

# A SURVEY ON NEOPLASIA IN DOMESTIC SPECIES OVER A 40-YEAR PERIOD FROM 1935 TO 1974 IN THE REPUBLIC OF SOUTH AFRICA. I. TUMOURS OCCURRING IN CATTLE

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## ABSTRACT

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A survey was carried out on all the bovine neoplasms recorded in the registration files of the Section of Pathology of the Veterinary Research Institute, Onderstepoort, Republic of South Africa, over a 40-year period from 1935 to 1974. The 606 neoplasms were divided and tabulated into 20 groups according to body systems or tissue types.

Skin, connective tissue, lymphoid tissue and ocular tumours in that order accounted for the majority of neoplasms. Squamous cell carcinoma was the most frequent neoplasm and the 2 main sites for it were the eye and the vulva. Fibromas and fibrosarcomas made up the majority of the connective tissue tumours. The lymphoid tissue tumours, composed almost entirely of lymphosarcomas, were the 3rd most common group of tumours. Penile fibropapillomas and cutaneous papillomas were commonly encountered, and there was also a noteworthy incidence of melanomas, mesotheliomas and neurofibromas. The male and female genital tracts were relatively frequently neoplastic, due principally to the occurrence of penile fibropapillomas, vulvar squamous cell carcinomas and uterine carcinomas. The incidence of respiratory, hepatic and vascular system tumours was moderate, whilst tumours of the endocrine, central nervous, skeletal and muscular systems were rarely encountered.

## INTRODUCTION

Numerous surveys conducted in countries throughout the world give a good indication of the frequency of occurrence of different types of tumours encountered in the bovine species. In Canada and the United States of America (USA), ocular squamous cell carcinoma was the most common bovine neoplasm, followed by tumours of the lymphoid tissue (Priester & Mantel, 1971), whilst in Israel lymphosarcomas were the most frequent type of neoplasm encountered (Nobel, Neumann & Klopfer, 1970). Tumours of connective tissue origin were commonly encountered in cattle in India (Sastry & Tweihaus 1964) and in New Zealand (Shortridge & Cordes, 1971). Jackson (1936) reported on the pathology and incidence of tumours encountered in the domestic animal species of the Republic of South Africa (RSA) for a period of 15 years up to 1934. He found that cutaneous squamous cell carcinoma was the most frequent neoplasm in cattle, followed by cutaneous papillomas.

The purpose of this present survey is to report on the incidence and type of tumours encountered since the time of Jackson's survey. Furthermore, it is intended that this survey should serve as a basis for a comparison of the tumours occurring in South African cattle with those found in cattle in other countries.

## MATERIALS AND METHODS

The data for this survey were obtained from material submitted by private or state veterinarians and stock inspectors from all parts of the RSA to the Section of Pathology of the Veterinary Research Institute (VRI), Onderstepoort. A 40-year period was chosen as this is an extensive timespan and so should give an accurate account of the tumours occurring in cattle. The period 1935-1974 was selected because during this period the Section of Pathology of the VRI was the only veterinary laboratory in the RSA to which specimens from domestic animals could be submitted for histopathological examination. Hence the types of tumours encountered through the course of this survey should reflect the true country-wide situation.

The registration files for each year of the survey were carefully screened and all cases diagnosed as tumours were noted. The pertinent data on these cases were recorded in a separate registration file. The specific bovine tumours for each year were tabulated under arbitrarily selected headings of tissue types or body systems.

The totals for each of 20 groups and for the entire survey period were recorded and the percentage incidence for each different group of tumours was calculated. When necessary the neoplasms within each group were subdivided and tabulated for further analysis.

For the first 15 years of the survey (1936-1951), all the cases retained in our files as preservation cases were collected. The embedded tissues of these cases were routinely recut at 4-6  $\mu\text{m}$ , stained with haematoxylin and eosin (HE) and re-examined under the light microscope. This was necessary, it was felt, to ensure that the diagnoses recorded in the registration files were correct and to obtain uniformity with regard to the nomenclature, since, in the past, some tumours were diagnosed under names no longer used today. Any cases for which no diagnoses could be made because of insufficient material for re-examination were not included in the survey. For the purpose of this survey all tumours recorded were tabulated, using only the present-day terminology.

## RESULTS

The number and type of tumours encountered for each 10-year period of the survey were tabulated into 20 different groups (Tables 1-3). The data in the groups for which the specific tumours were both numerous and varied have been further tabulated, and a histogram compiled from it (Tables 4-9 and Fig. 1).

Of the 606 tumours recorded those most commonly encountered were of 11 types (Table 4). Squamous cell carcinomas were the most common neoplasms, followed by tumours of the connective tissue and lymphosarcomas. Cutaneous papillomas, penile fibropapillomas and melanomas had a similar incidence. Fibropapillomas occurred almost exclusively on the penis, except for 1 in the rumen (Table 1).

