A REPORT OF FORTY TUMORS OF SHEEP
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The relative infrequency of the occurrence of neoplasms in the common domestic sheep is apparent to those whose duties bring them in contact with large numbers of these animals. Practising veterinarians rarely encounter the condition, and meat inspectors who examine many sheep that have been slaughtered for food seldom see a carcass in which there is a true tumor. The incidence of tumors of sheep compared to the other domesticated mammals, as cattle, swine, horses, and dogs, is strikingly low. This fact is evident from statistics of meat inspection and from data obtained from veterinary clinics. The relative infrequency of neoplasms in sheep is further attested to by the paucity of cases reported in the literature. The series of cases constituting the basis of this paper is the largest reported up to the present time. The series includes several unusual specimens.

REVIEW OF THE LITERATURE

So far as literature has been available, a review has been made of the cases of neoplasia of sheep.

Williams commented on the relative infrequency of tumors in sheep and stated that in most of the few recorded cases the initial lesion was in the liver. In Sticker's large series of approximately 1,200 primary carcinomas of common domestic animals, only 7 were from sheep. Five of these were primary in the liver, one was primary in the lung, and one was listed as primary in the mesenteric lymph nodes.

Cases of primary adenocarcinoma of the liver of sheep were recorded by Trotter and by Kitt. Several malignant tumors of the lungs of sheep were reported by Schütz, Eber, and Besnoit. The two cases described by Schütz and by Besnoit were classified as proliferating papillary adenomas which were considered to have
originated from the mucous glands of the bronchial walls. Gibruth found an endothelioma in the region of the thigh and a spindle-cell sarcoma of the heart. Loeb reported one case of generalized lymphosarcoma with tumors in the thyroid gland, kidney, and heart muscle. A case of multiple lymphosarcoma in a sheep was also reported by Jowett. The tumors were limited in distribution to the liver and the cortical region of both kidneys, but the lymph nodes apparently were not involved. Worsely reported a melanosarcoma in the mammary gland of a sheep, and Eggeling described a carcinoma of the same organ.

Beatti described a condition as hyperkeratosis affecting the ear of a sheep. The lesion was in the horny layer of the skin, in one area of which the cells became invasive and neoplastic-like and extended through the skin to the cartilage. The invading strands of epithelial cells failed to exhibit keratinization. Mitotic figures were numerous, and the general cytology was that of epithelioma. Although Beatti was inclined to believe that the condition was due to some form of infection, the illustrations which accompany the text are suggestive of a true carcinoma.

Hodgson reported one case of carcinoma of the liver of a sheep, the only case of carcinoma found during the examination of more than 17,000 carcasses in the public abbatoir at Halifax. Fadyean also recorded data on two primary carcinomas of the liver of sheep, these being the only carcinomas of this animal observed in a total of sixty-three cases of malignant epitheliomas found in dogs, horses, cows, and sheep. Frenkel also reported six cases of primary carcinoma of the liver of sheep. Goldberg described a diffuse carcinoma which involved the turbinated bones of an ewe. Crisp described what he considered to be "encephaloid" tumor in an eight-months-old lamb. The tumor, which grew rapidly, affected both the external and internal portions of the thoracic wall on one side. A portion of the growth apparently had its origin from the periosteal covering of the ribs and its connection with the vertebral column also was observed. From the description of the tumor it is impossible to determine the exact character of the growth, although its anatomic situation would suggest osteoblastoma or mesothelioblastoma.

Aynaud reported a case of primary carcinoma of the lung in one of a group of sheep attacked by an epidemic of parasitic bronchitis. He also mentioned having observed lesions similar to those in the sheep in the lungs of two hounds from a pack in which
there was infestation with ankylostomiasis. Although parasites were not demonstrated in the lung of the sheep with carcinoma, the author supported the view that parasites act as a medium in the production of carcinoma by inoculating an unknown virus.

In Crocker's series of 2,814 post-mortem examinations of the common domesticated mammals, including sheep, tumors were not encountered.

The statistics of Thomas concerning the occurrence of neoplastic disease of animals in South Africa show that 123 cases were observed during a period of two years. The tumors affecting the respective species were as follows: cattle, 34; horse, 22; goat, 16; dog, 10; swine, 3; monkey, 1; fowl, 29; sheep, 8. Four of the tumors in sheep were classified as carcinomas and 4 as sarcomas.

