THE COMPARATIVE ANATOMY AND PATHOLOGY OF ANAL GLANDS

Arris and Gale Lecture delivered at the Royal College of Surgeons of England

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by

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THE TITLE OF this lecture may at first suggest an obscure and academic subject of no surgical importance. It would therefore be wise at the outset to explain its *raison d'être.*

During an examination of the longitudinal muscle layer of the anal canal in 1958 I repeatedly noticed anal glands extending through the internal sphincter. Although this was generally thought to be an unusual occurrence, my feeling was that it might well be a common anatomical feature which had been overlooked. It seemed worthwhile to pursue this study in view of the important role which these glands play in the aetiology of fistulae-in-ano.

Having confirmed my suspicions about the anatomy of these glands I turned to experimental surgery to mimic the conditions which are thought to give rise to fistulae in man. I attempted to reproduce infection and fistulae in the dog's anal scent glands which were considered analogous to the human anal glands. This analogy I soon thought to be false and for enlightenment on the subject I was obliged to enter the field of comparative anatomy. The pathological study involved a search for possible intermediate stages of fistula formation such as anal gland cysts, and a search to determine whether these glands are involved in more generalized diseases of the colon such as ulcerative colitis and Crohn's disease. Gradually, piece by piece, this comparative and pathological study took shape.

HISTORICAL REVIEW

The anatomy of human anal glands

The first reference to anal glands was made by the Swiss physiologist Albrecht von Haller in 1751.

"In eorum receffu oftia a magnis glandulis mucofis aperiuntur. Ambitum vero ani defendunt glandulae febaceae, ne ab acri, duraque faece excorietur."

(Into the recesses of these [anal crypts] open the mouths of large mucous glands; sebaceous glands also protect the circumference of the anus lest it should be torn by a hard stool.)

There followed further descriptions by Chiari in 1878 and Herrmann and Desfosses in 1880. The latter French anatomists described the

glands in the lower part of the anal canal. They supported the theory put forward by Chiari two years before that these were important in the aetiology of fistulae-in-ano. In 1901, however, Braun completely denied the existence of these structures. Many writers ascribe the first description of anal glands to Gay (1871), but this is incorrect, for Gay's paper " Die Zirkumanaldrüsen des Menschen " concerned the apocrine glands which are situated at the anal verge (Fig. 1). In Johnson's classical paper (1914) on the development of the rectum in the human embryo there is a more detailed account of the anal glands and their ramifications in the internal sphincter.

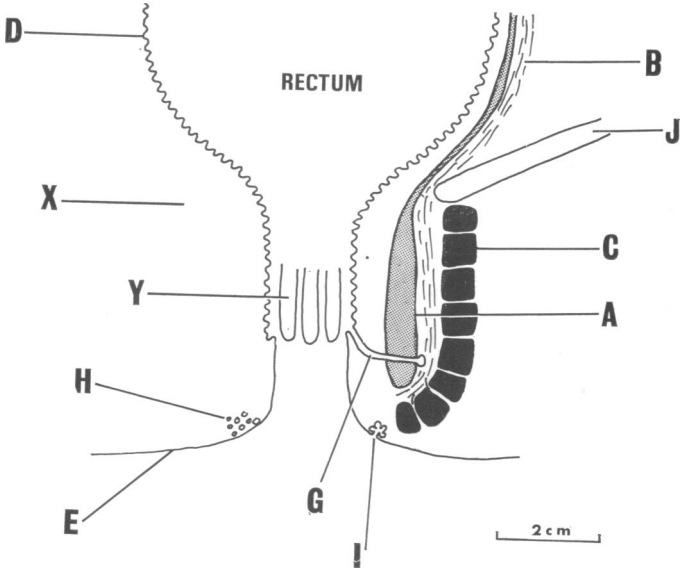

Fig. 1. Diagrammatic representation of a coronal section of a human adult anal canal to illustrate the main anatomical features. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), anal gland (G) extending down from a crypt through submucosa and internal sphincter, apocrine glands (H), sebaceous gland (I), levator ani (J), site of ano-rectal ring (X), columns of Morgagni (Y) at the lower border of which are the valves of Ball (or pectinate line).

Surgical interest was aroused in this subject in 1929 by Lockhart-Mummery and Harris and continued by other surgeons and pathologists who have presented conflicting views about the relationship of the anal glands to the internal sphincter and about their secretory capacity. Herrmann and Desfosses (1880) and Johnson (1914) imply that every anal gland extends through the internal sphincter and ends blindly between the sphincter and the conjoint longitudinal layer. According to Harris (1929), Tucker and Hellwig, (1934), Gordon-Watson and Dodd (1935), Morgan (1936) and Walls (1958), some of these glands penetrate into the internal sphincter. This penetration was noted in two out of 17 specimens

examined by Hill *et al.* (1943) and in three out of 20 specimens examined by Fowler (1957). Kratzer and Dockerty (1947) found that the glands often extended through the internal sphincter, and Parks (1958) stated that they commonly penetrated the internal sphincter, ending blindly between it and the longitudinal muscle. Gordon-Watson and Dodd (1935) reported that the glands may extend through the internal sphincter, the conjoined longitudinal muscle and external sphincter, into the ischio-rectal fossa, and into the true pelvis.

Herrmann (1880) and Tucker and Hellwig (1933, 1934) found no evidence of secretory activity, but other authors have noted mucus secretion in 10–35 per cent of their specimens (Hill *et al.*, 1943, 1949; Kratzer and Dockerty, 1947; Close and Schwab, 1955). According to Johnson (1914) and Brenner (1930) mucus secretion is found in anal glands of the embryo and newborn but not in those of the adult.

Comparative anatomy

The human anal glands are commonly thought to be analogous to the anal scent glands of other mammals (Harris, 1929; Lockhart-Mummery, 1929; Tucker and Hellwig, 1933; Parks, 1958). Herrmann (1880), however, considered that the human anal glands corresponded to the acinous glands found in the internal sphincter of the dog. There have been three detailed studies of anal glands in mammals, those of Chatin (1874), Schaffer (1940) and Grassé (1955). These works contain a series of descriptions rather than a comparative study, and their terminology is somewhat complex.

The pathology of anal glands

In this country there is a great deal of scepticism about the pathological conditions which anal glands are said to produce. This attitude may well have been engendered by extravagant claims of proctologists from other shores. For instance, cryptitis is a term given to inflammation confined to the anal crypts or sinuses and this has been described as one of the commonest undiagnosed infections. Some advocate the operation of multiple valvotomies, which entails cutting all the valves of Ball as a prophylactic measure against infection in the anal canal. Others take cultures from these crypts, and from cultures make vaccines which cure their patients of headaches and general debility. It is fair to say that these unusual claims have brought the subject of anal gland pathology into some disrepute. Perhaps it would be more charitable to leave this subject with Professor Goligher's words (1961), " acute cryptitis seems to be exceedingly rare in this country ", and as far as chronic cryptitis is concerned, " I must confess that I am completely unconvinced that there is such a disease ".

It was Chiari in 1878 who first suggested that fistulae-in-ano may be caused by infected anal glands. This theory was supported soon after by Herrmann and Desfosses (1880) and later by Lockhart-Mummery

(1929), Gordon-Watson and Dodd (1935), Tucker and Hellwig (1935), Morgan (1936), Hill *et al.* (1943) and Kratzer and Dockerty (1947). Parks (1961) reported a detailed study of 30 consecutive fistulae in each of which the whole fistulous tract was excised and sectioned serially. Seventy per cent showed anal gland epithelium in some part of the specimen and a quarter of these contained cystic dilatation of an anal gland. This is convincing evidence of the important role of these glands in the production of fistulae.

