
<td>55.2</td>
<td>32.8</td>
</tr>
<tr>
<td>Total</td>
<td>443</td>
<td>32.3</td>
<td>67.7</td>
<td>44.3</td>
<td>38.7</td>
</tr>
</tbody>
</table>

Figures in italics are per cent values.

The lymphoid tumor remained localized at the site with some exceptions, seemed to be the limit of growth (Fig. 4).

Metastases from the tumor were observed in 51 chickens (17 per cent of all birds in which growth was observed). In 21 birds one organ contained metastases; in 12 birds two organs were involved; in 8 birds three organs; in 5 birds four organs; and in 4 birds six organs. One bird used in the 28th passage of the tumor showed at necropsy 16 days after inoculation diffuse infiltration of neoplastic lymphoid cells in the liver, kidneys, adrenals, proventriculus, bone marrow, and thymus in addition to the breast muscle at site of implant. Instances of this type of diffuse metastasis have been frequently observed in more

---

**DESCRIPTION OF FIGURES 2 TO 5**

Fig. 2.—Cross section of sternum and both breast muscles of chicken M 35. The musculature of the right breast is largely replaced by growth of lymphoid tumor implanted 45 days previous to necropsy. The line of separation represents the division caused by the sheaths of the deep and superficial pectoral muscles.

Fig. 3.—Tumor mass of wing of chicken M 28. This mass developed after a supposedly intravenous inoculation of blood from the original chicken with lymphoid tumor. Photograph taken 82 days after inoculation.

Fig. 4.—Ventral view of sternum showing the large tumor mass infiltrating the right breast muscle. The tumor developed in 45 days from an implant of the 20th serial passage. The mass was estimated to weigh 200 gm. (actual weight of entire specimen with sternum, 244 gm.) which represented nearly ⅓ the total carcass weight of 665 gm. at necropsy.

Fig. 5.—Pancreas and duodenum, heart, adrenal glands, and gizzard and proventriculus of a chicken which died 21 days after receiving an implant of the lymphoid tumor. Note the nodular metastatic foci in the pancreas and heart and the diffuse metastases in the wall of the proventriculus. Both kidneys of this bird likewise contained diffuse metastases.
recent experiments with the transmissible lymphoid tumor. Such cases usually die 9 to 12 days after inoculation. This case resembles the diffuse lymphocytoma so commonly observed in routine necropsy work of the veterinary diagnostic laboratory.

The heart and proventriculus were sites of predilection for metastases, which were observed 24 times in each organ. The adrenals were involved in 21 cases. Foci of tumor were found in the substance of the liver in 7 cases, and in 13 instances a mass of neoplastic lymphoid tissue was found in the region of the gall bladder fossa. Other organs found involved with metastases and the number of instances of involvement were as follows: kidneys, 12; gonads, 9; spleen, 6; thymus, 4; bone marrow, 3; mesentery, 3; lung, 2; and thyroid, 1. In the heart, liver, and kidney the metastatic foci were usually circumscribed and easily detected upon gross examination. Those in the spleen were usually much smaller and often not apparent until the organ was examined histologically. Diffuse infiltration of neoplastic lymphoid cells was characteristic in the wall of the proventriculus, adrenals, thymus, gonads, bone marrow, and mesentery (Fig. 5). Of the 51 birds with metastases 31 died between 15 and 49 days after inoculation (average 27.7 days) and 20 were killed between 14 and 52 days after inoculation (average 25.4 days). The earliest time at which focal metastasis was observed was 14 days after implant of the inoculum (noted in 2 cases). In one of these, microscopic foci only were found in the spleen, and in the other, tumor foci in the liver and kidney were apparent to the unaided eye.

The transmissible lymphoid tumor retained its general cell type characteristics throughout the 30 serial passages (Fig. 6). The cell was somewhat larger than the young lymphoid cells in the normal lymphoid tissues. The nucleus, in tissue section preparations, was vesicular with chromatia arranged in clumps and condensed at the nuclear membrane. A relatively large and distinct nucleolus was usually evident. The cytoplasm was deeply basophilic with routine hematoxylin-eosin stain and relatively scant, being usually confined to one side of the cell. Imprint preparations stained with the May-Grünwald and Giemsa combination blood cell stain showed the nucleus to have a very fine and distinctive arrangement of the chromatia and parachromatin, not unlike the arrangement observed in the very immature lymphoid cells of transmissible fowl leukosis. One or two nucleoli were faintly apparent with the blood stain. The cytoplasm was finely granular and colored blue. In some cells a few azure granules were noted in the cytoplasm. There was a marked degree of uniformity in size and appearance of the tumor cells. The method of growth was usually infiltrative although in some organs in which the metastases were focal, as in the spleen, liver, and kidney, a more or less well defined capsule restricted the tumor. In many instances when the implant had been growing for a week, a variable amount of dry necrosis was found in the substance of the tumor. This was usually scattered in small areas. Frequently degenerated tumor cells with pyknotic nuclei were observed in sections. Fibrosis and scar tissue was all that remained at the site of implantation in those chickens in which growth had taken place and later regressed. The histological section of such an area made shortly after regression revealed many small foci of tumor cells circumscribed by fibroblasts (Fig. 7). Loose connective tissue containing many macrophages occupied the area formerly taken up with tumor. In birds killed some time after complete regression only a slight amount of connective tissue remained. No alteration was found at the site of inoculation in those birds in which the implants failed to grow.