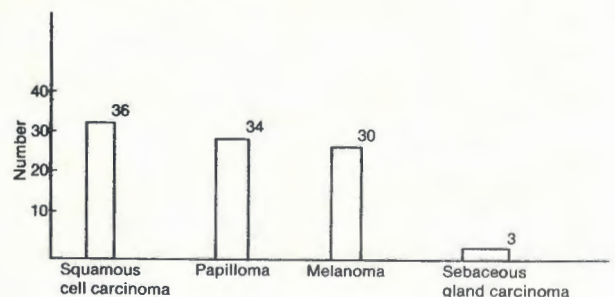


FIG. 1 The different types of bovine skin tumours

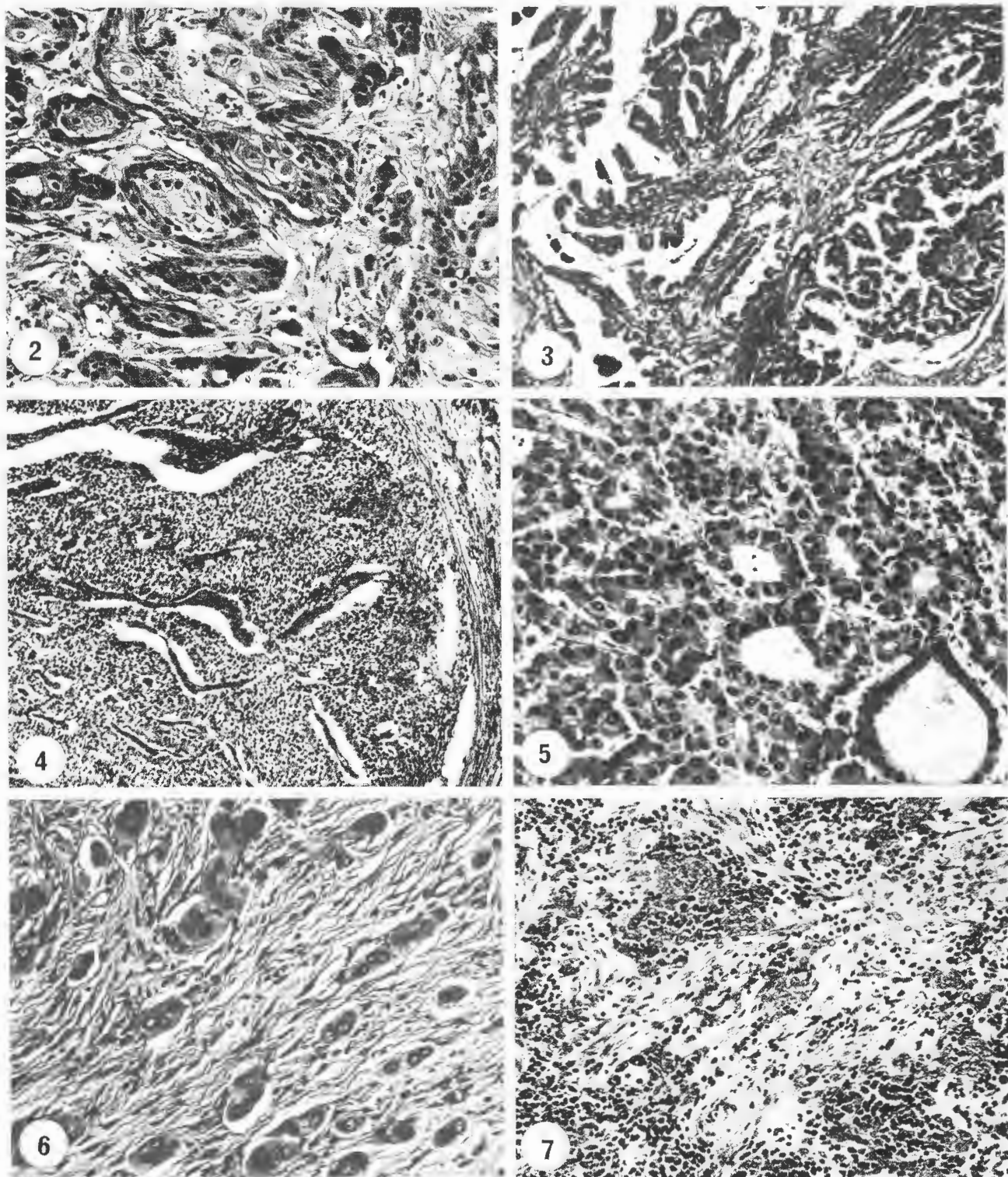


FIG. 2 Squamous cell carcinoma arising from the nictitating membrane: HE  $\times$  200