**Table I**

*Summary of Condemnations for Tumors and Abscesses for the Four-year Period Ending August 24, 1929*

<table>
<thead>
<tr>
<th>Animal</th>
<th>Necropsy</th>
<th>Carcasses Condemned</th>
<th>Parts of Carcasses Condemned</th>
<th>Total Condemned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>37,442,062</td>
<td>8,251</td>
<td>19,960</td>
<td>28,211</td>
</tr>
<tr>
<td>Calves †</td>
<td>19,692,247</td>
<td>392</td>
<td>8,374</td>
<td>9,126</td>
</tr>
<tr>
<td>Swine</td>
<td>178,604,139</td>
<td>10,462</td>
<td>1,212,426</td>
<td>1,222,838</td>
</tr>
<tr>
<td>Horses</td>
<td>305,945</td>
<td>199</td>
<td>20</td>
<td>219</td>
</tr>
<tr>
<td>Goats</td>
<td>144,755</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Sheep</td>
<td>52,000,947</td>
<td>876</td>
<td>214</td>
<td>1,690</td>
</tr>
</tbody>
</table>

* Data from reports of the Chief of the Bureau of Animal Industry, U. S. Department of Agriculture.
† Aged one year or less.

The large number of animals slaughtered annually for food and subsequently subjected to a careful examination by veterinarians in the federal meat inspection service provides certain data which should enable one to obtain some idea of the occurrence of tumors in the common meat-producing animals (Table I). Since the condemnations listed include carcasses with both tumors and abscesses, it is impossible to determine with any degree of accuracy the number of true neoplasms encountered. In certain species, as swine and calves, the incidence of abscesses is particularly high and it is reasonable to assume that the larger percentage of condemnations in these animals were due to abscesses and not to true tumors. On the other hand, the relatively small number of total condemnations listed for horses, goats, and sheep seems
significant. Horses and goats are rarely condemned for abscesses, and although abscesses are occasionally seen in sheep, they are by no means common. It might be proper to assume that most of the condemnations listed for horses, sheep, and goats were on account of some form of neoplasia, and that the figures given represent in a general way the approximate incidence of neoplasms other than so-called leukemia in these species.

The malignant lymphoid hyperplasia of animals commonly referred to as "leukemia" and "pseudoleukemia" I consider as neoplastic, and for that reason would include these lesions when the incidence of tumors in a given species is considered. Referring again to the reports of the Bureau of Animal Industry of the U. S. Department of Agriculture, it appears that, in the same four-year period for which the data here tabulated were compiled, there were 25 condemnations of the entire carcass for leukemia in sheep. During the same time 3,604 cattle carcasses were condemned for so-called leukemia. Comparing the total condemnation of cattle because of tumor with those of sheep, one is impressed with the striking difference in the incidence of neoplasia in the two ruminants.

Information available from various sources seems to indicate that neoplasms are less common in sheep than in most of the other domesticated animals.

**Material Studied**

For a period of several years I have had the opportunity to obtain for study a considerable number of neoplasms from common domesticated mammals. Much of the material from cattle, sheep, and swine has been obtained through the cooperation of veterinarians in the Federal Meat Inspection Service of the Bureau of Animal Industry of the U. S. Department of Agriculture. That obtained from horses and dogs was secured for the most part from practising veterinarians and from the necropsy service of The Institute of Experimental Medicine of The Mayo Foundation. The data contained in this paper are based on a total of 404 cases of neoplastic disease distributed among the respective species as follows: cattle, 207; horse, 39; mule, 5; swine, 73; dog, 75; goat, 1; sheep, 39. Forty separate tumors were obtained from the 39 sheep, since one animal had two primary neoplasms.

All of the specimens from sheep were obtained from animals that had been presented for slaughter, and the majority of the
tumors were observed for the first time in the subsequent examination, since they were situated internally, the integument seldom being affected. The data which accompanied the respective specimens failed to designate the breed of the animal from which the tumor was obtained in all but five instances, the breed in the majority of cases being designated as grade. The earliest age at which a tumor was found was one year; most of the animals were considered by those making the examination as "old" or "aged." The age incidence in the 39 animals follows: one to two years, 4 animals; three years, 6; four years, 5; four to six years, 2; old or aged, 21; age not stated, 1. A sheep which is designated as old or aged is usually an ewe past the age when it is a desirable breeder.

The fact that the presence of a tumor was not suspected during the life of the respective animals, although all were submitted to ante-mortem inspection, would suggest that so far as the general well-being of sheep is concerned the presence of a neoplastic process is usually without detectable significance. The physical make-up of the sheep renders the detection of diseases somewhat more difficult than in animals with an integument of less proportions. It must be recognized, also, that the maintenance of sheep in flocks adds to the difficulty of detecting disease among them. Although it might be possible in certain cases to recognize symptoms suggestive of the presence of a neoplasm if the animal were examined as an individual, in a group the same disease may escape notice.