There is now little doubt that anal glands may occasionally give rise to adenocarcinoma, but strict criteria should apply before accepting a case as a genuine example. The tumour must be situated within the territory of the anal glands and the overlying epithelial lining of the anal canal must not be ulcerated. The first cases were reported by Tucker and Hellwig (1938) and Scarborough (1941) and later ones by Burke *et al.* (1951), Kay (1954) and Close and Schwab (1955).

It is evident from this review that:

1. There are widely divergent opinions on the relationship of the anal glands to the internal sphincter and on whether they secrete mucus.

2. They are thought to be analogous to the scent glands of other mammals.

3. They play a role in the pathogenesis of fistulae-in-ano and may give rise to tumours.

The object of this work therefore is to determine:

1. The relationship of the glands to the internal sphincter.

2. Their secretory function.

3. Their relationship to the scent glands of other mammals.

4. Whether further evidence can be found supporting the view that anal glands cause fistulae. This involved:

(*a*) a search for intermediate stages in fistula formation in patients with peri-anal cystic lesions, ulcerative colitis, Crohn's disease or carcinoma of the rectum, and

(*b*) an attempt to produce fistulae-in-ano experimentally in dogs by mimicking the aetiological mechanisms.

INVESTIGATION OF HUMAN ANAL GLANDS

Material and methods

The material consisted of anal canals from 50 humans, 80 animals belonging to 20 separate species, and pathological specimens from 152 patients. Of the 50 normal human anal canals one-third were obtained from stillbirths or premature infants, one-sixth were from children and the

remaining half from adults. Twenty-eight* were embedded in celloidin and serially sectioned to give 617 sections 200μ thick. The other 22 were also serially sectioned and approximately one in 10 embedded in paraffin wax to give 10,006 sections 6μ thick. Material from 80 animals and 152 patients was cut 6μ thick to give 2,025 animal sections and approximately 600 pathological sections.

The thick sections were stained with anthracene blue and the thin ones with haemotoxylin and eosin and van Giesen's technique. Selected sections were treated with Masson's method. To detect mucus secretion in the anal glands, mucicarmine and periodic acid—Schiff (P.A.S.) technique were used.

General description

The anatomy of the anal canal is depicted in Figure 1. The lining of the canal changes at the level of the valves of Ball or pectinate line, which is probably the site of the anal membrane in embryo (Duthie and Gairns, 1960; Holmes, 1961) and marks the junction of endoderm and ectoderm; above this level is mucosa which is continuous with that of the rectum; below is an area called the pecten, which extends from the pectinate line to the lower border of the internal sphincter. It is 8–15 mm. in length (Walls, 1963) and consists of keratinized stratified squamous epithelium, but in general does not contain hair follicles, sweat or sebaceous glands. Below the pecten is normal skin and at this junction there are large apocrine glands (circumanal glands of Gay—1871) and large sebaceous glands.

Each valve of Ball conceals a small sinus or crypt (Fig. 2). About half of them lead downwards and outwards into a single anal gland and sometimes into two separate glands. These can be single or multiple branching tubules ramifying in the submucosa. Most anal canals contain five to ten of these structures. According to the original descriptions of last century all these glands extend into the internal sphincter, but this was denied by later authors who maintained that the internal sphincter was only occasionally involved. Moreover, most of these dissenting authors doubted whether they were really glands at all because they could find little or no evidence of mucus secretion.

Results

Of the 50 normal human anal canals examined, 25 have processes extending right through the internal sphincter. Often these processes pursue a tortuous course through the submucosa and internal sphincter. In seven of the 50 anal canals this limited extension of one or two glands is the only invasion of the internal sphincter seen. The remaining 18 specimens have

* These 28 specimens were prepared by Mr. A. G. Parks and, together with my work, formed the anatomical part of a paper on fistulae-in-ano published in *British Medical Journal*, 1961. I am very grateful to him for allowing me to examine this material and to include it in this lecture.

no part of the glands entering the internal sphincter (Table I). The average number of these processes traversing the sphincter is four per anal canal, but it is worth pointing out that five of these 25 specimens have from eight to 16 separate processes extending through the sphincter. Clearly 16 anatomical tunnels would provide ample opportunity for spread of infection in this region leading to abscesses and fistulae. Half of these

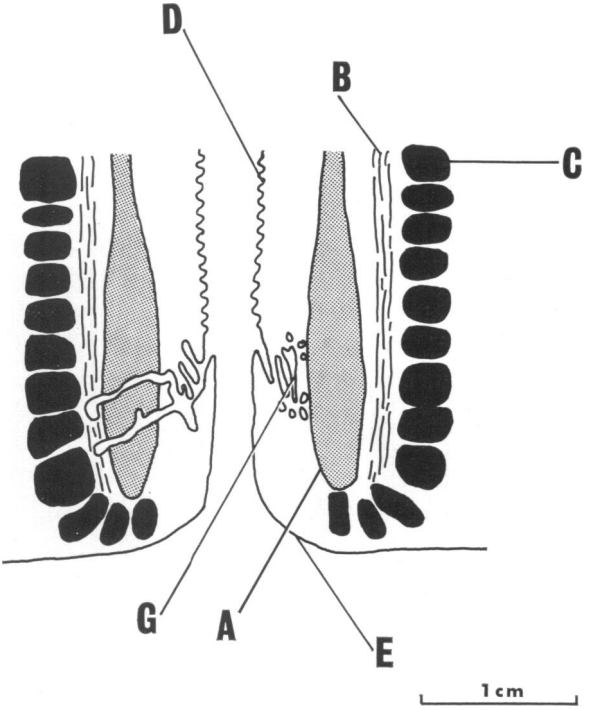

Fig. 2. Diagrammatic representation of a coronal section of the human adult anal canal to illustrate the anatomy of the anal glands. The anal gland on the right is confined to the submucosa, whereas that on the left has extended right through the internal sphincter. The diagram also illustrates the difference in appearance of the gland in a thin section (6μ) on the right and in a thick section (200μ) on the left. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), anal gland (G).

specimens also had one or two glands which only partially penetrated the internal sphincter.

It is unusual to see in one section the complete picture (Fig. 3*a*) of a sinus or crypt leading down into a gland which pierces through the internal sphincter and ends in the fibres of the longitudinal layer of the rectum. Quite often a single anal gland has processes through the internal sphincter at two, three, or even four different levels and sometimes there are two or three processes at the same level. The distribution of these glands is

variable and no concentration in any particular segment of the canal was found. Their lumen is frequently filled with an amorphous mass, possibly meconium in the specimens from stillbirths and faeces in the adult material.

Because they ramify in the internal sphincter muscle they are often called intramuscular anal glands. In Figures 3*b* and 4 one sees in the submucosa three main glandular ducts composed of several layers of polygonal cells which show no mitotic figures. It is therefore presumed that the turnover rate of these cells must be low. The basal cells look more like those of stratified squamous epithelium, but the cells on the surface are columnar and at their luminal end contain small amounts of mucus in 60 per cent of the specimens examined. The terminal branches are composed of one, but more often two, layers of cuboidal cells. These terminal branches are often surrounded by a little lymphoid tissue and occasionally form cysts up to 5 mm. in diameter, in anal canals which are otherwise normal. There is no sex difference in distribution or histology of these glands and no differences between the stillbirth and adult material.

