Problems of Comparative Oncology

With Special Reference to the Veterinary Aspects

E. COTCHIN, D.Sc., M.R.C.V.S.[1]

The author of this article stresses that study of the spontaneous tumours of animals, and of domesticated mammals in particular, from the morphological, biological, etiological, therapeutic and epidemiological aspects may prove of very considerable value in elucidating the nature of spontaneous tumours in man. Emphasis is also laid on the importance of studying the variation between animal species in the occurrence of different types of tumour and in their sites of origin.

The important tumours of the various body systems of domesticated mammals are reviewed and relevant comparisons drawn with human tumours.

Finally, an outline is given of a number of subjects for cancer research involving close collaboration between veterinary and medical workers at the international level.

It was realized long ago that, to gain an insight into the causes and nature of cancer in man, it would be necessary to make a study of the neoplasms, both spontaneous and experimental, of animals. It is interesting to note that the first article in the first report of the (Imperial) Cancer Research Fund in London (1904) dealt with the " Zoological Distribution of Cancer ". The study of experimental tumours in laboratory animals, which is in some ways so spectacular and rewarding, has tended to overshadow other aspects of comparative oncology, of which one of the most promising—that is, the study of spontaneous tumours in animals—still awaits adequate exploration.

In what follows the chief emphasis will be placed on the study of tumours of domesticated mammals —with special reference to the significance of the findings already made, or that may be made in future, in relation to cancer research in general, and the human cancer problem in particular—but the reader will recall the work arising from a study of the spontaneous tumours of fowls, such as Rous sarcoma and avian leukosis, which has extended our knowledge of neoplasia so widely. A strong plea may also be entered for a fuller study of the spontaneous tumours of laboratory, wild and captive animals.

The spontaneous tumours of domesticated mammals (for general references, see Cotchin, 1956) have been studied for many years, even if in a rather fitful way. Much of this work has been done by interested veterinarians—as exemplified in the monographs by Feldman (1932), Mulligan (1949) for the dog, and Tamaschke (1951-52)—but more recently there has been a rapid development of interest on the part of cancer research workers, who are becoming more aware of the many opportunities offered by this line of investigation. Over the past few decades many articles have been published in this field of study (for continuing references to current literature, see *Index Veterinarius* from 1933 onwards). There have been many individual case reports, along with more extensive surveys of series of tumours examined in veterinary schools, abattoirs and elsewhere; and recently a few specific tumours have been subjected to intensive study, e.g., " cancer eye " in cattle in the United States of America, bovine lymphatic leukosis in Europe, urinary bladder cancer in cattle in Turkey.

The veterinary aspects of comparative oncology have understandably been slow to be explored. In general, neoplasms are not of any great economic importance in farm animals, which are in any case often slaughtered at a relatively early age, and most attention has necessarily been given to infectious and other common diseases. It is natural that more has been learnt about the tumours of domestic pets, which are often allowed to live to old age and have a

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[1] Reader in Veterinary Pathology, Royal Veterinary College, London, England.

sentimental value placed on them which encourages interest in their diseases. The number of veterinary pathologists who can afford time to study animal tumours is always bound to be small, but in the aggregate there is over the world quite a lot of work going on in this field, and this needs encouraging, chiefly perhaps by facilitating contacts and communication not only between veterinary workers but also between them and interested workers from other fields of cancer research.

STUDY OF SPONTANEOUS NEOPLASMS IN ANIMALS

The ways in which information can be obtained about the spontaneously occurring tumours of domesticated animals are naturally much more limited than those available to the student of human cancer. For example, the pathologist or other expert may be approached for help by the veterinary practitioner only if the latter is also interested in the subject, and usually the practitioner will not even see the affected animal, let alone refer to a laboratory unless the affected animal's owner is led to present it for clinical examination. Veterinary schools themselves often conduct clinics of various kinds to which owners may have direct access, or to which practitioners may refer. In these schools, series of operation or autopsy specimens of neoplasms may be built up, but there will still be very many cases missed. Another source of information is the surveys that have been made of abattoir and knacker-yard material, but these will give an incomplete coverage of animal disposal, and in too many instances the system of identification and recording of specimens is inadequately developed.

From these various sources of information an incomplete and to some extent misleading idea of the prevalence of different kinds of tumour may be obtained. Even when information is available, due allowance has to be made for the influence of such factors as differing systems of husbandry and management (e.g. more or less close inbreeding), of licensing or identification of animals (e.g., whether a dog licence identifies the animal as well as the owner), of age at slaughter and so on, which may combine to produce a picture which is very complicated, and would hardly be predictable from general considerations. One further point to bear in mind is that, in some respects, easily recognized conditions will appear to predominate while, on the other hand, rarities may receive undue attention.

LINES OF APPROACH

Despite these limitations the study of spontaneous tumours in animals does offer certain advantages. To quote Julian Huxley (1956):

" Cancer is not merely a medical problem: it is a biological problem, whose elucidation is bound up with advances in a number of key fields of present-day biology ... A first step in the analysis of any biological problem is descriptive and comparative study: a natural history of tumours is a necessary basis for cancer research."

For example, it seems inherently probable that an elucidation of the nature of spontaneous tumours in man may in some ways be better facilitated by the study of spontaneous tumours in animals than by dealing with tumours experimentally produced. Domesticated animals represent species of different kinds (herbivorous, ruminant, carnivorous, omnivorous), living in more or less close relation and proximity to man, and sharing many but not all features of his environment or even, as pets, of his diet.

Again, animals bearing spontaneous tumours can be investigated in ways that would not usually be applicable to man. For example, tests of transplantation can be made using the same species of animal as the one in which the primary tumour arises, and trials of suspected etiological or chemotherapeutic agents can also be made on animals of this same species.

From a more general point of view, too, any theories of the nature of cancer in man that cannot adequately be applied also to spontaneous tumours of animals must be faulty or erroneous.

Some of the particular ways in which the study of tumours in domesticated animals can be of value in cancer research will be indicated later, but the relevant studies will generally fall into one or more of the following groups:

Morphological studies, including histology, histogenesis, cytology, electron microscopy and histochemistry.

Biological studies, including: (*a*) Organ localization and incidence. (*b*) Transplantation. For instance, Allam et al. (1954) found it possible, with the use of total body irradiation and cortisone or hydrocortisone, to transplant a spontaneous canine

thyroid carcinoma through a number of generations of mixed-breed puppies. Nielsen & Cole (1961), again with the use of irradiation plus adrenocorticosteroid, obtained successful growths out of 67 implants in 48 dogs, of three tumours: osteosarcoma, mixed mammary tumour and ovarian adenocarcinoma; these authors also refer to successful transplants of four differing canine tumours into the anterior chamber of the eye of guinea-pigs. (c) Biochemistry and serology. (d) Tissue culture. For instance, Rosanoff (1959) obtained tumours in two out of three dogs inoculated with the tenth culture passage of a canine testicular tumour. A number of viruses were tested for their capacity to produce cytopathogenic changes in fortieth tissue culture passages of this cell line; those giving positive results included canine hepatitis virus, and those giving negative results included canine distemper virus.