FIG. 3 Renal papillary adenocarcinoma. Papillary outgrowths extending into lumens: HE  $\times$  75

FIG. 4 Hepatocellular carcinoma, trabecular pattern. Capsule at edge of tumour nodule and trabeculae dissecting tumour nodule: HE  $\times$  30

FIG. 5 Hepatocellular carcinoma, acinar pattern: HE  $\times$  200

FIG. 6 Mesothelioma. Epithelioid cells within sarcomatous stroma: HE  $\times$  500

FIG. 7 Thymoma. Epithelial tumour cells scattered amongst lymphocytic cells: HE  $\times$  75

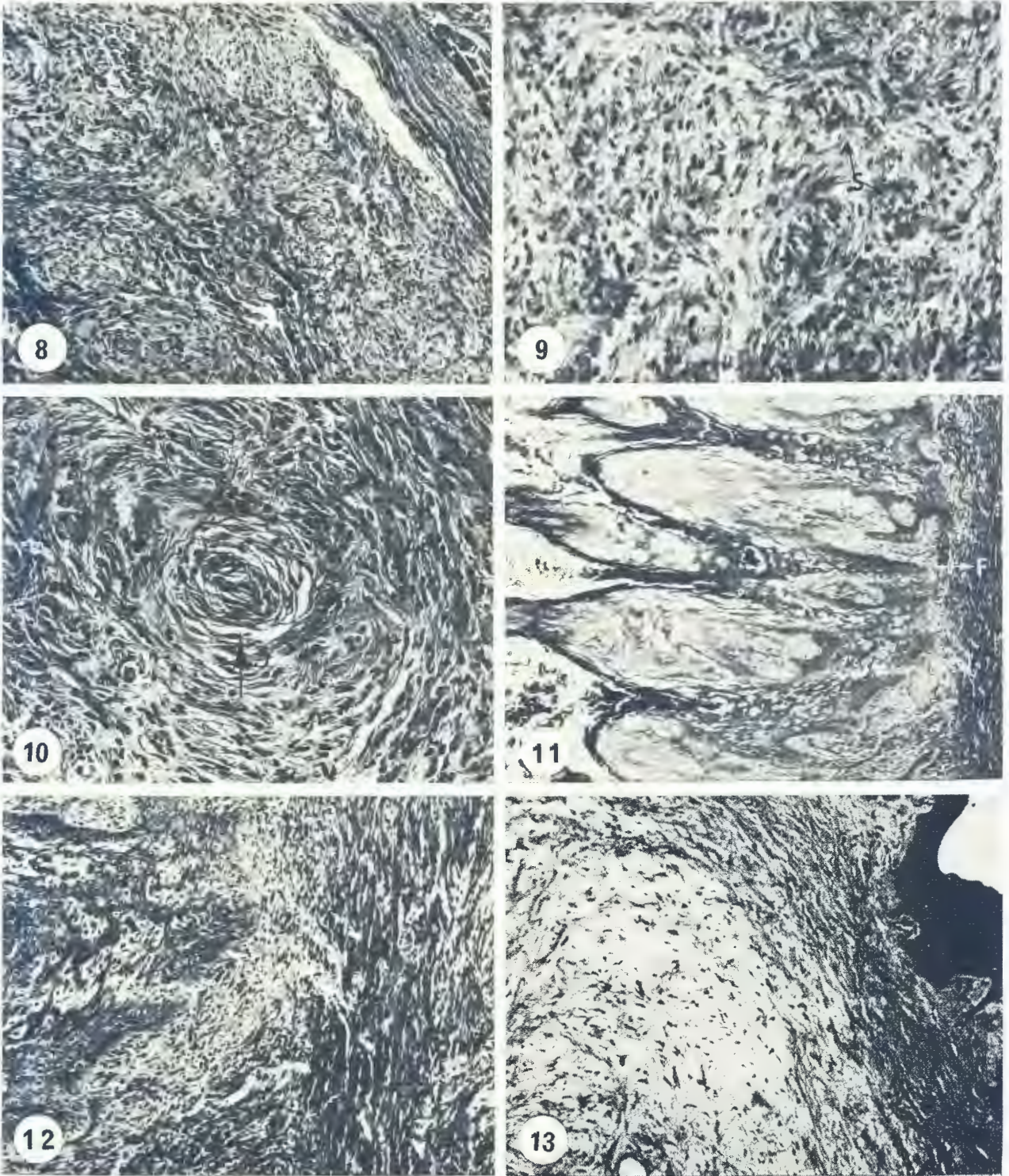


FIG. 8 Neurofibroma in the tongue of an ox. Note capsule of tumour: HE  $\times$  75