In the forty neoplasms the following varieties of tumors were represented: carcinoma, 17; adenocarcinoma, 5; adenoma, 1; cystadenoma, 1; hemangio-endothelioma, 1; lymphocytoma, 6; leiomyoma, 2; mesothelioma, 1; fibroma, 1; chondroma, 1; osteogenic sarcoma, 2; lymphoma, 2.

Anatomically the forty tumors had a rather wide distribution, affecting most of the important organs besides the skin and the skeletal system. The relative frequency of involvement of the various regions is shown in the following brief summary of the tumors studied.

**Adrenal Gland:** In 10 cases one or both of the adrenal glands were affected by primary tumors. In 7 cases the tumor was unilateral, with no apparent predilection for either the right or the left side. In 3 cases the tumors were identical in both of the adrenal glands. The tumors varied in weight from 15 to 120 gm.
and, although practically all were histologically malignant, metastasis was not observed.

Six of the unilateral and all of the bilateral tumors were carcinomatous. The structure was very cellular; the cells were evidently derived from some portion of the adrenal cortex (Figs. 1, 2, and 3). Although it was not observed that any of the growths had broken through the capsular covering of the adrenal glands, they were nevertheless of a destructive type. Mitotic figures were numerous in most of the material, and the neoplastic elements were destroying and replacing a large portion of the normal tissues. The tumor from one of the cases in which the growth was unilateral was composed of cells histogenetically derived from the cortex of the adrenal gland but, unlike the others in the series originating from the same portion of the gland, this tumor was without the usual histologic features of malignancy. Instead it revealed much evidence of the effects of retrogression and contained a considerable amount of mineral salts. It was considered to be an adenoma. Three of the animals in which unilateral carcinoma of the adrenal glands was found, belonged to a
Fig. 2. CARCINOMA OF THE ADRENAL CORTEX OF A SHEEP
The majority of the closely packed cells possess fusiform nuclei. × 150.

Fig. 3. CARCINOMA OF THE ADRENAL CORTEX OF A FOUR-YEAR-OLD EWE
In this case similar tumors were observed bilaterally. × 285.
A REPORT OF FORTY TUMORS OF SHEEP

lot of 650 which were slaughtered at one time. Since the previous history of the animals was not available, it was impossible to determine whether there was a familial relationship.

The age of two of the animals with carcinoma of the adrenal gland was given as three years and four years, respectively; the others were described as old. These meager data would indicate that carcinoma of the adrenal gland of sheep usually occurs in animals which can no longer be considered young.

**Bone and Cartilage:** Three of the tumors originated in, or were associated with, bone or cartilage. One of these, which was intimately attached to the substance of the right scapula of a one-year-old male sheep, had the histologic appearance of a very immature, rapidly growing fibrosarcoma. The site of origin of this tumor would probably justify a more correct diagnosis of osteogenic sarcoma, even though the differentiating features characteristic of an osteoblastoma were not observed. Careful necropsy did not disclose metastasis. The scapula of a five-year-old ewe was also the site of a tumor which measured about 10 cm. in diameter and weighed about 1 kg. This was considered histologically to be a chondroma (Fig. 4). The third tumor of this group affected the ribs of the entire thoracic cavity of a

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![Figure 4](image_url)
three-year-old Shropshire ewe. Practically every rib had from one to several enlargements, and the growths, which were cartilaginous, extended to and involved the spinous processes of the vertebrae. None of the long bones was affected nor was metastasis to any of the internal organs observed. Sections taken from different parts of the tumor revealed considerable variation in appearance. In some areas there was predominance of a mucus-like substance, whereas in others cartilage and even bone forma-

![Image](https://example.com/image.png)

*Fig. 5. Osteogenic Sarcoma of the Thoracic Region of a Sheep*
A few irregular areas of cartilage are present. × 120

tions were seen (Fig. 5). The tumor might be called a myxochondrosarcoma, or perhaps more correctly osteogenic sarcoma.

*Orbital Region:* Both of the tumors obtained from the tissues of the orbital region were epidermoid carcinoma (Fig. 6). Neither had established discernible metastases, although the tumors were large and had destroyed much of the eyeball and the surrounding normal tissue. Both of the affected animals were old ewes.