Etiological studies, as, for example, in the search for a virus in bovine leukosis.

Therapeutic trials. These might include: (a) X-irradiation. (b) Temporary ligation. Allen et al. (1960) studied the effect of the surgical procedure of temporary occlusion of the entire blood supply to canine tumours; 49 accessible spontaneous tumours were treated by temporary ligation for 4- to 11-hour periods by appropriate application of rubber bands or tubes. There developed total tumour necrosis in 29 of 41 benign tumours and in all eight malignant tumours, within periods of several hours to several days; 12 dogs, however, died, possibly because they were poor surgical risks at the time of ligation. (c) Chemotherapy. (d) Regional perfusion (e.g., of canine limb bone sarcomas, by Owen & Stevenson, 1961). (e) Treatment by tissue lysate. Livingston (1958) obtained some successes in treating canine tumours by injecting the host animal with material prepared from a lysate resulting from nonspecific bacterial degradation of human placenta autolysing under pressure for about three months.

Epidemiological studies, as, again, on bovine leukosis.

It is likely that the last two of these groups—therapeutic trials and epidemiological studies—will be the most immediately profitable lines of research to develop in the case of spontaneous animal tumours.

In surveying briefly the important aspects of what is known about the tumours of domesticated mammals, it would be possible to take each species in

turn and mention its important tumours, or to deal with tumour types such as squamous-cell carcinoma, osteosarcoma and so on; but it will probably be more instructive for those with specialized knowledge of human cancer or of tumours of laboratory animals if the tumours of the different animals are taken system by system, with the intention in this way of bringing out the similarities to and differences from human and experimental cancers.

SPECIES VARIATION IN INCIDENCE OF NEOPLASMS

It will become evident during the course of the survey that some tumours occur in a large number of species, while others are more restricted in their range of occurrence, some of them indeed being more or less characteristic of a single species (Dobberstein, 1953; Innes, 1958). Some tumours of man, for example, are practically unknown in animals (choriocarcinoma has not been definitely identified in domesticated animals; Dobberstein, 1955), and conversely, some tumours that are rare in man may occur quite commonly in some other species (for example, Sertoli-cell tumours of the testis are common in dogs). This variation in incidence in different species has given rise to the concept of " wide-range " and " narrow-range " types of tumour. Man is subject to tumours of both these types and the " tumour spectrum " of man can be looked upon as being just as specific or even " peculiar ", as that of, say, the horse. The significance of such a broad grouping of tumours is that " wide-range " tumours will presumably be due to factors capable of affecting susceptible tissue in a variety of species, while the " narrow-range " tumours may be due to specific differences in susceptibility of tissues, or to specific differences in exposure to etiological agents.

The species variation in sites of origin of cancer (Schlumberger, 1957; Lombard, 1961) is a very striking fact, and when it is possible to give an adequate explanation of it we shall be much nearer to an understanding of the causes and nature of cancer than we are today. Some of the differences are undoubtedly due to differences in the relative age of death or slaughter, and a study of aging processes and of neoplastic diseases in animals which are normally slaughtered for food when young but which would be allowed to live out their life-span should be encouraged. Perhaps closeness of inbreeding in some farm stocks may be important, and some specific tumours rest on species peculiarities, e.g., the common hepatoid adenoma of the specialized skin

glands of dogs. Other differences may be due to species differences of a more fundamental nature, and there is a great need for a systematic survey of available knowledge of, and research into, species differences of an anatomical, histological, physiological, biochemical or biological nature.

INCIDENCE OF TUMOURS IN DOMESTICATED MAMMALS

As indicated previously, different kinds of surveys of tumours in animals will yield different figures of incidence—e.g., operation specimens as against autopsy specimens in dogs (Krook, 1954) or in domestic animals in general (Kronberger, 1960, 1961)—and there is no exact information about the absolute prevalence of neoplasms in animals. Some indications of the types of tumour that are encountered in surveys of farm animal tumours can be gained from such reports as those of Monlux, Ander-

son & Davis (1956), Plummer (1948, 1951, 1956) and Nair & Sastry (1953-54).

The following interesting figures are quoted by Innes (1958) from meat inspection returns in the USA, showing the total numbers of animals slaughtered and the total number of carcases condemned for neoplasia: cattle 18 725 455 and 10 838 respectively; calves 7 601 035 and 228; sheep 14 488 712 and 224 ; goats 86 659 and 3; pigs 57 055 438 and 1982; horses 237 462 and 57. Innes comments that these will not usually be sick or senile animals and yet neoplasia was recorded for 5% of all animals condemned for disease at slaughter.

In dogs and cats incidences of the order of 5% and 1%, respectively, of clinical cases have been given by different observers (e.g., Knight & Douglas, 1943, in London), but such estimates must be very inexact. Krook (1954) found an incidence of carcinoma in autopsied dogs of 6.07%.

OCCURRENCE OF NEOPLASMS IN DIFFERENT BODY SYSTEMS OF DOMESTICATED MAMMALS

SKIN AND RELATED TISSUES

Probably because of their superficial and thus ·clinically obvious position and operability, skin tumours generally (but not always) predominate in reported series of tumours of domesticated mammals, more especially, of course, of those obtained at operation. A very wide variety of tumours occurs, and only a few examples of particular interest can be referred to here.

Horses

The tumour of most general interest in the skin of the horse is the melanoma, which occurs frequently in aging grey horses, although it is not confined to animals of this coat colour. It is claimed that at least 80% of grey horses will develop one or more melanomas if they reach old age. The tumour, which is a dermal or subcutaneous lesion, commonly occurs on the underside of the root of the tail, or in the perianal, perineal or preputial regions. The tumours tend to run a clinically benign course over a long period of time, but widespread metastasis does sometimes occur; the metastases are then of considerable extent and highly pigmented, and would provide enormous quantities of melanin for study.

The development of this common lesion of the horse appears to be linked in some way with the progressive whitening of hair that occurs in grey

horses as they grow older. The histology of these equine melanomas suggests a mesodermal rather than an ectodermal melanoblast origin, and a close study of the histogenesis of these tumours will certainly give valuable information. It is rather surprising that, despite the fame of these tumours, they still await adequate histological examination.

Huxley (1956) raises interesting questions about equine melanomas; for instance, do melanomas occur frequently in the Lipizzaner horses in the Imperial Riding Stables in Vienna, which are born black and turn almost white as they develop, or in Percheron draught horses which change colour in a similar way as they grow older?