TABLE I

SHOWING RELATION OF ANAL GLANDS TO INTERNAL SPHINCTER IN 50 NORMAL ANAL CANALS

Number of specimens	*Relation to internal sphincter*
25 (50%)	Extending right through sphincter
7 (14%)	Extending into, but not through sphincter
18 (36%)	No extension into sphincter

The importance of establishing that anal glands are present in the newborn as well as in adults will be appreciated when it is recalled that in adults downgrowths of epithelium readily occur in the presence of infection (Johnson and Anderson, 1953) and are also found in healing wounds (Gillman, 1958).

Conclusions

Anal glands are present in all anal canals, but in only 50 per cent do they extend through the internal sphincter. Most of these send an average of four separate processes through the sphincter, but a few send as many as 16. In another 14 per cent there are anal glands extending into, but not through, the sphincter. In 60 per cent of the specimens the anal glands are mucus secreting. As these glands are generally believed to be important in the aetiology of fistulae, the author's findings suggest that those who are born with extensive anal glands ramifying in their internal sphincter, and which in addition are mucus secreting, are congenitally predisposed to fistulae-in-ano.

INVESTIGATION OF THE COMPARATIVE ANATOMY OF ANAL GLANDS

Material and methods

The mammals are divided into three subclasses:

Prototheria (egg laying mammals) comprising platypus and spiny anteater.

Metatheria (marsupials)—the placenta is usually undeveloped. When the young are born they are in a comparatively rudimentary condition, and are nourished in the pouch or marsupium. Examples of this subclass are kangaroos, opossums, bandicoots and wombats.

Eutheria. The young are nourished *in utero* and when born they are in a well-developed state. Most better known mammals belong to this subclass.

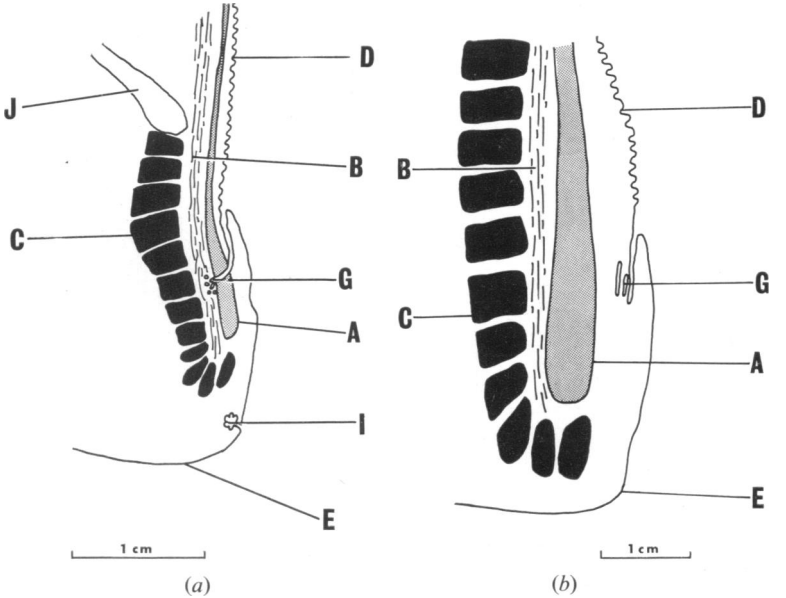

Fig. 3. (*a*) Camera lucida reproduction of a coronal section of the anal canal of a 31-week male stillbirth showing an anal gland extending downwards from a valve of Ball through the internal sphincter and terminating in the conjoint longitudinal layer. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), anal gland (G), sebaceous gland (I), levator ani (J). (*b*) Diagrammatic representation of a coronal section of an adult anal canal to show the orientation of the anal gland (G) in Figure 4. Internal sphincter (A), conjoint longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E).

The subclass of eutheria is made up of nine main orders. Examples from all these orders were examined with the exception of cetacea (whales). Details of these examples are set out in Table II.

Altogether 80 mammals were examined and these belonged to 20 different species. Almost all the material offered from the London Zoo, animal houses, anatomy departments, slaughter houses and pest control offices was accepted. I did, however, decline an elephant and I avoided the skunk. The few workers who have studied the scent glands of the skunk soon found themselves quite alone in this field (Aldrich, 1896; Blackmann, 1911).

TABLE II

Order	*Species*	*Number examined*	
		Male	*Female*
Insectivora	Erinaceus europaeus (hedgehog) . .	1	1
	Talpa europaea (mole)	1	1
Chiroptera	Pipistrellus pipistrellus (European pipistrelle)	1	1
	Plecotus auritus (long-eared bat)	1	1
Edentata	Dasypus septemcinctus (seven-banded armadillo)	1	
Rodentia	Mus musculus (mouse)	3	2
	Rattus rattus (rat)	3	2
	Microtus arvalis (common vole) . .	1	1
	Cavia cobaya (guinea pig) . .	4	2
Carnivora	Oryctolagus cuniculus (rabbit) . .	2	2
	Felis domesticus (cat)	3	2
	Phoca vitulina (common seal) . .	4	(of unknown sex)
	Canis familiaris (dog)	14	14
Ungulata	Ovis aries (sheep)	1	2
	Sus scrofa (pig)	1	1
	Bos taurus (cattle)	3	
Primata	Macaca mulatta (Rhesus monkey)	1	1
	Papio cynocephalus (baboon) . .	1	
	Cebus capucina (Capuchin monkey)	1	
	Macaca cynomolgus (monkey) . .	1	(of unknown sex)

Classification of glands

The various exocrine glands with which this study is concerned are classified according to the mode of secretion (Table III).

In a holocrine gland, the secretion is liberated on the disintegration and death of the individual cells. This process requires constant replacement from the actively dividing basal cells; the sebaceous glands secrete in this way. In an apocrine gland only that part of the cell containing the secretion disintegrates and the remainder regenerates to its former state; sweat glands function in this way. In the merocrine gland the cells remain intact while the secretion is discharged. The mucous and serous glands function in this way, as indeed do most glands of the body. These different modes of secretion reflect in part the viscosity of the secretory substance (Le Gros Clark, 1952). Presumably in apocrine glands the secretion is too viscid to pass through the intact cell membrane, which must therefore rupture to allow it to escape. In sebaceous glands the sebum is so viscid that its release can be achieved only by complete disintegration of the cell.

TABLE III

CLASSIFICATION OF GLANDS

Name	*Mode of secretion*	*Examples*
Holocrine	Involves death of cells	Sebaceous glands
Apocrine	Partial disintegration of cells, followed by regeneration	Sweat glands
Merocrine	Cells remain intact	Serous and mucous glands (most other glands in the body)

The scent gland in mammalian ecology

The characteristic smell of the rabbit is produced by its scent glands, which open in front of the anus. The musk-glands of some deer and the civet-glands of carnivora occupy a similar position (Young, 1957). The cat has a pair of anal scent glands and it can be deodorized by removing them. Scent glands are found in other situations, for instance below the eye in antelopes, on the forehead of elephants, on the back at the posterior end of the mane of the peccaries, at the base of the neck in some marsupials and on the feet of ungulates. Man does not possess highly developed scent glands, but does have simple apocrine glands in the axilla and perineal

Fig. 4. Photomicrograph of the anal gland depicted in Figure 3 (*b*), showing intracellular mucus appearing black. P.A.S. × 25.

and peri-anal region which emit characteristic odours. Certainly the axillary glands are enlarged during the menstrual period (Young, 1957).