*Heart:* One tumor, a fibroma, involved the heart. It was situated at the apex of the organ of a four-year-old ewe. It measured about 8 and 6 cm. in two diameters and weighed approximately 250 gm. The tumor contained some calcification.
FIG. 6. Epidermoid Carcinoma of the Orbital Tissues of an Old Female Sheep. × 150

FIG. 7. Adenocarcinoma of the Liver of a Three-Year-Old Sheep. The tumor possibly originated from the epithelium of the bile duct. × 150.
Liver: The liver was affected in five cases. Each of the tumors was epithelial in origin and histologically disclosed a malignant type of structure, although metastasis was observed in only one case. Two of the tumors were adenocarcinomas, perhaps originating from the bile ducts (Fig. 7), two were carcinomas of the hepatic cells (hepatoma), and one was an extremely vigorously growing carcinoma; the origin of the type cell could not be determined. One of the mediastinal lymph nodes showed the presence of destructive metastasis from the hepatic tumor. The lung of this sheep also contained a malignant epithelial tumor which was diagnosed as adenocarcinoma, possibly originating from the mucous lining of the bronchioles or bronchi (Fig. 8). There was no morphologic relationship between the tumors of the liver and mediastinal lymph node and that of the lung. They were quite unrelated and represent an example of multiple primary neoplasia in the same individual.

The carcinomas of the hepatic cells (hepatoma) were similar in most respects to those described as occurring in cattle (Feldman).
neoplasms, it is difficult to account for the fact that they did not exhibit a greater tendency to metastasis.

_Lung:_ Besides the adenocarcinoma of the lung which was present with carcinoma of the liver, tumor of the lungs was found in two other animals. In both lungs of one animal, a four-year-old ewe, were extensive pearly white areas which were raised slightly above the surface of the organs. The adjacent or regional lymph nodes were not affected. On histologic examination the neoplastic process was found to be multiple cystadenoma with large areas of myxomatous degeneration (Fig. 9).

The other tumor was observed in the anterior lobe of the right lung of an old ewe. The tumor measured 20 × 18 × 8 cm. and was found in association with lesions of caseous lymphadenitis. Metastasis from the tumor had not occurred, although lesions of caseous lymphadenitis were present in the liver and in several of the lymph nodes in addition to the lesions in the lung. The tumor consisted of irregular whorls of closely arranged ovoid cells with rather clear, faintly staining, elongated nuclei (Fig. 10). The growth was diagnosed a mesothelioma originating perhaps from cells of the visceral pleura.

**Fig. 9. Primary Cystadenoma of the Lungs of a Four-year-old Sheep. × 130**
Lymph Nodes: In four cases the neoplastic process was confined to lymph nodes. Two of the lesions were considered, histologically, as malignant and two as benign. Non-inflammatory hyperplasia of the lymphoid elements I consider as true neoplasm, and the histologic diagnosis of tumors of this kind which are included in this report was made in conformity with that view.

Two of the tumors were simple lymphomas. One tumor involved one of the superior cervical lymph nodes of a six-year-old ewe and weighed about 1.5 kg. The other tumor, which weighed about 2.7 kg., was in the anterior mediastinum. In both of these cases careful examination failed to disclose evidence of tumors anywhere else in the carcass. In one of the cases which presented a malignant lymphoblastoma the neoplastic process affected the parotid, retropharyngeal, and mediastinal lymph nodes; in the other there was bilateral involvement of the prescapular lymph nodes. In the absence of demonstrable changes in the blood in the material studied a diagnosis of aleukemic lymphocytoma was made in each of these cases.
Skin: Tumors of the skin were obtained in two cases. One tumor occurred in an old ewe, and weighed about 1.3 kg. It was irregularly spherical, and was situated in and under the skin in the region of the right prescapular lymph node. Other tumors were not found, although a careful search was made. The tumor was diagnosed squamous-cell carcinoma (Fig. 11). The other tumor occurred in the region of the external surface of the scapulo-humeral joint of a one-year-old sheep whose sex was not recorded.

A nearby subcutaneous lymph node of the leg was also affected. The tumor measured about 6 cm. in diameter and weighed about 90 gm. It was found to be a cystic type of adenocarcinoma. The cells appeared to be rather immature, and mitotic figures were demonstrable. The tissue contained many polymorphonuclear leukocytes and other evidence of infection. The exact origin of the type cell in this tumor is somewhat difficult to determine, although the apparent absence of primary tumor elsewhere would necessarily implicate one of the skin structures.
Thymus: One tumor was obtained from the thymus of a three-year-old ewe; it measured about 8 cm. in diameter. The mass, which was not encapsulated, weighed about 0.5 kg. Metastasis was not observed. Microscopically the tumor consisted of epithelial cells arranged in diffuse sheets, which extended in all directions and replaced much of the normal lymphoid elements of the thymus (Fig. 12). The tumor was considered to be carcinoma, which was probably primary from cells constituting Hassell’s corpuscles.