A second tumour of the integument of the horse that is of great comparative interest is the squamous-cell carcinoma of the glans penis. This tumour, which is of a rather low grade of malignancy, is most often seen in castrated animals, and this has suggested that the lesion is in some way related to the accumulation of smegma in such animals. One report has, in fact, assigned a carcinogenic action to horse smegma as tested on the skin of mice (Plaut & Kohn-Speyer, 1947) and, since carcinoma of the penis is practically unknown in other species of animals, a renewed search for a carcinogen in horse smegma would be rewarding in relation to the penile cancer of uncircumcised man.

Cattle

" *Cancer eye* ". The most interesting tumour of the integument of cattle is the so-called " cancer eye " lesion, which is a squamous-cell carcinoma affecting cornea, conjunctiva or eyelids. (All squamous-cell carinomas in this region are included under the term " cancer eye ", but it is not necessary to assume that they are all of the same type and etiology.) Whereas one very extensive survey in the USA showed lesions of the bulbar conjunctiva or cornea in over 50% of cases (Monlux, Anderson & Davis, 1957), a much more limited survey of the condition in cattle in England showed that most cases there developed from the eyelids (including the membrana nictitans), with the cornea a much less common site of origin.

Conjunctival cancer is a very rare lesion in man, but " cancer eye " in cattle has a very high incidence in certain southern States of the USA (Russell, Wynne & Loquvam, 1956, refer to reports of incidences of 3% or more in some herds), where it is particularly reported in Herefords. The condition occurs in many other countries and in other breeds, but the Hereford, in tropical or subtropical areas, appears to be the most often affected. A detailed study of the disease is being made in America, from the viewpoints of etiology, heredity and relation to eyelid pigmentation. The disease is generally more prevalent in sunny countries than in more temperate climates, and the possibility that ultraviolet light plays a role in etiology clearly exists. The report of French (1959) from Australia is of interest. He states that, in the environment in which he worked (Central Coastal Queensland), there was a striking contrast between the susceptibility of Herefords and that of Shorthorns. There was evidence that complete or nearly complete lid pigmentation was required to give significant protection against the occurrence of eyeball lesions, and he also suggests that the lack of pigmentation of the eyelids may not be the primary cause of susceptibility to carcinoma formation, but may be merely a good indicator of the susceptibility.

While American workers have recommended direct selection for resistance to eye cancer, French suggests that selection based on degree of lid pigmentation would be preferable. The former method has the disadvantage that it cannot be applied at an early stage in the animal's life, while the latter could be carried out accurately at three months of age.

Particular attention has been given to the possibility that " cancer eye " is due to a virus, and should such a virus be demonstrated, this would have great significance in relation to human squamous-cell carcinoma. Similar studies could be made of the rather similar lesions of ocular squamous-cell carcinoma which occur in horses and in sheep.

Other interesting skin tumours of cattle include melanomas and " horn-core cancer ".

Melanomas. In contrast with the melanomas of horses, these lesions in cattle are usually found in young rather than in old animals (they may even be present, as large tumours, at birth), and in dark-coloured breeds (chiefly the black Aberdeen Angus).

" *Horn-core cancer* "—squamous-cell carcinoma of the base of the horn. This condition is seen practically exclusively in Zebu cattle, and in India and the Far East. Lall (1953) refers to 6286 cases in Meerut Circle, Uttar Pradesh, India, in the period 1947-62; 93% occurred in bullocks, but none in bulls. The affected animals were chiefly over 5 years of age. The left or the right horn was affected, but there were no records of both being involved. Lall comments that this condition has not received the attention it deserves. Its exact anatomical site of origin is not known—whether from the base of the horn or from the mucosa of the adjacent frontal sinus—but its high incidence and peculiar localization suggest that some specific etiological agent is concerned. The role of trauma in yoked cattle has been invoked, but this is not generally accepted.

The commonest proliferative lesion of the skin of cattle is the *fibrous wart*, believed to be of virus origin, and an apparently self-limiting condition which is not truly neoplastic.

Sheep and goats

Skin tumours are of little importance in sheep, but in goats a rather high incidence of carcinoma (which may be melanotic) of the skin, especially of the perineum, has been reported occasionally in Angora goats in Africa.

Pigs

The pig in general does not seem prone to develop skin tumours, but recently, in South Africa, there have been reported a number of cases of " multiple acanthoma " of the skin of pigs (Schulz & Schutte, 1960). These tumours, which took the form of squamous-cell carcinomas and occasionally metastasized to regional lymph-nodes, were recorded with a variable incidence in different herds of Large White pigs. The lesions occurred over most of the

body. Attempts to transmit the disease to pigs or to small laboratory animals have so far failed.

Dogs

In the dog, large numbers of skin tumours of many types have been described (Head, 1953; Nielsen & Cole, 1960, for epithelial tumours). For special mention may be singled out melanomas and mast-cell tumours.

Melanomas. Melanotic tumours occur commonly in the skin of the dog (Cotchin, 1955), particularly in breeds with heavily pigmented skin, such as Scottish or Airedale Terriers. The benign forms often have the structure of pigmented neurofibromas, and in some benign tumours dendritic melanoblasts of mesodermal type are numerous. These benign melanomas may correspond to the blue naevus of man (true pigmented naevi appear not to occur in animals). Malignant melanomas which often affect the region of the digits of dogs resemble human malignant melanomas structurally, although junctional change is at least not a prominent feature. A histopathological study of these common tumours of dogs would throw light on melanomas in man.

Mast-cell tumours. According to Larsson (1957), about 10% of skin tumours in dogs are mast-cell tumours (mastocytomas). They appear to be most often seen in Boxer and Boston Terrier dogs (Nielsen & Cole, 1958, found 19% of their cases in Boston Terriers). These mast-cell tumours (Bloom, Larsson & Åberg, 1958) show an intense accumulation of mast cells in the dermis and subcutis, and they are of interest for the light they throw on the properties of mast cells in general, providing enormous numbers of such cells for biological study. The tumours have been shown by Riley and colleagues (Riley, 1959) to contain histamine and heparin, and they may contain 5-hydroxy-tryptamine (Rice & Mitchener, 1961). Lombard & Moloney (1959) reported the homologous transplantation of mast-cell tumours in dogs, and the successful transmission by filtrate from a second generation transplant.

It may be that this mast-cell tumour of the skin of the dog is a particular form of development of the reticulo-endothelial proliferation with sarcoma-like properties and myeloid differentiation that occurs so commonly in the skin of the dog.

Cats

In the cat, the commonest skin tumours (Cotchin, 1961b) are of the basal cell type (and often melano-

tic), in contrast to the dog, whose epidermal tumours are mostly of the glandular type.

Two most interesting tumours of the integument of the cat are the squamous-cell carcinoma, and the ceruminous adenocarcinoma.

Squamous-cell carcinoma. Most squamous-cell carcinomas of the skin of the cat affect the head region, and they occur most often on the ear flap. There is an indication that white cats are particularly susceptible to ear-flap lesions, and the possibility exists that these tumours may be related to the effect of sunlight on unpigmented skin.