As Bourlière (1955) has emphasized, man's knowledge of animal scents has been limited by his own poor sense of smell. There is no doubt, however, that the secretions of the anal scent glands of some animals play a part in sexual attraction, in social communication and in delineation of the territory and home range. In some species they constitute an important means of defence. The home range is the area over which the individual normally travels in search of food, but is not his exclusive property and therefore several such ranges may peacefully overlap (Bourlière, 1955). A territory, in contrast, is an area defended by its occupant against competing members of the same species. The home range of small

mammals generally varies from a fraction of an acre to a few acres; that of the brown bear (*Ursus arctos*) in Russia extends from 10 to 13 square miles, while the woolly opossum (*Philander philander*) remains in a single tree for several months (Bourlière, 1955). The home range is made up of living quarters and a network of paths which are frequently signposted by secretions from scent glands, deposits of urine and faeces. Martens and mongooses deposit the scent from their anal glands on trees. Some antelopes mark trees with their preorbital scent gland secretions and with deposits of urine and faeces. The secretion from anal scent glands probably imparts its odour to the dung during defaecation. The unpleasant smell in some animal houses at the Zoo is due to certain carnivores marking the boundaries of their cages with their anal gland secretions. According to Linsdale, members of the same family of Californian ground squirrels (*Citellus beecheyi*) sniff at one another's face for mutual recognition, but when strange males meet they smell each other's anal glands.

" Another well-known habit, with an apparently similar kind of epideictic function, is the establishment of special points to which animals go to deposit their scent and seek that of their fellows. There is no more familiar instance of this than the domestic dog. Any stone or tuft of vegetation, preferably rising above the ground surface, will serve his needs of the moment, though in a populous street there is a strong tendency to investigate and add to the scent-deposits of others. When two male dogs meet, the greeting ceremony usually includes an opportunity for sampling each other's individual odour, and it is variously accompanied by signs of goodwill, assertiveness or rivalry. Social urination, like the three-legged stance that directs it sideways, is entirely confined to males; the ' lamp-post ritual ' is strictly their affair, and can easily be distinguished from the epigamic interest they show in the odours left by females (especially if the latter are on heat), or from the female's reciprocal investigation of male odours. As an epideictic phenomenon it is readily understood—the dogs are making known their presence and keeping check on status relations with each other, acquiring in the process an indication of the field of male competition and local density of numbers " (Wynne-Edwards, 1962).

The anal scent glands have an important role in defence in some species such as the striped-neck mongoose (*Herpestes vitticolis*) and the crab-eating mongoose (*Herpestes urva*). It is in the skunk, however, that this mode of defence is particularly well developed. Their large anal glands are surrounded by powerful muscles which give them an accurate firing range of 12 feet. It never turns its foul weapon on another skunk, however, and will fire at a foe only when there is no other means of escape and only after warning its attacker of things to come. This it does by adopting threatening attitudes. Some stamp on the ground with the hind feet, while others walk on the front paws with their hindquarters in the air (Johnson, 1921).

It will be seen from this brief review that the scent glands are of considerable importance in mammalian ecology. The object of this comparative study is to determine whether the human anal gland is, as commonly believed, analogous to the scent gland.

Results

During the course of the comparative anatomical study (McColl, 1965, 1966), it became clear that in the 20 species studied there were two quite different kinds of anal gland:

1. The scent glands, and
2. The human type of anal gland.

The fundamental difference is highlighted in the anatomy of the dog's anal canal. It will be recalled that this comparative study emanated from an experiment to produce peri-anal abscesses and fistulae in dogs. The dog was chosen because it has two large anal glands, each with a well-defined duct which opens on to the anal verge. Figure 5 (*a*) shows a coronal section of a dog's anal canal with an anal gland clearly shown.

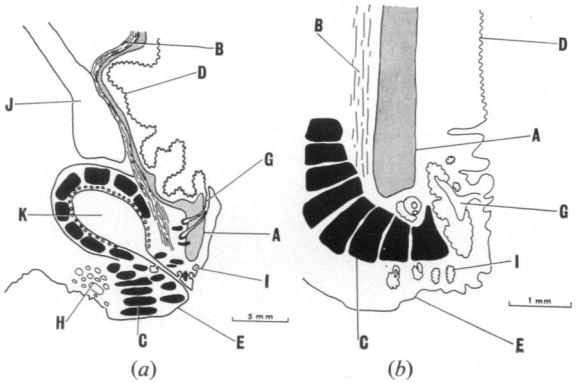

Fig. 5 (*a*) Camera lucida reproduction of a coronal section of the anal canal of an adult dog showing a scent gland (K) surrounded by external sphincter, its outlet duct also surrounded by external sphincter (C) and by sebaceous glands. Internal sphincter (A), longitudinal muscle layer of rectum (B), rectal mucosa (D), peri-anal skin (E), anal sinus (G) extending distally into anal intramuscular glands, hepatoid glands (H), peri-anal sebaceous glands (I), levator ani muscle (J). (*b*) Camera lucida reproduction of a coronal section of the anal canal of a rat (*Rattus rattus*) showing its enlarged sebaceous anal gland (G). Internal sphincter (A), longitudinal muscle layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), peri-anal sebaceous gland (I).

This is the scent gland, and the anal gland of man is supposed to be its vestigial analogue. If, by obstructing the outlet of the dog's anal glands, abscesses and fistulae could be produced, this might support the idea that fistulae in man can have their origin in these glands. These large anal glands, or anal sacs, measure 1 cm. in diameter and lie on each side of the anal canal. They are between the conjoint longitudinal muscle and the external sphincter and each opens onto the anal verge by its own duct. The whole structure represents an invagination of peri-anal skin. Deep to its lining of stratified squamous epithelium there is lymphoid tissue and a layer of glands embedded in connective tissue, rich in lymphatics. They are apocrine glands and open into the lumen of the sac through several

ducts which pierce the lining obliquely, thus acting as valves. Around the outlet duct and opening into it are holocrine sebaceous glands. This duct discharges an unpleasant smelling yellow mixture which usually looks like thin pus, but can have a much thicker consistency. On further scrutiny of this region four other gland-like structures (Fig. 5*a*) can be seen:

1. Hepatoid glands, so called because they resemble liver lobules. Very little is known about them except that they give rise to one of the commonest tumours of dogs, which usually takes the form of a benign adenoma, but occasionally a carcinoma (Nielson, 1964).

2. Large sebaceous glands at the anal margin.

3. Apocrine glands, also at the anal margin. These were originally described by Gay (1871) and in man they may give rise to the uncommon conditions of hidradenitis suppurativa and benign apocrine adenoma.

4. Anal glands ramifying in the internal sphincter very similar to the human anal glands.

It has been repeatedly stated that the human anal glands are the vestigial analogues of the scent glands of other mammals. The author suggests that the human anal glands are not analogous to the scent glands of the dog for four reasons:

(*a*) Their histology is different; the human intramuscular anal gland is a merocrine type of gland, whereas the scent gland is apocrine.

(*b*) Their positions are different; in man the gland lies in the submucosa and the internal sphincter, whereas the scent gland lies further laterally between the external sphincter and the longitudinal muscle layer of the rectum.

(*c*) In the dog and in the armadillo (see later, Fig. 7*b*) both structures are present, a scent gland and an intramuscular gland.

(*d*) In man there are scent gland remnants in the form of apocrine glands at the anal margin.

On this basis it seems reasonable to think that the human anal intramuscular glands are not analogous to the scent glands of the dog, but may be homologues of their intramuscular glands.

Having drawn attention to the two different groups of anal gland, they will now be examined from a developmental point of view. It should be made clear that this is not an attempt to trace the evolutionary path of anal glands, but rather a comparison of the levels of development which the various species have attained. Both groups will be considered in turn.