Thyroid Gland: There was only one tumor in the series of forty which involved the thyroid gland. This occurred in an old ewe. The mass was about 16 and 20 cm. in two diameters, and weighed about 4 kg. It was very cystic, with many areas of necrosis. Metastasis was not observed. Microscopically there was little colloid present and little if any normal thyroid tissue in the sections examined. The bulk of the tumor was undergoing retrogression and there was considerable hemorrhage. A small
FIG. 13. Hemangio-endothelioma of the Kidney of a Sheep. × 170

FIG. 14. Leukemic Lymphocytoma of the Liver of a Sheep
Lungs, kidneys, omentum, and peritoneum were also extensively involved. × 120.
amount of calcification was observed. The areas of tumor consisted of overgrowths of closely packed, cuboidal epithelial cells, which were arranged in incomplete alveoli-like masses. Aggressiveness on the part of the tumor cells was not particularly apparent. The diagnosis was adenocarcinoma.

Uterus: In two animals uterine tumors were found. One animal was aged four years and the other was listed as old. In the four-year-old animal the growth, which measured 2 cm. in diameter, was attached to the distal portion of the left cornu by a strand of connective tissue. The tumor was diagnosed a leiomyoma. The other tumor occupied the body of the uterus and was about 10 cm. in diameter. It weighed approximately 2.3 kg. No other structures were affected. Microscopically this growth also proved to be a leiomyoma.

Site of Initial Lesions Not Determined: In six cases it was not possible to ascertain the origin of the tumor, due in most instances to the fact that tumor was present in two or more places. Subsequent microscopic studies failed to be of much assistance in this respect. In one case the tumor, which measured $14 \times 12$ cm., was attached to the pericardium and extended into the anterior mediastinum. Other involvement was not observed. Microscopically this proved to be a metastatic carcinoma involving a lymph node. The pericardium was probably affected by extension of the growth, which had become established by metastasis in one of the mediastinal lymph nodes.

In one two-year-old male a tumorous condition was present which occupied the liver, spleen, and lung. Involvement of the lymph nodes was not mentioned. A diagnosis of lymphocytoma was made.

A mass weighing about 0.5 kg. was found in the subcutaneous tissue of the left axillary region of a three-year-old ewe. Tumorous tissue was also present in the left prescapular lymph node, in one of the bronchial lymph nodes, and in the lung. A diagnosis was made of leukemic lymphocytoma.

The right kidney and the lungs of an old grade ewe contained numerous vascular tumors. Microscopically the tumor in the respective organs consisted for the most part of small to large, alveolus-like structures lined with a flat type of cell (Fig. 13). Many of the alveolar structures were filled with red blood corpuscles, although from many of the spaces the blood had escaped. In some areas the cells were growing in a diffuse manner. Mitotic
figures were numerous in the less differentiated portions of the growth. A diagnosis was made of malignant hemangio-endothelioma.

Numerous tumorous foci were found to be extensively distributed throughout the lungs, kidneys, liver, omentum, and peritoneum of an old ewe. The condition of the lymph nodes was not observed at the time of the post-mortem examination. A diagnosis was made of leukemic lymphocytoma (Fig. 14).

Tumors of the right kidney, right renal lymph node, right adrenal gland, and liver of an old grade ewe were observed. The general lymphatic system was not grossly affected. A diagnosis was made of leukemic lymphocytoma.

Summary and Conclusions

A report is made of a study of 40 tumors obtained from 39 sheep (*Ovis aries*). The tumors were classified histologically, and as far as possible the anatomic situation of the primary growth was recorded. A review of the literature pertaining to tumors of sheep is included.

Briefly outlined, the more important of the data contained in this report are as follows:

1. The incidence of neoplasms in sheep is less than that for the other domesticated mammals.
2. The tumors usually occur in animals beyond the age of the lamb or young animal.
3. Sheep may be susceptible to any of the histologic varieties of neoplasia.
4. The malignant epithelial tumors constituted the largest group in the material studied.
5. The adrenal glands seem to possess a greater predilection for the development of tumor than any of the other specific tissues or organs; the liver is perhaps second in frequency of specific involvement of organs.
6. Malignant lymphoblastomas, which are common in cattle, constitute only a relatively small percentage of the neoplasms of sheep.
7. The digestive tract of the sheep appears to possess at least a relative insusceptibility to neoplasia.
8. Neoplastic disease does not constitute a factor of economic significance in the practice of sheep husbandry.
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