Other features noted in chickens in which the tumor had been present for two or more weeks preceding death were emaciation, atrophy of the thymus, and hyperplasia of the myeloid elements of the bone marrow, particularly those involved in granulopoiesis.

**DISCUSSION**

For the present, only such factors as appear well substantiated by the results of the first 30 passages of the lymphoid tumor will be discussed.

During the early passages of the tumor the period between transmission experiments was spread over a considerable time range (from 7 to 89 days). It was later found that reliable inoculums could be prepared from tumors resident in the host for 14 days and this
was the age of the tumor used in the later passages. The interval between passages was on the average longest in the first 10 passages (24.5 days), 19.9 days for passages 11 to 20, and shortest for the last 10 (average 15.6 days). Despite this variation the results were about the same in the three groups (Table II).

Intramuscular implantation of the inoculum usually gave rise to a larger and more active tumor growth than subcutaneous implantation. The reason for this may be a more adequate blood supply in the muscle than in the loose connective tissue.

The age of the chicken at the time of inoculation appeared to be a significant factor affecting the fate of the implant. Chickens in which the tumor grew and those in which it metastasized were on the average aged 57.9 and 58.7 days, respectively (Table III). Birds in which regression occurred after growth were on an average 101.6 days old at time of inoculation. Birds which remained negative had an average age of 89.9 days at the time of inoculation.

Sex of the host had no effect on the results. Chickens from three groups of inbred stock representing different matings and from two other sources were used, but no effect could be attributed to the genetic composition of the host.

Fowl paralysis developed in 15 of the 443 birds (3.38 per cent) inoculated with the tumor, and lymphocytoma was observed in 6 birds (1.35 per cent). First symptoms of fowl paralysis were observed from 1 to 58 days (average 21.3) after inoculation. Fowl paralysis was also observed in 13 of 151 uninoculated chickens (8.61 per cent) held as controls. The average age at which symptoms were first observed in inoculated birds was 72.86 days and in control birds 67.6 days. Two of the 6 cases of lymphocytoma found in inoculated chickens could be interpreted as representing metastasis of the implant. To regard them in this light would, however, imply ability of the tumor to metastasize within 5 days after inoculation in one case and an uninterrupted growth of a metastatic focus after complete regression of the implant in the other case. For the present such interpretation does not seem justified. Three instances of lymphocytoma were noted among the 151 control chickens (1.98 per cent).

Numerous unsuccessful attempts have been made to transmit other spontaneous lymphoid tumors (lymphocytomas) of chickens by the methods which were used in this instance. The types of disease described as lymphomatosis and transmitted by Jungherr (15), Johnson (14), Patterson et al. (24), and Lee et al. (16) are diverse and associated with a much longer incubation period than was observed with this lymphoid tumor. The strain 2 agent of Furth (9, 10) also produced more than one type of disease in birds into which it was inoculated. The transmissible lymphoid tumor described in this report has maintained its general characteristics and has reproduced itself as essentially the same type of disease in a large number of experimental chickens.

**SUMMARY**

A transmissible lymphoid tumor of the chicken is reported and the results of the first thirty serial passages of the tumor are described. Transmission has been accomplished by transplants of tumor tissue. These transplants failed to grow in some chickens, in others regression took place after a short period of growth, in still others growth was progressive and in some instances metastasized to the visceral organs. The results gave no indication of an etiological con-

---

1 Later reports will discuss blood changes and attempts to demonstrate transmissibility by a cell-free agent.
connection between the lymphoid tumor, fowl paralysis, or fowl leukosis. The transmissible neoplasm is unlike any other transmissible tumor described in the chicken.2

REFERENCES


Since this was written an abstract of an article (Transplantable Lymphosarcoma of the Chicken, Cancer Research, 1:69-70. 1941) by Pentimalli has appeared, in which he described a transplantable lymphoid tumor. The original case from which the tumor was derived and the behavior of the tumor in experimental chickens was very similar to that observed in the present work.
A Transmissible Lymphoid Tumor of the Chicken

Carl Olson, Jr.


Updated version
Access the most recent version of this article at:
http://cancerres.aacrjournals.org/content/1/5/384.citation

E-mail alerts
Sign up to receive free email-alerts related to this article or journal.

Reprints and Subscriptions
To order reprints of this article or to subscribe to the journal, contact the AACR Publications Department at pubs@aacr.org.

Permissions
To request permission to re-use all or part of this article, contact the AACR Publications Department at permissions@aacr.org.