1. *The anal scent glands*

The scent glands of the dog are comparable to the scent glands of the cat, skunk and other carnivores, and to the armadillo. They are probably comparable to those of the rodents and rabbit and to the apocrine glands of the axillary and peri-anal regions in man. All these examples of scent

glands are apocrine or sebaceous, or a mixture of the two. Table IV illustrates the levels of development of the anal glands. On the left at the bottom of the scale are the rodents, which have a sebaceous type of anal gland lying between the internal and external sphincters, but penetrating neither muscle. The mouse and the rat have the simplest type in the form of enlarged sebaceous glands (Fig. 5*b*) which surround the anal canal. In the common vole there is a great development of this gland

TABLE IV

Suggested developmental scale of the scent gland and human type of anal gland

SCENT GLAND (sebaceous and/or apocrine)	HUMAN TYPE OF ANAL GLAND (serous and/or mucous)
SKUNK (apocrine and sebaceous)	PIG (mucous)
	CATTLE (mucous)
DOG (apocrine)	MAN (mucous)
CAT (apocrine and sebaceous)	
ARMADILLO (apocrine and sebaceous)	DOG (serous)
	SEAL (mucous)
	ARMADILLO (mucous)
RABBIT (apocrine)	
	HEDGEHOG (serous and mucous)
MAN (apocrine)	MOLE (serous)
SQUIRREL (apocrine and sebaceous)	BAT (serous)
GUINEA-PIG	
VOLE	
RAT (sebaceous)	
MOUSE	

(Fig. 6*a*) which tends to dwarf the sphincters. A further stage of development is seen in the guinea-pig (Fig. 6*b*), whose glands are not only larger but whose secretion is contained in three special pouches of stratified squamous epithelium. These very large modified sebaceous glands have extended in between the two sphincters and have taken with them an invagination of peri-anal skin. The external sphincter is thinned out over the outer aspect of the gland and the whole arrangement is similar to the dog's scent gland, apart from its different histology which is apocrine in the dog. Perhaps the greatest development of this kind of sebaceous anal

gland is seen in the squirrel, which was studied in detail by Sleggs (1926). The ground squirrel (*Citellus richardsonii*) has three very large anal glands similar to those of the guinea-pig, but having a small apocrine component as well as the predominantly sebaceous type of gland. When the animal is alarmed it may turn onto its back, utter sharp cries, and evaginate its anal glands so that they protrude spasmodically and discharge an inoffensive secretion. The significance of this display is not understood, but it has been suggested that it is mimicking the façade of a skunk. The acouchi (*Myoprocta pratti*) has a similar arrangement of anal glands and can be seen at the Zoo frequently protruding them as it marks the boundaries of its cage.

Next in order of development are the human scent glands which are found at the anal margin (Fig. 1) and in the axilla. These simple apocrine glands are the only human representatives of the scent glands of other mammals (Schaffer, 1940). They emit characteristic odours which vary in potency from person to person and are particularly active during periods of excitement and fear.

The characteristic smell of a rabbit is due to extensive apocrine scent glands around the anal canal (Fig. 7*a*). These are much more highly developed than those of man and ramify in both internal and external sphincters. The rabbit used to be included among the rodents, but now belongs to a separate order called lagomorpha. It is therefore interesting to note that the rabbit's scent glands are quite different in histology and extent from those of the rodents.

On a higher level of scent gland development is the armadillo, which combines sebaceous and apocrine components into a complex scent gland (Fig. 7*b*) resembling that of the dog (Owen, 1868; Cooper, 1930). It, too, has a pair of these structures, one on either side of the anus, and, when excited, it will evert them like the squirrel, as a kind of repulsive mechanism (Haynes and Enders, 1961). As these scent glands are active all the year round it is very likely that they are chiefly concerned with orientation, especially as the armadillo has poor vision but a very good sense of smell (Clark, 1951). In addition to its scent glands the seven-banded armadillo (*Dasypus septemcinctus*) has a mucus-secreting gland in the submucosa of the anal canal corresponding to that of man, but not extending into the internal sphincter. This will be considered later.

The scent glands of the cat follow a similar pattern to those of the armadillo in being a pair of complex anal sacs with apocrine and holocrine components (Fig. 8*a*). The holocrine component can be looked upon as a larger and more complex type of sebaceous gland, the cells of which are smaller and the cytoplasm of which contains more eosinophilic granules and is not foamy like that of a sebaceous gland. Unlike the armadillo and dog, the cat possesses no human type of anal gland. The odorous substance produced by the scent glands of the cat, dog and armadillo are not

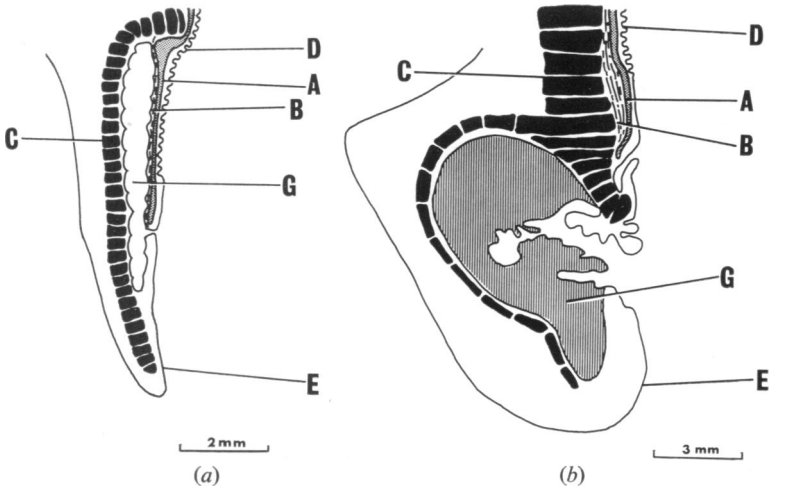

Fig. 6. (*a*) Camera lucida reproduction of a coronal section of the anal canal of a vole (*Microtus arvalis*) showing great development of its sebaceous type of anal scent gland (G). Internal sphincter (A), longitudinal muscle layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E). (*b*) Camera lucida reproduction of a coronal section of the anal canal of a guinea pig (*Cavia cobaya*) showing one of its large modified sebaceous scent glands (G). Internal sphincter (A), conjoint longitudinal layer of rectum (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E).

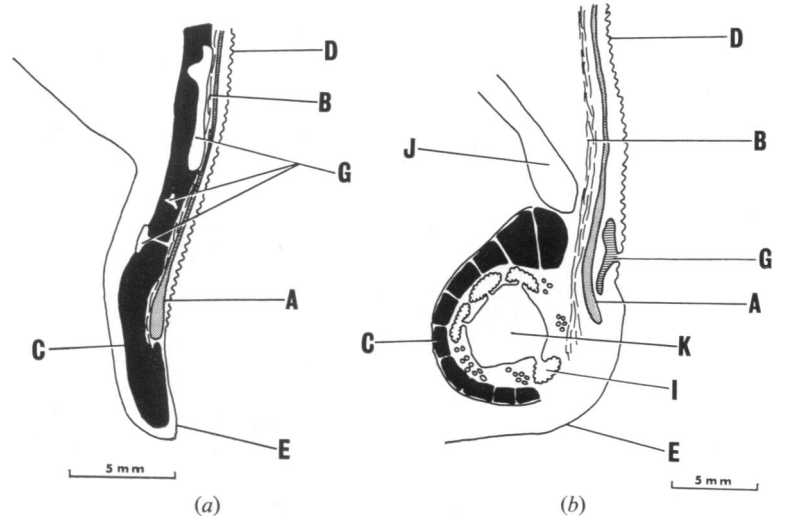

Fig. 7. (*a*) Camera lucida reproduction of a longitudinal section of the anal canal of a female rabbit (*Oryctolagus cuniculus*) showing extensive apocrine anal glands ramifying in the internal and, particularly, in the external sphincter. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), anal gland (G). (*b*) Camera lucida reproduction of a coronal section of the anal canal of an armadillo (*Dasypus septemcinctus*) showing one of its two scent glands composed of an anal sac (K) opening into which are a sebaceous type of gland (I) and an apocrine type. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), human type of anal gland (G), levator ani muscle (J).

too unpleasant and allusion has already been made to its role in mammalian ecology.