FIG. 9 Neurofibroma showing storiform pattern ( $\leftarrow$ S $\rightarrow$ ): HE  $\times$  200

FIG. 10 Neurofibroma with attempt at nerve sheath formation (arrow): HE  $\times$  200

FIG. 11 Penile fibropapilloma. Proliferating epithelial outgrowths showing vacuolar degeneration and hyperkeratosis overlying the fibrous portion (F): HE  $\times$  30

FIG. 12 Penile fibropapilloma. Loose fibrous tissue below the dark hyperkeratotic superficial epithelium: HE  $\times$  75

FIG. 13 Penile fibropapilloma. Hyperkeratotic superficial epithelium overlying oedematous fibrous tissue: HE  $\times$  75

Of the 173 squamous cell carcinomas encountered, it was not possible from the available data to determine the site of origin of 61 (35%) of these. The remaining 112 (65%) were classified according to their site of origin (Table 5). The eye (eyelids, cornea, nictitating membrane and conjunctiva) was the most common site for squamous cell carcinoma in cattle, followed by the skin in general and, lastly, the vulva (Table 5).

The 93 connective tissue tumours were of fibrous, myxomatous or adipose tissue origin (Table 6). Fibromas and fibrosarcomas accounted for 82,8% of all the connective tissue tumours and made up 12,7% of all the tumours recorded in this survey. Lipomas were relatively common amongst the connective tissue tumours (15%), whilst myxomas, myxofibromas and myxosarcomas were very rare. The subcutis was the most common site for both fibromas and fibrosarcomas (57%), whilst the male and female genital tract together accounted for 20% (Table 6).

Out of a total of 103 skin neoplasms, squamous cell carcinomas, papillomas and melanomas had a similar incidence, while sebaceous gland carcinomas occurred only rarely (Fig. 1). Besides occurring on the skin, papillomas were also present as an incidental finding in other organs, such as the rumen, eyelids, vagina and udder.

Tooth and gum tumours were very rare, making up only 3 (0,5%) of the total, and all of these were adamantinomas (Table 1).

Gastro-intestinal tract tumours were also rare, and numbered only 10 (1,7%) of the total (Table 1). They included 2 squamous cell carcinomas, 3 papillomas and 1 fibropapilloma in the rumen, 1 myxosarcoma in the reticulum, 2 fibromas in the oesophagus and 1 adenocarcinoma in the intestine.

Neoplasms of the pancreas were rare, only 2 carcinomas and 1 adenoma being recorded (Table 1).

Tumours of the liver and biliary system made up 3,1% of the total (Table 1). Of the 19 tumours, hepatocellular carcinomas were the most common. They accounted for 11 (59%) of all hepatic tumours. These were followed by 5 cholangiocarcinomas (26,3%) and 1 each of a bile duct adenoma, a hepatic adenoma and a fibrosarcoma.

Respiratory system tumours numbered 34 and accounted for 5,6% of the total (Table 1). Twenty occurred in the lungs, 12 in the nasal cavities and 2 in the pharynx and larynx (Table 7). Approximately 60% of the respiratory tumours were primary pulmonary neoplasms, the most frequent type being pulmonary adenocarcinomas. Nasal cavity neoplasms made up 33% of all the respiratory tumours, whilst a fibroma of the pharynx and one of the larynx were incidental findings.

Tumours of the urinary system were rare, only 0,7% in total (Table 2). These included 2 embryonal nephromas and 2 renal adenocarcinomas.

The female genital tract, accounting for 6,9% of the total tumours (Table 2), was relatively frequently involved and was the 6th most commonly affected system (Table 6). Ovarian tumours made up only 9,5% of all the female genital tract tumours (Table 8). Cervical tumours were rare, whilst the uterus accounted for 28,5% of the tumours, 75% of which were uterine adenocarcinomas. Fifteen (35%) of the tumours occurred in the vulva, almost all of which were squamous cell carcinomas. The latter accounted for 33% of the total tumours of the female genital tract, followed by uterine adenocarcinomas (22%). Fibromas occurred at various sites of the genital tract. There were 3 tumours arising from smooth muscle, 2 in the uterus and 1 fibroleiomyoma in the vulva (Table 8). Only 1 other leiomyoma was recorded, but its site could not be ascertained (Table 3).

Neoplasms of the mammary gland were extremely rare, only 0,5% of the total (Table 2.) These consisted of 2 papillomas and 1 adenoma.

The male genital tract was the 5th most commonly involved system, accounting for 8,4% of the total tumours (Table 2). The penis accounted for 46 (90,2%) of the total 51 tumours, 36 of which were fibropapillomas (Table 9). Only 7,8% of the neoplasms in the male genital tract were primary testicular tumours.