Ceruminous adenocarcinoma. Tumours of the ceruminous gland, which are rare in man, are not uncommon in cats. Otitis in cats is quite a common disease, and is often accompanied by ceruminous gland hyperplasia. In some cases, the development of ceruminous gland adenocarcinoma has been preceded by a long-standing otitis, and this may be of etiological significance.

MAMMARY GLAND

The two outstanding facts about neoplasia of the mammary gland in domesticated mammals are, firstly, that mammary cancers, or, indeed, mammary neoplasms of any kind, are extremely rare in cows, and, secondly, that mammary tumours are very common in the female dog, where they are commonly of mixed type and appear to develop in middle-aged or older animals that have had few or no litters.

Cattle

Only some half-dozen or so cases of mammary adenocarcinoma have been reported in cattle. Even in animals of an age-group where other forms of cancer occur, the mammary gland is very rarely affected. Once cows cease to be economic yielders of milk, they will tend to be disposed of, but even so, and while it is possible that some neoplastic lesions have been overlooked, this rarity seems to be significant and needs explaining. It may be that repeated lactation hinders the development of mammary cancer in cows, or that breeding for high milk yield has at the same time bred for resistance to mammary neoplasia.

Dogs

The mammary tumours of the bitch are of interest from two aspects—their histogenesis and their possible hormonal etiology.

Histogenesis. The great majority of the benign mammary tumours of the bitch (Cotchin, 1958) are of the mixed type, and they often show the formation of mucoid, chondroid or osteoid tissues. While some of this complex tissue is formed by metaplasia of intralobular connective tissue (the appearance suggesting an inductive influence of the neoplastic mammary epithelium), some of the complex tissue seems to form as a result of the proliferation of myoepithelial cells. These cells become embedded in a mucoid material, which is in turn changed into cartilage. This latter may be converted, by endochondral ossification, into bone, and bone marrow may form too.

This apparent involvement of the myoepithelial cells in the formation of the benign mixed mammary tumour, recalling the part that has been claimed to be played by these cells in the formation of mixed tumours of salivary glands in man, is very striking, and is possibly related to their high alkaline phosphatase content. Another feature of these mammary tumours is that many of the malignant tumours are not simply adenocarcinomas, of duct or acinar origin, but are more often sarcomas, which are frequently of mucoid type, or may be chondrosarcomas or even osteosarcomas. There are indications that these sarcomas may themselves be of myoepithelial origin.

Among the malignant tumours of the bitch's mammary gland, too, are quite a few lesions which appear to be carcinosarcomas, truly mixed in type, each component being capable of metastasizing independently. These tumours may arise by a neoplastic transformation of both luminal epithelium and myoepithelium.

A study of these common mammary tumours of the bitch should throw light on the myoepithelial cell and on the factors which cause it to proliferate neoplastically. Nielsen & Cole (1961), in their studies of tumour transplantation of dogs, found mucoid and chondroid metaplasia in the connective tissue surrounding a duct structure in a transplanted benign mixed mammary tumour. The problem arises, whether this represents a metaplasia of stroma under the influence of the transplanted duct epithelium, or whether it indicates (as seems likely) that myoepithelial elements were also transplanted and involved in this chondroid change. In passing, it is worth mentioning that mixed tumours of the salivary gland are apparently uncommon in animals (including dogs).

Possible hormonal etiology. Mammary neoplasms are not known to develop at all in bitches that have been ovarohysterectomized before they reach sexual maturity, nor are they likely to occur in bitches which are allowed to produce regular litters. On the contrary, there is a strong indication that mammary tumours develop more commonly in entire bitches that have bred infrequently, if at all. The bitch, should she not conceive at oestrus, passes through a phase of pseudo-pregnancy, and it is possible that it is these repeated pseudo-pregnancies which are concerned in the production of these tumours. It may indeed be that repeated pseudo-pregnancy, with its periodic progesterone stimulation of the mammae which is not followed by full lactation and normal post-lactational involution, is of itself an abnormal physiological state.

Clinical observations suggest that some forms of mammary neoplasia of the bitch may be hormone-dependent, and further endocrinological investigations are clearly indicated.

Cats

Mammary tumours are less often seen in cats than in dogs, but they are not uncommon, and are mostly adenocarcinomas. Mixed mammary tumours in cats, or in any domesticated species but the dog must be very uncommon.

FEMALE GENITAL SYSTEM

There is a striking paucity of reports of uterine cervical carcinoma in animals, and carcinoma of the uterine body also seems to be of relatively little importance, except possibly in cows; there are reports of a rather high incidence of uterine adeno-carcinoma in cattle in the USA (Monlux, Anderson, Davis & Monlux, 1956), but the uterus seems in general not to be very susceptible to neoplasia in domesticated animals. This is so, even in the bitch, which is, conversely, very commonly affected with cystic endometrial hyperplasia.

The important tumours of the female genitalia of domesticated mammals affect the ovary, particularly in the bitch. In this species (Cotchin, 1961a), ovarian tumours, which may sometimes be responsible for hyperoestrogenism, are often granulosa-cell tumours, or adenomas or adenocarcinomas while occasional cases of dysgerminoma are also seen. A striking feature in some cases of granulosa-cell tumours of the bitch is their histological tubular structure, leading to an appearance resembling that of the canine testicular Sertoli-cell tumours. These canine ovarian tumours provide good material for histo-

genetic and other studies, and for comparison with homologous testicular tumours.

Ovarian tumours were found in seven of eight bitches given subcutaneous injections of diethyl-stilboestrol every seven or eight weeks (Jabara, 1959), the tumours developing within 19 months. One of the tumours was an adenoma, the rest were adeno-carcinomas. Three bitches died from the adeno-carcinomas; these animals had also received an implant of methylcholanthrene in a mammary gland.

MUSCULOSKELETAL SYSTEM

The important tumours of this system are the limb bone osteosarcomas of dogs (Brodey, McGrath & Reynolds, 1959); these account, indeed, for practic-ally all tumours of bone origin in this animal. These tumours occur commonly in the limb bones of large dogs (Great Danes and the like), where they arise almost entirely in the region related to the longer of the two epiphyseal plates—upper humerus, lower radius, lower femur especially. They also quite commonly affect the ribs, arising near the costochondral junctions, most often in young adult dogs. The significance of the rather special breed incidence, and of the particular localizations in the limb bones, needs explanation. Schulz (1958) has suggested a possible relationship to disturbed healing processes complicating repair after previous injury, and the sheer weight of the large dog could also possibly be a predisposing factor. However, here as elsewhere, the role of trauma in the etiology of animal tumours remains obscure (Lombard, 1960).