It is in the skunk that the scent gland has attained the maximum development and is placed at the top of the development scale. It is as large as a pigeon's egg and constitutes a potent deterrent. According to Aldrich (1896), " the vapours of this fluid are highly inflammable and burn with a luminous flame. It contains sulphides, mercaptans and α-methyl quinoline. It is a powerful anaesthetic and when inhaled the victim loses consciousness, the temperature falls, the pulse slackens and if the inhalation were prolonged the results would doubtless prove fatal."

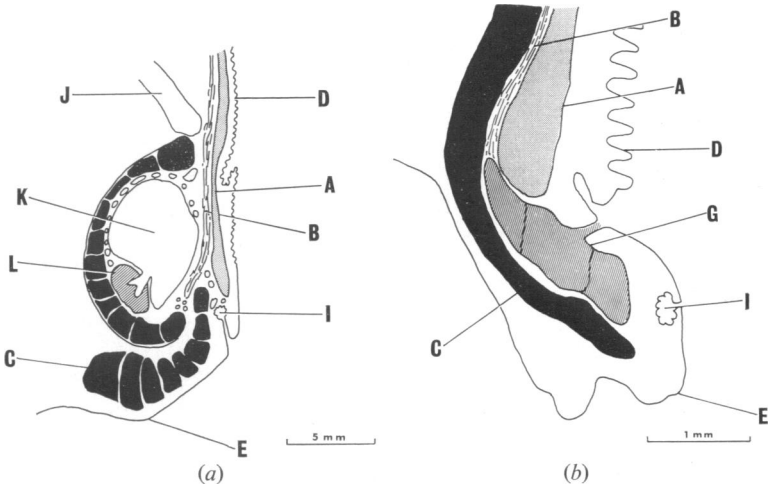

Fig. 8. (*a*) Camera lucida reproduction of a coronal section of the anal canal of a cat (*Felis domesticus*) showing one of its scent glands comprising an anal sac (K) opening into which are holocrine (L) and apocrine components. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), peri-anal sebaceous gland (I), levator ani muscle (J). (*b*) Camera lucida reproduction of a coronal section of a bat (*Pipistrellus pipistrellus*) showing its serous type of anal gland (G). Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), sebaceous gland (I).

Of all eight orders involved in this study, examples of both sexes were examined, with the exception of the edentates in which only one male has hitherto been available. No sex differences were detected in the morphology of the scent glands.

2. *Human type of anal gland*

It will be recalled that whereas the scent glands are either holocrine (sebaceous) or apocrine, or a mixture of the two, the human type of anal gland is a merocrine gland and its function is unknown. Reference to Table IV again will reveal the suggested levels of development of the human type of anal gland.

At the bottom of the scale are placed the bats (the pipistrelle and the long-eared bat). They have a large serous gland around the anal canal (Fig. 8*b*) extending into the external sphincter. It is circumscribed and contrasts with that of the mole, which has a serous gland which makes extensive inroads into the external sphincter at many sites on its medial aspect (Fig. 9*a*). There is further development of this arrangement in the hedgehog's anal gland (Fig. 9*b*), which is partly serous and partly mucus-secreting.

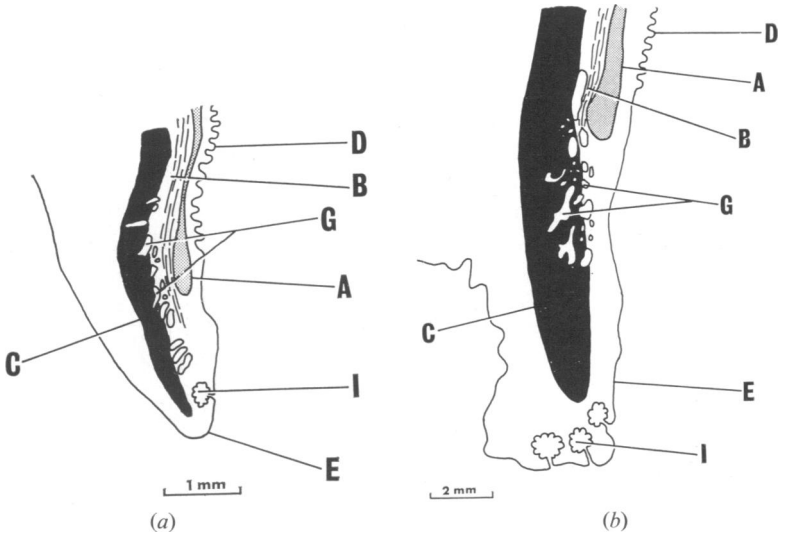

Fig. 9. (*a*) Camera lucida reproduction of a longitudinal section of the anal canal of a mole (*Talpa europaea*) showing its extensive serous anal gland (G) on the medial aspect of, and making many inroads into, the external sphincter (C). Internal sphincter (A), conjoint longitudinal layer of rectum (B), rectal mucosa (D), peri-anal skin (E), sebaceous gland (I). (*b*) Camera lucida reproduction of a coronal section of the anal canal of a hedgehog (*Erinaceus europaeus*) showing its serous and mucous anal gland (G) extending into the external sphincter (C). Internal sphincter (A), longitudinal layer (B), rectal mucosa (D), peri-anal skin (E), sebaceous gland (I).

Next in order is the seven-banded armadillo, which has, as already stated, in addition to a pair of scent glands, anal glands in the submucosa of the lower anal canal (Fig. 7*b*). As far as the author can ascertain, they have not been described previously. They are surrounded by lymphoid tissue and correspond in position and character to those in man, but differ in being productive of much more mucus, having fewer ducts and having no prolongations into the internal sphincter. Only one seven-banded male armadillo was available and clearly more need to be studied. Post-mortem specimens in this country are scarce, however, and can only be obtained from the zoos.

The anal glands in the common seal resemble those of the armadillo

in their site and general morphology. They secrete mucus and are found in the submucosa near the distal end of the internal sphincter (Fig. 10*a*). Many ducts and large cysts are present and are accompanied by plentiful lymphoid tissue. The more extensive duct system in the anal glands of the seal is presumably a reflection of their great size and distance from the surface as compared with the armadillo.