Very few tumours were encountered in the central nervous system, only 4 (0,7%) in all (Table 2). Of these 3 were ependymomas and 1 a meningioma.

Tumours of the peripheral nervous system numbered 18 (2,9%) (Table 2), 16 of which were neurofibromas. These were the 8th most common type of tumour encountered in cattle (Table 4). The other 2 included a neurofibrosarcoma and a schwannoma (Table 2).

Lymphoid tissue neoplasms, the 3rd most common group of tumours, numbered 64 (10,6%) of the total (Table 2). Only 2 of these were thymomas, the rest being lymphosarcomas, one of which arose from the lymphoid tissue of the eye (Table 3).

Neoplasms of the blood vessels numbered 16 (2,6%) of the total. Twelve (75%) of these were haemangiosarcomas and the remaining 4 haemangiomas (Table 3). Two of the haemangiomas occurred in the liver. The sites of origin of the haemangiosarcomas varied and included muscle, skin, liver and spleen. Tumours arising from lymph vessels were very rare and only 1 lymphangiosarcoma was recorded.

Endocrine tumours were rare and numbered only 5 (0,8%). These included 4 thyroid adenomas and 1 pheochromocytoma.

The eye accounted for 10,2% of all the tumours. Of these 57 (92%) were squamous cell carcinomas involving either the eyelid, cornea or nictitating membrane. The remaining 5 comprised a lymphosarcoma, a lacrimal gland adenoma and adenocarcinoma and 2 papillomas. Fifty-seven (51%) of the squamous cell carcinomas for which the site of origin could be determined arose in the eye (Table 5).

Mesotheliomas made up 3% of the tumours. They were the 7th most common type of neoplasm encountered (Table 4).

Bone tumours were extremely rare and only 6 (1%) were recorded. These consisted of 3 osteosarcomas, 2 osteomas and 1 chondrosarcoma (Table 3).

## DISCUSSION

The 4 tissue types that were most frequently neoplastic in cattle were the skin, connective tissue, lymphoid tissue and eye in that order of frequency. Surveys conducted in several other countries also showed these 4 tissues to be the most commonly involved, although not always in the same order.

Priester & Mantel (1971) found that in the USA and Canada the eye, followed by the lymphoid tissue, was the most frequently neoplastic. Squamous cell carcinoma of the eye was the single most common tumor encountered in cattle in India (Chandrasekharan Nair & Sastry, 1954), Colorado (Monlux, Anderson & Davis, 1956) and Kansas (Sastry & Tweihaus, 1964) in the USA, and East Africa (Murray, 1968). In the RSA, Squamous cell carcinoma was also the most common single neoplasm encountered, making up 28,5% of the total tumours. Fifty-seven of the squamous cell carcinomas the site of origin of which was known arose from the eye and orbital region.

TABLE 1 Tumours of the skin, connective tissue and the digestive and respiratory systems

Period	Connective tissue*	Skin and appendages	Tooth and gum tumours	Gastro-intestinal tract	Pancreas	Liver and biliary system	Respiratory system
1935-1944	2 fibrosarcoma 1 fibroma 1 lipoma	8 papilloma 2 squamous cell carcinoma 3 melanoma		1 papilloma 1 intestinal adenocarcinoma 1 squamous cell carcinoma (rumen)	1 pancreatic adenocarcinoma	4 hepatocellular carcinoma	9 nasal carcinoma 2 combined epidermoid/adenocarcinoma
1945-1954	1 fibrosarcoma 1 fibroma 1 lipoma	6 papilloma 8 squamous cell carcinoma 2 melanoma 1 sebaceous gland carcinoma	1 adamantinoma	1 myxosarcoma (reticulum)		2 hepatocellular carcinoma 2 cholangiocarcinoma 1 hepatic adenoma	2 nasal carcinoma 4 pulmonary adenocarcinoma 1 epidermoid carcinoma
1955-1964	2 fibrosarcoma 14 fibroma 1 lipoma	9 papilloma 16 squamous cell carcinoma 10 melanoma 1 sebaceous gland carcinoma		1 papilloma (rumen) 1 fibroma (oesophagus)	1 pancreatic adenocarcinoma 1 pancreatic adenoma	2 hepatocellular carcinoma 2 cholangiocarcinoma 1 fibrosarcoma	5 pulmonary adenocarcinoma 1 epidermoid carcinoma 1 fibroma (pharynx)
1965-1974	7 fibrosarcoma 26 fibroma 11 lipoma 1 myxoma	11 papilloma 10 squamous cell carcinoma 1 sebaceous gland carcinoma 15 melanoma	2 adamantinoma	1 squamous cell carcinoma (rumen) 1 papilloma (rumen) 1 fibropapilloma (rumen) 1 fibroma (oesophagus)		3 hepatocellular carcinoma 1 cholangiocarcinoma 1 bile duct adenoma	1 nasal carcinoma 6 pulmonary adenocarcinoma 1 combined epidermoid/adenocarcinoma 1 fibroma (larynx)
TOTAL	69	103	3	10	3	19	34
% of total tumours in survey	11,4%	17,0%	0,5%	1,7%	0,5%	3,1%	5,6%

\* connective tissue = fibromatous, myxomatous and adipose tissue.