These limb bone sarcomas in dogs provide valu-able material for histogenetic, biochemical and other studies. Owen & Stevenson (1961) have employed limb perfusion techniques in therapeutic studies on canine osteosarcomas.

Limb bone tumours appear to be rare in farm animals; and in view of the possibility that future environmental radioactivity may cause an increase in neoplasms of the bone, the present incidence of such neoplasms in animals—grazing animals, in particular—should be determined, with special reference to local levels of natural or acquired radio-activity.

RESPIRATORY SYSTEM

There is no high incidence of lung cancer in animals, and in any case little that at all closely resembles the typical hilar carcinoma of man. Carci-noma of the nasal cavities and sinuses of the head is of some importance in the horse (Santi, 1960). Endemic carcinoma of the ethmoid region has been described in horses and cattle in Sweden, and in sheep in Germany. A transmissible adenoma of the nasal mucosa has been reported in sheep in Germany (Cohrs, 1952), and similar lesions have been reported in France, and recently in two flocks in the USA (Young et al., 1961).

The rather limited number of reports of primary lung neoplasms in animals have been reviewed by Monlux (1952), who added some cases of his own. In cattle, Monlux, Anderson, Davis & Monlux (1956) refer to primary lung tumours in relation to differen-tiation of such lesions from the pulmonary metas-tases of uterine carcinoma, which appear to be more frequent. Primary lung tumours—apparently bron-chial papillomas arising from epithelium which had undergone squamous metaplasia—were reported by Pearson (1961) in 10 out of 1600 autopsied goats, assumed to be mostly more than five years old; these were all in white castrated males. (This report is of more general interest, as it shows that the lesions could be confused with pulmonary abscesses or with lesions of caseous lymphadenitis, indicating again how abattoir material can give misleading diagnoses unless checked pathologically.)

In reporting 16 primary lung tumours in dogs, Nielsen & Horava (1960) concluded that the most common primary tumour of the canine lung is a bronchiolar adenocarcinoma, characteristically a solitary, peripherally located, well-circumscribed nodule, growing expansively and only rarely metas-tasizing. In their material anthracosis was constantly present in lung and bronchial nodes, and they failed (although more studies were needed) to reveal a significant difference in the incidence of lung tumours between city dogs and country dogs.

There have been suggestions that the incidence of primary lung tumours in animals is increasing, but the supporting evidence is not strong.

In sheep there is the curious condition of pulmon-ary adenomatosis (*Jaagziekte*) which has its counter-part in other species, including man (Duran-Reynals et al., 1958), and is of uncertain nature but may very occasionally be expressed in a malignant form.

CARDIOVASCULAR SYSTEM

Primary tumours of the heart or blood vessels are uncommon in domesticated mammals. A sub-cutaneous haemangioma sometimes occurs in the

dog, and congenital rhabdomyomas have been reported in pigs. Magnusson (1961) has described some instances of apparently primary tumours of the bovine heart, chiefly fibrous or neurofibromatous in nature.

HAEMATOPOIETIC AND LYMPHOPOIETIC SYSTEM

In domesticated mammals, most cases of leukosis are of the lymphatic type, although other forms do occur. (It appears that myeloid leukosis has been reported in ox, pig, dog, cat; plasma cell myeloma in horse, ox, dog; eosinophil leukosis in cat; basophil leukosis in dog and cat; monocytic leukosis in dog and cat; erythroleukosis possibly in pig and cat. Further studies will possibly show that all forms occur in all species.) It is, perhaps, very significant from the viewpoint of etiology that lymphosarcoma, including its more or less generalized form of lymphatic leukosis, occupies a leading and sometimes a primary place among the malignant tumours of these animals, with the exception of the horse.

(In passing, it may be commented that lymphatic leukosis is herein accepted as a form of lymphosarcoma; also it is pointed out that, while recognizing that there is historical priority in use of the term " leukaemia ", this word causes as much semantic and didactic difficulty in the case of animals as of man, and the term " leukosis " is to be preferred.)

Most interest attaches to lymphosarcoma of cattle, dogs and cats, although the condition is of some importance in pigs (Englert, 1955), and it may also occur in sheep to a hitherto unrecognized extent (Enke et al., 1961). In cattle, lymphosarcoma seems to be of world-wide distribution, but its exact incidence remains to be determined. It is striking to note that Nair & Sastry (1953-54) reported only four cases of " lymphocytoma " in cattle in their large series of bovine tumours in India.

Lymphosarcoma in cattle may take the form of " lymphadenosis ", with more or less generalized involvement of lymph-nodes, and infiltrations in spleen, liver, kidneys and elsewhere; or the lesions may be most prominent in certain special sites, including the wall of the right auricle of the heart, the wall of the fourth stomach, the epidural space, and the retro-orbital tissues. In young animals the thoracic or cervical parts of the thymus may be particularly affected.

Of particular significance is the reported occurrence in Western Europe (Germany, Denmark, Sweden) of an endemic form of bovine lymphosarcoma, which is chiefly seen in adult cattle, and with which has been associated the occurrence in affected herds of a high incidence of certain blood changes (lymphocytosis; presence of lymphoblasts or other abnormal lymphocytes) which have been claimed to form a precursor " haematological " stage in which later the classic " tumorous stage " may supervene.

Observers in Germany (Götze et al., 1954) were responsible for fashioning the " leukosis key ", which is an attempt to define " leukosis herds " by a survey of white cell counts and lymphocyte percentages.

In Denmark, Bendixen (1957, 1958, 1959) found a non-uniform geographical distribution of bovine leukosis, with a particular incidence in parts of Zealand and Lolland. The total incidence of cases was 4.1 cases per 100 000 head of cattle annually, varying in most to least affected countries from 40 cases to less than 1 case per 100 000. In certain herds, particularly the relatively large ones, cases of leukosis appeared over a number of years. There was an indication in some cases that there was a connexion between the appearance of leukosis in a hitherto healthy herd and the purchase of breeding animals from a " leukosis herd ". There was generally an interval of some years (four on average) between such a purchase and the recognition of leukosis. In the newly affected herds cases were encountered not only among the purchased animals and their offspring, but also among other cattle. Bendixen refers to the sporadic occurrence of a form of leukosis in cattle up to 1½ years of age which occurred all over Denmark, and is not accompanied by herd " haematological " changes.

The possibility has been considered, and some tentative evidence offered, that a virus may be associated etiologically with bovine leukosis. Much work is being done on this disease, and more is planned, with particular reference to its epidemiology in herds and in geographical areas and to its possible viral etiology.

Bovine lymphatic leukosis represents a form of lymphosarcoma occurring in a ruminant animal, and in a species in which lymphocytes normally predominate among the white blood cells. Canine lymphatic leukosis, which is a common disease, represents the condition in a carnivore, and in a species in which neutrophils predominate in the blood. This canine condition is being studied on epidemiological and etiological lines, and has been well described by Meier (1956) and by Irfan (1961). The latter studied 56 affected dogs, in 53 cases

haematologically; two showed leucopenia, 18 normal white cell values, 17 leucocytosis, and only 16 leuk-aemia.