Further specialization of these glands is to be found in the dog, which

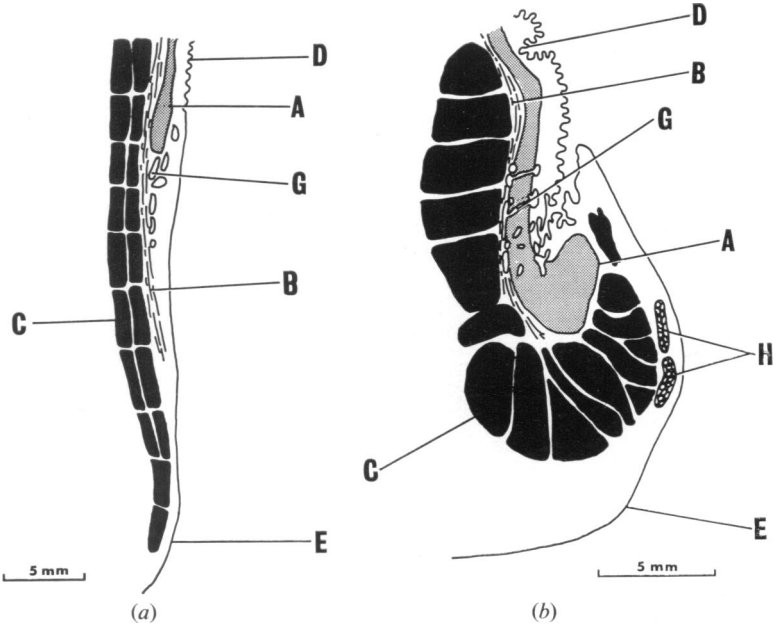

Fig. 10. (*a*) Camera lucida reproduction of a coronal section of the anal canal of a common seal (*Phoca vitulina*) showing its mucous anal glands (G). Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E). (*b*) Camera lucida reproduction of a coronal section of the anal canal of a bullock (*Bos taurus*) showing extensive anal gland formation (G) in the internal sphincter (A) and adjacent submucosa. Conjoint longitudinal layer of rectum (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), peri-anal apocrine glands (H).

has an acinous type of gland with no mucus secretion. These glands have extensive ramifications in the internal sphincter and have therefore been described by some authors as intramuscular glands. They are associated with areas of lymphoid tissue which are much more marked in pigs and cattle and have even been described as " anal tonsils ". They were originally described by Herrmann (1880) and Hebrant (1899) and later by Schaffer (1924) and others. These glands open into the anal canal through sinuses in the same position as in the human (Figs. 3*a* and 5*a*). This arrangement was demonstrated by fixing in formalin the anal canal and rectum *in situ* in an intact dog's pelvis. In this way the shape and

exact relations of the anal canal were preserved. The bony parts were removed and the whole block embedded in celloidin, cut into serial sections 100μ thick and stained with anthracene blue. This method gives a true picture of the position of the outlet of the anal glands and contrasts with the inaccuracy of earlier accounts of Schaffer (1924), who depicts the outlet situated more distally.

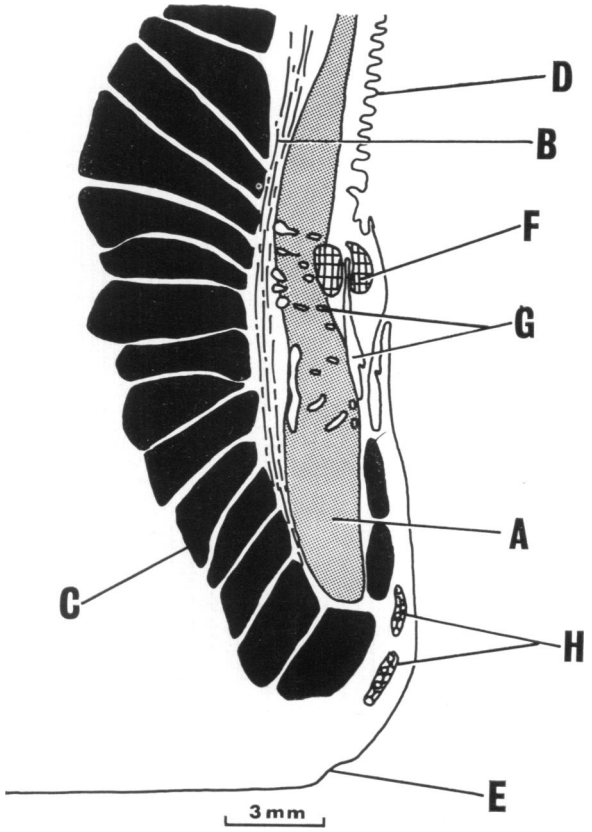

Fig. 11. Camera lucida reproduction of a coronal section of the anal canal of a pig (*Sus scrofa*) showing anal glands (G) which are even more extensive than in cattle. They are associated with a large amount of lymphoid tissue (F). Internal sphincter (A), conjoint longitudinal layer of rectum (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), peri-anal apocrine glands (H).

At the summit of this developmental scale are cattle and pigs, which have extensive mucus-secreting anal glands ramifying in the internal sphincter. In cattle (Fig. 10*b*) there is more mucus production in the glandular part but no mucus production in the ducts. In the pig, however (Fig. 11), the glands are even more extensive and even the ducts secrete mucus. A great deal of lymphoid tissue is associated with the glands,

especially in the pig. Although no anal glands were found in the sheep, this area contained a large quantity of lymphoid tissue. No glands were found in the monkeys.

No sex differences in these anal glands were detected in seven of the eight mammalian orders examined. As already noted, only one male edentate was involved in this study.

It will be seen in the developmental scale (Table IV) that the anal glands of man have been represented as more akin to those of the pig and cattle, but showing evidence of degenerating in that their comparative size and their mucus production is much less. There seems little doubt, however, from the morphological point of view, that the human anal glands are homologous to those of the pig, cattle and dog, and comparable with those of the seal, armadillo, hedgehog, mole and possibly the bats.

Conclusions

This comparative study set out to try to determine the relationship of the human anal glands to the scent glands of other mammals. It is suggested that these merocrine anal glands are not related to the more primitive holocrine or apocrine scent glands, but are homologues of the intramuscular gland in pigs and cattle and dogs.

INVESTIGATION OF THE PATHOLOGY OF ANAL GLANDS

The theory of fistula formation

In the introduction reference was made to the accepted view that anal glands commonly give rise to fistulae-in-ano. The finding of anal gland epithelium in 70 per cent of the fistulous tracts examined by Parks (1961) is good evidence that they do. It is thought that the first stage in fistula production is some obstruction to the outlet duct of the anal gland (Fig. 12). This may result in the formation of a cyst, especially if the affected gland produces mucus. This cyst is liable to become infected and if the abscess arises in the submucosa it will probably discharge spontaneously into the anal canal. A submucous fistula may result and sometimes produces no symptoms. If the anal gland extends through the internal sphincter, the abscess may form between the internal and external sphincters (Fig. 12) and spread downwards to discharge spontaneously in the peri-anal space with the formation of a fistula. The abscess may drain in other directions to form more complicated fistulae. Alternatively, surgical drainage may supervene and the anal gland rudiments may be destroyed by the thorough curetting of the abscess cavity. These anal glands provide the avenue for pus to pass through the internal sphincter, and the more channels there are the greater the opportunity. As already suggested, people born with mucus-secreting glands ramifying through the internal sphincter may be congenitally predisposed to fistulae.

Method and materials

As cyst formation is an integral part of anal gland disease, a search was

made among suitable pathological material at St. Mark's Hospital* for cystic lesions which might conceivably have arisen from the anal glands. This constituted the first part of this pathological study. The second part was concerned with a search for any other intermediate stages in fistula formation in patients who underwent excision of the rectum for ulcerative colitis, Crohn's disease or carcinoma. Histological sections from 152 patients were examined and most of these were stained with haematoxylin and eosin. The third part of this pathological study was an attempt to produce fistulae-in-ano experimentally in dogs by mimicking the aetiological mechanisms.