TABLE 2 Tumours of the urogenital and nervous systems and of the lymphoid tissue

Period	Urinary system	Female genital system	Udder	Male genital system	Central nervous system	Peripheral nervous system	Lymphoid tissue
1935-1944		7 squamous cell carcinoma 1 fibrosarcoma 1 fibroleiomyoma		2 fibroma	1 meningioma	2 neurofibroma	3 lymphosarcoma
1945-1954	1 renal adenocarcinoma 1 embryonal nephroma	2 squamous cell carcinoma 2 uterine adenocarcinoma		7 fibropapilloma		10 neurofibroma 1 neurofibrosarcoma 1 schwannoma	8 lymphosarcoma 1 thymoma
1955-1964	1 renal adenocarcinoma	8 squamous cell carcinoma 1 uterine adenocarcinoma 3 fibroma 2 fibrosarcoma 1 myxofibroma 1 papilloma 1 ovarian adenocarcinoma	1 papilloma (skin—udder) 1 papilloma (teat)	4 fibropapilloma 6 fibroma 1 seminoma		3 neurofibroma	11 lymphosarcoma 1 thymoma
1965-1974	1 embryonal nephroma	6 uterine adenocarcinoma 2 fibroma 2 leiomyoma 1 ovarian adenocarcinoma 1 granulosa cell tumour	1 mammary gland adenoma	25 fibropapilloma 3 fibroma 1 seminoma 2 Sertoli cell tumour	3 ependymoma	1 neurofibroma	40 lymphosarcoma
TOTAL	4	42	3	51	4	18	64
% of total (606) tumours in survey	0,7%	6,9%	0,5%	8,4%	0,7%	2,9%	10,7%

TABLE 3 Tumours of the vascular, endocrine and skeletal systems of the eye, undifferentiated and unclassified tumours

Period	Blood vessels and lymphatics	Endocrine system	Skeletal system	Ocular system	Undifferentiated tumours	Site unspecified or unclassified tumours
1935-1944	1 haemangiosarcoma (site unspecified)			3 squamous cell carcinoma (eyelid) 2 squamous cell carcinoma (nictitating membrane)	1 undifferentiated carcinoma	1 mesothelioma
1945-1954	1 haemangiosarcoma (liver)	1 phaeochromocytoma	1 osteosarcoma	20 squamous cell carcinoma (site unspecified) 1 lacrimal gland adenocarcinoma 2 papilloma (eyelid)		3 squamous cell carcinoma (site unspecified) 2 mesothelioma
1955-1964	1 haemangiosarcoma (muscle) 2 haemangiosarcoma (skin) 2 haemangiosarcoma (spleen) 2 haemangiosarcoma (site unspecified) 2 haemangioma (liver) 1 lymphangiosarcoma	2 thyroid adenoma 2 thyroid cystadenoma	1 osteosarcoma 1 chondrosarcoma	16 squamous cell carcinoma (site unspecified) 1 lymphiosarcoma 1 lacrimal gland adenoma	4 undifferentiated carcinoma	5 squamous cell carcinoma (site unspecified) 7 mesothelioma
1965-1974	3 haemangiosarcoma (site unspecified) 2 haemangioma		1 osteosarcoma 2 osteoma	16 squamous cell carcinoma (site unspecified)	4 undifferentiated carcinoma	53 squamous cell carcinoma (site unspecified) 8 mesothelioma 1 leiomyoma (site unspecified)
TOTAL	17	5	6	62	9	80
% of total (606) tumours in survey	2,8%	0,8%	1,0%	10,2%	1,5%	13,2%

The high incidence of ocular squamous cell carcinoma in cattle throughout the world implies a possible viral aetiology. This has never been proven but recently, Ford, Jennings, Spradbrow & Francis (1982) electronmicroscopically demonstrated the presence of papilloma viral particles in 8 out of 25 lesions such as papillomas, plaques and cutaneous horns of the eyes of cattle. These lesions potentially can develop into squamous cell carcinomas. These authors suggested a multiple aetiology for ocular squamous cell carcinoma, namely, papilloma virus together with prolonged exposure to sunlight. Lytle, Hellman & Telles (1970) cited by Moulton (1978) indicated that ultraviolet irradiation can enhance viral transformation and so induce the development of tumours. The intense sunlight in the RSA can thus account for the high incidence of ocular squamous cell carcinoma in this country. The incidence is, however, not as high as in parts of the USA such as Colorado (Monlux *et al.*, 1956) probably because the Hereford breed is less popular in this country than in the USA. The Hereford breed lacks melanin pigment in the eyelids and around the eyes. Moulton (1978) suggested that this lack of pigment could enhance the carcinogenic effect of ultraviolet irradiation on the eye.