In the cat, lymphosarcoma, sometimes taking the form of lymphatic leukosis, is a common disease, which would seem to offer, as in the case of the canine and bovine disease, ample opportunities for etiological, therapeutic and other studies of relevance to human lymphosarcoma. At the Angell Memorial Hospital in Boston, Mass., for example, Holzworth (1960) reported that, over a twelve-year period, about 10% of cats autopsied were affected with some type of malignancy of blood-forming tissue, pre-dominantly lymphosarcoma (the corresponding figure for dogs was about 3.5%). While all ages of cat were affected with lymphoid malignancies, about half the cases were in cats 1-5 years of age. The condition chiefly affected the kidneys, intestines, mesenteric nodes, anterior mediastinum (possibly thymus), spleen and liver. Frank leukaemia occurred in about 15% of cats with lymphoid malignancies.

There is no completely certain case of true Hodg-kin's disease in animals. Histologically similar con-ditions have been reported in dogs and pigs. Forbus & Davis (1946) gave an account of material from seven cases of a chronic granulomatous disease of pigs, affecting liver, spleen and lymph-nodes, the histology of which they found to have a close resemblance to that of human Hodgkin's disease. This latter observation should be followed up, pos-sibly by using the pig as a test animal for trans-mission studies on human Hodgkin's disease. The use of the pig as an experimental animal has some advantages—pigs breed rapidly and have large lit-ters, and pathogen-free pigs can be obtained by Caesarian section. Tissue cultures might facilitate experimental work, as the use of pig-kidney mono-layer cultures in detecting virus action is well understood.

ALIMENTARY SYSTEM

Although carcinoma of the glandular stomach is occasionally seen in dogs, it is a very rare lesion in other species; for example, it has not yet been seen in cats, which is perhaps surprising in view of the relative frequency of tumours of the upper alimentary tract in this species. Carcinoma of the large intestine is also rarely seen in a form corresponding to the important human tumour (a few cases of rectal carcinoma occur in dogs). The important tumours of the alimentary system in animals are squamous-cell carcinoma of the upper part of the tract, and

lymphosarcoma of the intestines. Malignant mela-nomas of the mouth are also of some frequency in dogs. While the important upper alimentary tract squamous-cell carcinomas occur in dogs, reference is made to the occurrence of such tumours of the car-diac part of the horse's stomach, which have been thought by some to follow on local damage by horse bot larvae (*Gasterophilus* spp.), and to the endemic occurrence of squamous-cell carcinoma of the rumen and oesophagus which has been seen in Zebu cattle in a limited geographical region of Kenya (Plow-right, 1955).

In the dog, the important squamous-cell carcinoma in a series of dogs examined in London (Cotchin, 1959b) affected the tonsillar epithelium, accounting for about 20% of the tumours from the alimentary tract of that species. The strict localization and quite common occurrence of this tumour, in some regions at any rate, would allow histogenetic study, and a search for a possible causal agent ingested or in-haled by the dog could be made. There have been few cases of canine tonsillar carcinoma described in Europe or America, except that Brodey (1960) reported that this lesion was second only to oral melanoma in a series of malignant mouth tumours in dogs in Philadelphia. Brodey drew attention to the incidence of squamous-cell carcinoma on the gum as well as on the tonsils, and suggested that the high frequency of involvement of these two sites might be related to their anatomical structure, with ingested carcinogens possibly becoming entrapped between the gums and the teeth, or in the tonsillar crypts, where they could perhaps remain protected for long periods of time. The etiological importance of inflammatory lesions of the gums or tonsils also needs consideration.

Malignant melanomas are not rare in the mouth of dogs, especially in breeds with pigmented oral mucosae. In a series of malignant melanomas of the dog's mouth, Gorlin et al. (1959) found "junctional" changes adjacent to the tumour. Squamous-cell carcinoma involving the tongue or the oesophagus is rarely seen in dogs, but in a series of cats examined in London (Cotchin, 1959b) a squamous-cell carci-noma of the upper alimentary tract made up over 10% of the tumours examined (incidentally, most tumours of this type occurred in castrated male cats). The important sites of origin were the epithelium of the ventral surface of the tongue, and the mucosa of the oesophagus just within the entrance to the chest. The geographical incidence of these tumours should be determined. It seems possible that they might be

due to something the cat swallows, either in its food and drink or in the process of licking and swallowing fur. It might be that aerial pollution, for example, could lead to contamination of the fur by some carcinogen.

While carcinoma of the oesophagus is rarely seen in animals other than cats, there is an interesting reported association between the development of oesophageal sarcoma in dogs and infestation in the relevant part of the body by the nematode *Spirocerca lupi*, which has a widespread incidence (Innes, 1958), although it does not occur in Great Britain. The adult worms occur in the thoracic oesophagus and aorta (Seibold et al., 1955).

The important tumours of the intestines of animals are lymphosarcomas, seen chiefly in dogs and cats, but Dodd (1960) has reported a number of cases of carcinoma of the small intestine in ewes of the Romney Marsh breed in New Zealand, occurring chiefly in animals five or more years of age. Dodd suggested that these tumours were sufficiently common (they formed 0.5% of the total number of sheep cases received) to suggest that the sheep would be a suitable animal for experimental studies which might aid the search for means of early diagnosis and treatment of such tumours in humans.

In sheep, liver-cell tumours (unrelated to liver-fluke infestation) predominated among the few tumours of this species that have been examined in London (Cotchin, 1960b). Liver tumours occur not uncommonly in dogs (Rooney, 1959), while gall-bladder tumours occur in cattle (Anderson, Monlux & Davis, 1958) and have been produced experimentally in dogs (Fortner & Leffall, 1961) and in cats (Fortner, 1955).

Tumours of the exocrine pancreas are not very often seen in animals, being found mostly in dogs and cats (Stünzi & Suter, 1958).

URINARY SYSTEM

The two important forms of tumour in this system (excluding the common bilateral renal involvement in cases of visceral lymphosarcoma in cats) are the embryonal nephroma of pigs (Sullivan & Anderson, 1959) and bladder cancer in cattle (Pamukçu, 1957) and dogs (Cotchin, 1959a), although renal carcinoma and adenoma are sometimes seen (e.g., Kast, 1957). Embryonal nephroma is an important tumour of pigs, taking second place in incidence to lymphosarcoma. The lesions affect males or females, are unilateral or bilateral, and may be multiple. They

commonly arise at one pole of the kidney and may very occasionally metastasize. This tumour would offer material for histogenetic study.