The strong South African sunlight probably also accounts for the relatively high incidence (15% of all squamous cell carcinomas) of vulvar squamous cell carcinoma. Burdin (1964) suggested that the higher occurrence of vulvar squamous cell carcinoma in Kenyan cattle with unpigmented vulvas as opposed to those with pigmented vulvas could be ascribed to the effects of intense solar irradiation.

Two squamous cell carcinomas of the rumen were found. Similar tumours were also reported incidentally in a survey conducted in Canada (Plummer, 1956).

The number of cutaneous squamous cell carcinomas in this survey was high (32%) when compared with that reported in other countries, including India, 5,15% (Chandrasekharan Nair & Sastry, 1954), the USA, 0,1%; 2,7% (Monlux *et al.*, 1956; Sastry & Tweihaus, 1964) and New Zealand, 6,2% (Shortridge & Cordes, 1971).

Connective tissue tumours were the 2nd most common group of tumours, accounting for 17,0% of the total. A similar incidence was recorded in cattle in India (Sastry & Tweihaus, 1964) and New Zealand (Shortridge & Cordes, 1971). However, in other surveys, connective tissue tumours were lower down the list as regards frequency of occurrence and tumours of the lymphoid tissue were either the most common tumours (Hayes, Priester & Pendergrass, 1975; Nobel *et al.*, 1970) or the 2nd most common after ocular squamous cell carcinoma (Sastry & Tweihaus, 1964). Amongst South African cattle lymphosarcomas made up only 10,2% of the total, although these tumours were the 3rd most common type of tumour encountered. This incidence of 10,2% has been derived from examination of biopsy or post-mortem material. However, as the herd status of leukosis in cattle in the RSA has not been determined, this level of 10,2% may likely be a low reflection of the true incidence of leukosis in cattle in this country.

Of the connective tissue tumours, just over 80% were either fibromas or fibrosarcomas. Anderson & Sandison (1969) encountered a similar incidence for these 2 tumours (if nerve sheath, bone, muscle and blood vessel tumours were excluded as connective tissue tumours.) Nobel, Klopfer, Perl & Nyska (1979) also found that fibrous tissue tumours accounted for the majority of connective tissue tumours. Tumours arising from myxomatous tissue were rare, but one can expect to encounter them occasionally in the forestomachs of ruminants

because of the nature of the connective tissue present in the papillae of the rumen and omasum. Anderson & Sandison (1969) recorded a myxoma in the rumen. The incidental finding of a myxofibroma in the ovary can also be expected, if one considers the nature of the connective tissue present within the ovary.

Penile fibropapillomas had a relatively high incidence and accounted for 5,9% of the total tumours. These tumours have been reported to be common in young bulls in several countries including the USA, Canada, Great Britain, France and Germany (McEntee 1950; Moulton 1978).

TABLE 4 The commonest bovine neoplasms

Type	Number	% of 606 tumours
Squamous cell carcinoma	173	28,5
Connective tissue tumours	93	15,3
Lymphosarcoma	62	10,2
Penile fibropapilloma	36	5,9
Cutaneous papilloma	32	5,3
Melanoma	30	5,0
Mesothelioma	18	3,0
Neurofibroma	16	2,6
Pulmonary adenocarcinoma	15	2,5
Haemangiosarcoma	12	2,0
Nasal carcinoma	12	2,0
	499	82,3

TABLE 5 Site of origin of the squamous cell carcinomas

Site	Number	%
Eye	57	51
Skin	36	32
Vulva	17	15
Rumen	2	2

TABLE 6 The connective tissue tumours

Tumour	Site	Number	% of total connective tissue tumours
Fibroma	Subcutis	42	45,1
	Penis	8	8,5
	Scrotum	1	1,0
	Female genital tract	5	5,3
	Oesophagus	2	2,1
	Pharynx/larynx	2	2,1
Fibrosarcoma	Subcutis	11	11,7
	Vagina	3	3,1
	Penis	2	2,1
	Liver	1	1,0
Lipoma		14	15,0
Myxoma		1	1,0
Myxofibroma	Ovary	1	1,0
Myxosarcoma		1	1,0
TOTAL		93	100