Tumours of the urinary bladder of cattle are rather common in certain parts of the world, and they have been particularly described in Turkey, in association with lesions of the disease " haematuria vesicalis ". In Great Britain carcinoma of the urinary bladder is rarely seen in cattle, but there is a more frequent incidence of haematuria vesicalis. Perhaps the occurrence of bladder carcinoma and of the angiomatous lesions of haematuria vesicalis in the Turkish cases is merely coincidental, or perhaps carcinoma is a further phase of development of haematuria vesicalis which does not occur in Great Britain because the presumed causal agent in Turkish cases is acting either in greater concentration, or over a longer period of time, or in a more susceptible type of cattle, than in Great Britain. Olson et al. (1959), have reported the production of mucosal tumours, with a suggestion of early malignant change, by the experimental introduction of bovine cutaneous papilloma material into the bladder mucosa of calves.

The dog has, of course, been used for the study of the experimental production of bladder cancer, but it also appears to develop the spontaneous disease on occasion. The cause of these spontaneous tumours in dogs is not known, but, as in the case of cattle, further work on the presence of tryptophane or other derivatives in the urine of normal and affected animals might be rewarding. An inquiry in one series of cases gave no special indication that the tumours might be related to the ingestion of a dye such as might be present as colouring matter in canned pet food.

It was once thought that carcinoma of the urinary bladder did not occur spontaneously in cats, but an example has recently been reported (Thoonen & Horens, 1960). This observation again cautions one not to conclude that certain tumours do not occur in certain species; it may merely be a matter of time needed to reveal them.

MALE GENITAL SYSTEM

Prostatic carcinoma is an uncommon tumour in animals, being practically confined to the very occasional occurrence of cases in dogs (Grant, 1957) —animals which are, however, very prone to develop prostatic glandular hyperplasia.

One tumour of interest in this system is the equine testicular teratoma (Crew, 1922; Willis, 1938). This

teratoma (which may be multiple and sometimes bilateral in origin) is seen in normally descended as well as in ectopic testes—in some instances, its presence is thought to prevent the normal descent of the testis. There are no definite indications that these equine teratomas ever become malignant.

In dogs, teratomas of the testis are so far unknown, but other testicular tumours are common (Cotchin, 1960a), and include seminomas, interstitial-cell tumours, and Sertoli-cell tumours. Canine testis tumours have a strikingly high incidence as compared with man, and in particular a high incidence of Sertoli-cell tumours. They are commonly associated with ectopia of the neoplastic testis, particularly in the case of Sertoli-cell tumours. Especially also in relation to Sertoli-cell tumours, affected dogs often show endocrine disturbances indicative of oestrogen production by the tumour, and thus, presumably, by their parent cell. Affected dogs are often feminized and show a rather typical alopecia—this tends to be symmetrical in distribution, and involve primarily the ventral thorax and abdomen, posterior and lateral aspects of the thighs, and occasionally the neck and shoulder area if the animal wears harness or collar. The hair is rather dry and brittle and can easily be pulled out. The dog may show gynaecomastia, be attractive to other male dogs as though it were a bitch in season, and develop a flabby and oedematous prepuce, penile atrophy, loss of libido, marked lethargy and premature aging (Brodey & Martin, 1958).

In contrast with man, seminomas in dogs do not seem to be at all liable to metastasize, although their histology is that of a highly malignant tumour; the reason for this discrepancy between structure and behaviour should be sought. Again in dogs, the intratubular origin of seminomas from the seminiferous epithelium is clearly seen, and the absence of teratomas from dogs' testes again indicates that the theory of the development of seminoma from teratoma is without firm foundation, in this species at any rate.

Mention may be made of the occasional occurrence of congenital Sertoli-cell tumours in the testes of bull calves, and of the experimental production of teratomas in the testes of fowls by the injection into the testis, at the proper time of the year and at a suitable age, of zinc salts.

The transmissible venereal tumour of dogs may be referred to here, although it affects both males and females. This lesion, which lies on the borderland between neoplastic and granulomatous prolifera-tions, is transmitted in nature from dog to bitch, and from bitch to dog, at coitus, apparently by the actual transplantation of viable cells. The disease has a world-wide incidence, but as dogs are increasingly brought under social control it tends to disappear from the dogs in a region. The lesion, which is of uncertain cell type, is very susceptible to X-irradiation.

This transmissible venereal tumour of dogs is thought by some to be a true neoplasm; if it is, it is an apparently unique example of a tumour propagated in nature by inoculation of viable cells. The properties of the tumour cells which allow for this transmissibility need characterizing, and a study of the tumour could perhaps elucidate some tissue transplantation problems. If it is not a neoplasm, it may be a granuloma with a peculiarly restricted anatomical localization, the causal agent being transmitted in the transplanted cells. In either case, whether neoplastic or granulomatous, the lesion could be due to a virus.

ENDOCRINE SYSTEM

Tumours of the thyroid gland were commonly reported in some early surveys of tumours in dogs, their incidence appearing roughly to parallel the incidence of goitre in the human population. They do not seem to have a high incidence nowadays. The occasional occurrence of mixed tumours of the thyroid gland of dogs, with an osteosarcomatous mesenchymal component accompanying an adenocarcinoma, is of interest.

Tumours of the parathyroid gland are rare in animals. Not much is known about pituitary gland tumours either, except that they are rather more frequently reported, and are of a variety of types. The adrenal gland of cattle not infrequently shows tumours, either of cortical or of medullary origin, and benign and malignant tumours sometimes occur in dogs (a species in which cortical nodular hyperplasia of the adrenal gland is often seen). A high incidence of cortical adrenal adenomas (or adenomalike foci) was found by Richter (1958) at routine autopsies of female, entire male, and castrated male, clinically normal goats; the tumours were practically confined to the latter.

Tumours of the islets of Langerhans (insulomas) have been especially reported in cattle, chiefly in Italy (see Tokarnia, 1961), and occasionally occur also in dogs (Grant, 1960; Teunisson et al., 1961).

CENTRAL NERVOUS SYSTEM

Tumours of the central nervous system have been little studied until recently, probably because the brain and cord are not often carefully examined at routine autopsies. However, studies such as those made at the Institute for Comparative Neuropathology in Berne show that tumours of this system are not so rare in animals as was once thought. Most reports refer to gliomas, particularly in dogs, but tumours of many other kinds occur as well.

EYE

In the globe of the eye (Saunders & Barron, 1958; Barron & Saunders, 1959), the majority of tumours of primary origin are either melanomas or tumours of iridal or ciliary epithelium; the latter, although quite rare in man, occur rather commonly in dogs. Retinoblastomas are rarely seen in animals.

MISCELLANEOUS TUMOURS

" Mesothelioma "

The development of bovine congenital tumours which seem to arise from the serosa of the peritoneal cavity may be rather commoner than was once thought, as the lesions could be confused with those of tuberculous serositis (Grant, 1958). As tuberculosis comes under increasing control in cattle, it is possible that tumours of this and of other kinds that have been misdiagnosed in the past may be increasingly reported.

Tumours of aortic and carotid bodies

Tumours of the non-chromaffin paraganglia, affecting the aortic bodies of the heart base or the carotid body, most particularly the former, are not rarely reported in dogs (Nilsson, 1955; Jubb & Kennedy, 1957; Kast, 1958; Scotti, 1960). Glomus tumours of the skin are also reported in dogs (Rudolph, 1961; Ferri & Matera, 1960).

COMMENT

The foregoing outline of some features of neoplasia in domesticated mammals has necessarily been very brief, but it will have indicated a number of aspects of veterinary oncology that will catch the interest of workers in the field of human and experimental cancer. Experience has in fact shown that medical pathologists find a study of spontaneous tumours in domesticated animals a very stimulating and rewarding exercise. For example, some difficult points in the classification of human testis tumours are at present being clarified by a study of canine testicular neoplasms, and, similarly, interest is growing in the mixed mammary tumour of the bitch as a common example of a mixed tumour. However, while these rather specialized aspects are well worth study, there are broader approaches which need following, and for this close and growing collaboration between veterinary, medical and other cancer research workers is essential.

The special role of veterinary oncology in the future development of cancer research is under consideration by the World Health Organization at the present time, and groups of medical and veterinary experts have been called together to try to assess the best ways of using the information and material already available, and of encouraging the development of fruitful comparative studies. As time goes on, specific tumours will, of course, be more and more intensively studied, perhaps leading to the publication of an atlas of animal tumours, but special international interest will probably be exhibited in facilitating the exchange of information, material and workers between the contiguous medical and veterinary areas of cancer research. Again, epidemiological surveys may be organized, which may serve to reveal special environmental factors of etiological significance.

It has become clear that, apart from a continuing shortage of trained veterinary workers, one of the factors limiting the value of much veterinary effort is the present unsatisfactory situation with regard to the nomenclature of animal tumours. It is of importance that this should be placed on a firm basis and be fully acceptable to medical as well as veterinary workers, or errors and misunderstandings will multiply.

Again, it is clear that workers in human and experimental cancer too seldom trouble to inform themselves about relevant aspects of veterinary oncology—a failure of communication which is not entirely the fault of the veterinary worker—and a framework of reference centres to which both have access would be of great mutual benefit to medical and veterinary cancer research workers. At such centres, from the veterinary side, there might be studied those tumours of animals which would be

selected because (*a*) they are the counterparts of particularly important tumours of man; (*b*) they offer promise of discovery of etiological agents; (*c*) they may elucidate problems of causation and of pathogenesis; (*d*) they are, or may prove to be, transmissible or transplantable; or (*e*) they offer useful subjects for therapeutic trials.

With this in mind, it seems convenient to place the important tumours of animals into one (or more) of the following groups in respect of how they may most fruitfully be studied at present.

Group 1. This would include tumours that offer very suitable subjects for epidemiological study. In this group would be found such tumours as lymphosarcoma (including lymphatic leukosis) in all species, but particularly in cattle and in dogs; carcinoma of the urinary bladder in cattle, which is particularly reported in certain restricted areas and the distribution of which might have a geological basis; and alimentary cancer in dogs and cats, in relation to which the geographical distribution of carcinoma of the tonsil of the dog, or of carcinoma of the tongue or oesophagus of cats, should be determined with particular reference to any possible relationship to atmospheric pollution.

Epidemiological investigations in animal diseases have certain advantages over similar studies in human diseases. For instance, the environmental factors may be more easily identified from the controlled mode of husbandry and management; genetic, nutritional and pathological information may be fairly readily obtained; and the shorter life-span, as compared with humans, may conveniently telescope the processes under review.

Group 2. In this group, there are those tumours which would seem to be suitable for intensive

research at certain institutes. Apart from the tumours already referred to in Group 1, this Group would include: transmissible venereal tumour of dogs; mammary tumours of the bitch (especially from endocrinological and histogenetic aspects); and bone sarcomas of dogs.

Group 3. Other tumours in animals not falling into the first two groups would be studied as time permitted, with particular attention to characterizing the tumours, and making information available to other interested workers by preparation of study sets of slides, and so on. In this group would fall such tumours as the melanomas and testis tumours of dogs.

Further, therapeutic studies on the spontaneous tumours of animals should be extended. Such studies would exploit the property that distinguishes them from the experimental tumours of laboratory animals usually employed—that is, that these neoplasms are spontaneous. A transplanted tumour might well behave differently in such trials from a spontaneous tumour. The dosage rate, too, applicable to a small laboratory animal may be such that results obtained are different from what they would be in an animal that is big enough, both absolutely and relatively to the tumour it bears, to receive a dosage rate and treatment regime that are more comparable with what can be given to humans.

In conclusion, it is hoped that it has been made clear that in veterinary comparative oncology there is a vast and largely unknown field awaiting exploration. If this field is to be adequately and fruitfully explored, then close collaboration of veterinary workers with workers in the field of human and experimental cancer will be necessary, and a bold and imaginative approach cannot fail to produce very important results.

RÉSUMÉ

L'oncologie comparée est une science à développer, car l'étude des tumeurs spontanées des animaux domestiques peut éclairer la pathogenèse et l'étiologie de processus analogues chez l'homme. Certaines tumeurs — à spectre étendu — affectent plusieurs espèces (y compris l'homme); d'autres — à spectre restreint — ne concernent que peu d'espèces, parfois une seule. Ces différences ne sont pas dues seulement au fait qu'une partie des animaux domestiques sont abattus prématurément (par rapport à leur durée de vie normale). L'auteur décrit ensuite divers types de tumeurs du bétail, des chiens et chats, intéressants pour les cancérologues étu-

diant les tumeurs humaines. Il souligne l'intérêt de l'étude épidémiologique des tumeurs animales, qui peut mettre en relief certains facteurs du milieu, favorisant la néoplasie, qui joueraient le même rôle chez l'homme.

Les recherches, sur le plan international, entre vétérinaires et cancérologues, pourraient être poursuivies sur les tumeurs animales en fonction des points suivants: leur homologie avec certaines tumeurs importantes de l'homme; les promesses qu'elles offrent de faciliter la découverte d'agents étiologiques; l'occasion qu'elles donnent d'élucider des problèmes de pathogenèse; le fait qu'elles sont greffables ou transmissibles, ou, enfin,

qu'elles se prêtent à des essais thérapeutiques. Les études épidémiologiques et les essais de traitement sur les tumeurs animales seront particulièrement importantes: il est en effet plus facile de dépister les facteurs du milieu ambiant pouvant jouer un rôle dans la genèse de tumeurs, dans des élevages d'animaux dont il est plus facile de connaître les caractères génétiques, les conditions de vie et d'alimentation, et dont la taille est plus proche de celle de l'homme que ne l'est celle des animaux de laboratoire.

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