TABLE 7 The respiratory system tumours

Site	Type	Number
Lung	Pulmonary adenocarcinoma	15
	Combined epidermoid/adenocarcinoma	3
	Epidermoid carcinoma	2
Nasal epithelium	Nasal carcinoma	12
Pharynx	Fibroma	1
Larynx	Fibroma	1
TOTAL		34



TABLE 8 Neoplasms of the female genital tract

Organ	Type	Number
Ovary	Ovarian adenocarcinoma	2
	Granulosa cell tumor	1
	Myxofibroma	1
Uterus	Uterine adenocarcinoma	9
	Fibroma	1
	Leiomyoma	2
Cervix	Fibroma	1
Vagina	Fibroma	3
	Fibrosarcoma	3
	Squamous cell carcinoma	3
	Papilloma	1
Vulva	Squamous cell carcinoma	14
	Fibroleiomyoma	1
TOTAL		42

TABLE 9 Tumours of the male genital tract

Site	Type	Number
Testis	Seminoma	2
	Sertoli cell tumour	2
Scrotum	Fibroma	1
Penis	Fibroma	8
	Fibrosarcoma	2
	Fibropapilloma	36
TOTAL		51

The incidence of cutaneous papillomatosis was also relatively high (5.3% of the total). Chandrasekharan Nair & Sastry (1954), in India, Nobel *et al.* (1970) in Israel and Sastry & Tweihaus (1964) in the USA recorded a similar incidence. Moulton (1978) also reports on the frequent occurrence of cutaneous papillomas in young cattle. It has been shown by various researchers that cutaneous papillomatosis of cattle is caused by the bovine papilloma virus (Moulton, 1978). This condition is commonly encountered in calves and recognized as such by veterinarians in the field. It is thus likely that only a few specimens of bovine cutaneous papillomas are submitted for histopathological examination. Consequently the figure of 5.3% recorded in this survey probably represents a lower incidence than the true occurrence of bovine cutaneous papillomatosis in the field.

In this survey melanomas accounted for about 1/3rd of all skin tumours and 5% of the total. This is a relatively high incidence and only in 2 other surveys, one conducted in India (Chandrasekharan Nair & Sastry, 1954) and the other in New Zealand (Shortridge & Cordes, 1971), was a similar incidence recorded. On the other hand, Moulton (1978) states that melanomas occur commonly in the dog and horse but not in cattle and goats. As this paper deals only with the number and type of tumours encountered in cattle the reason for this discrepancy is not apparent.

Mesotheliomas are a rare tumour in most animal species but, according to Moulton (1978), they are encountered most frequently in the bovine species. They usually occur as a congenital tumour in foetuses or young calves up to a few months of age (Baskerville, 1967). They made up 3% of the total tumours in this survey which tends to support the statement that amongst domestic animals they are the most common in cattle (Moulton, 1978).

According to Fankhauser, Luginbühl & McGrath (1974), neurofibromas are fairly common in cattle and dogs. In this survey these tumours accounted for 2.6% of the total, so that the neurofibroma can be regarded as a neoplasm that is regularly encountered in cattle.

Twelve nasal carcinomas were recorded. This is noteworthy, as no reference to the occurrence of nasal tumours in cattle could be found in the literature reviewed. Eleven of these tumours were recorded in the first 11 years of this survey.

The uterine adenocarcinoma was a common tumour of the female genital tract, second only in incidence to the vulvar squamous cell carcinoma. In this survey, this tumour accounted for only a small number of the total (9 out of 606). Monlux *et al.* (1956) regarded it as an important bovine tumour. They found that the uterine adenocarcinoma was the second most common type of tumour encountered but the actual number was low (16 out of a total of 813) and comparable to the proportion encountered in this survey.

Tumours of the endocrine glands were rare, numbering only 5 in all, 4 of which were thyroid adenomas. Only 1 pheochromocytoma and no adrenocortical adenomas or carcinomas were encountered in this survey. This is rather unexpected as both pheochromocytomas and adrenocortical carcinomas of domestic animals are reported most commonly in the bovine species (Moulton, 1978). Misdorp (1967) in the Netherlands recorded an incidence of 26 adrenal tumours out of a total of 208 tumours, and Monlux *et al.* (1956) in the USA, 10 out of 813. Both surveys were conducted on abattoir material, whilst this survey was based mostly on material submitted by veterinarians throughout the country. This could explain the above conflicting findings, as both pheochromocytomas and adrenocortical tumours are usually only noticed as an incidental finding in older cows when slaughtered (Wright & Conner, 1978).

Tumours arising from smooth muscle were very rare. Of the 4 encountered, 3 occurred in the female genital tract, which suggests that this body system is the site of preference for the development of leiomyomas in cows.

Central nervous system tumours had a low incidence. This finding agrees with that reported in other countries (Nobel *et al.*, 1970; Shortridge & Cordes, 1971).

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