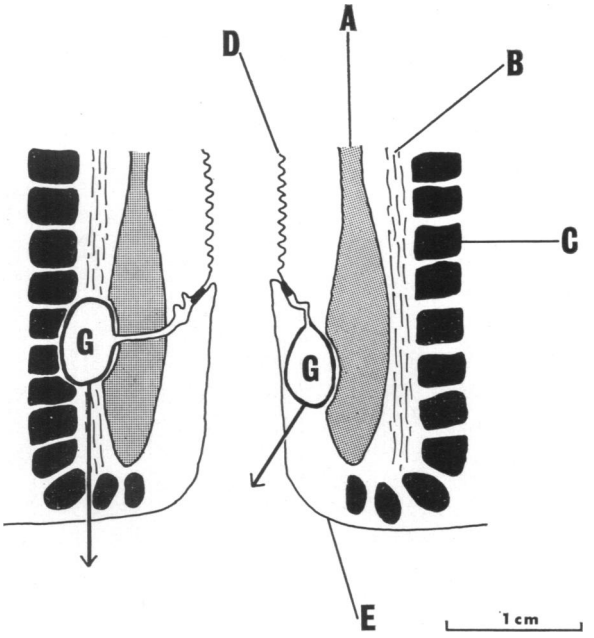

Fig. 12. Diagram illustrating mode of fistula formation. Internal sphincter (A), longitudinal layer (B), external sphincter (C), rectal mucosa (D), peri-anal skin (E), infected anal gland (G).

Cystic lesions

The search for cystic lesions arising from anal glands was limited to the anal canal and rectum. Thirty-one cystic lesions were found and these occurred at two sites:

1. In the peri-anal region, and
2. In the pre-sacral region.

* I am much indebted to Dr. Basil Morson and the surgical staff of St. Mark's Hospital for their help and encouragement in this part of the lecture.

1. *Peri-anal cysts*

Excluding sebaceous cysts and peri-anal haematomata, cysts around the anus were found in 14 patients. All were males whose ages ranged from 30 to 70 years. The cysts were always situated in the anterior quadrant of the anus and were of two types: pilonidal sinuses in an unusual position, and cysts derived from anal glands.

(*a*) *The pilonidal sinuses* presented in five adult males with discharge of recent onset which escaped from a small opening at the anal verge anteriorly (McColl, 1966). The sinus usually contained free hairs, and measured 1–2 cm. in length; its lining was partly granulation tissue and partly stratified squamous epithelium. Some of these lesions were originally described by Gabriel (1945) as anterior dermoid fistulae, but they are virtually the same as the ordinary pilonidal sinus which occurs several inches posterior to the anus. There was no indication at all that these lesions were related to the anal glands.

(*b*) *Anal gland cysts.* The other nine peri-anal cysts measured 1–2 cm. in diameter and occurred in adult males. They presented as a lump at the anus or were discovered on rectal examination or at operation for some other condition. All the cysts were excised and none recurred. Five of them (Fig. 13) were lined by anal gland epithelium, leaving no doubt about their origin. The other four were lined by stratified squamous epithelium and communicated with the anal canal in the region of the anal glands. It is probable that these were also anal gland cysts, the lining of which had undergone metaplasia as a result of infection, but this would be difficult to prove.

2. *Pre-sacral cysts*

At first sight it may seem unlikely that a cystic lesion in the pre-sacral region could arise from anal glands which are several inches distant, but there are pertinent reasons for pursuing this matter.

1. Some of these lesions contain epithelium similar to that of anal glands (McColl, 1963).

2. According to Gordon-Watson and Dodd (1935) anal glands are much more extensive than is believed and may reach as far afield as the ischio-rectal fossa, the levator ani muscle and the true pelvis.

3. The aetiology of the rare anal fistula which extends into the presacral region has not been satisfactorily explained.

4. It has already been noted how extensive the human type of anal gland is in mammals, such as the rabbit.

Table V is a convenient classification of pre-sacral lesions—lesions which occur behind the rectum, between the rectum and sacrum and coccyx. They are not common, and Table V indicates the number of these lesions which have been seen at St. Mark's Hospital in the past 20 years. This study is concerned only with the cystic lesions consisting of dermoid,

teratoma, meningocele, hamartoma and chordoma. The pathology of dermoid, teratoma, meningocele and chordoma is well understood and, as expected, histological examination of these cases revealed nothing to suggest an anal gland aetiology. There were five pre-sacral cystic lesions which were called cyst-hamartomata. Their ages ranged from 43 to 52

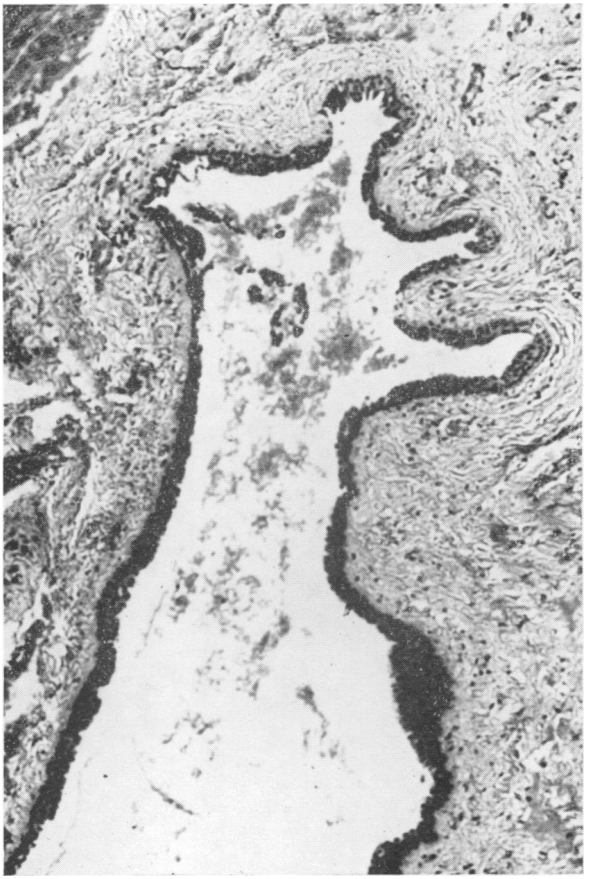

Fig. 13. Photomicrograph of an anal gland cyst. Male patient, aged 62, who presented with a tender swelling at the anal margin. Haematoxylin and eosin × 57.

years and two were male and three female. Two presented with pain over the coccyx, one with prolapse from the rectum, one simulated a pilonidal sinus, and one was symptomless. Their average diameter was 5 cm. and they were intimately associated with the muscle of the rectal wall.

The histological picture is that of multiple cysts embedded in smooth muscle. Some cysts are lined by columnar or cuboidal epithelium, mucus-secreting in places and resembling the epithelium of anal glands, other

cysts are lined by stratified squamous epithelium and filled with keratin. Lesions with exactly this histological picture have been described in many papers, but the names given to them have varied widely; for example, teratoma, enterogenous cyst, post anal gut cyst and cyst of the neurenteric canal. They certainly should not be called teratomata as they do not contain multiple bizarre tissues foreign to the part. Enterogenous cysts, post-anal gut cysts, and cysts of the neurenteric canal, are terms which are concerned with aetiology, but as the aetiology is unknown it is preferable, as Edwards (1961) has pointed out, to use the term cyst-hamartoma, which is purely descriptive. A hamartoma is defined by Willis (1962) as a tumour-like, but primarily non-neoplastic, malformation, characterized by an abnormal mixture of tissues indigenous to the part. Neoplasms may arise in them and do not differ from neoplasms elsewhere.

TABLE V

CLASSIFICATION OF PRE-SACRAL CYSTS AND TUMOURS

Congenital anomalies	Dermoid	4
	Teratoma	2
	Meningocele	1
	Pelvic kidney	
	Hamartoma	5
Bone tumours	Chordoma	5
	Osteochondroma	
	Giant cell tumour	
	Sarcoma	
	Myeloma	
Neurogenic tumours	Neurofibroma	2
	Ependymoma	
Miscellaneous tumours	Metastasis	2
	Fibrosarcoma	1
	Haemangio-endothelioma	1
	Lipoma	

As they contain epithelium which resembles that of anal glands, it could be argued that they arise from these glands. The author thinks that this is unlikely, however, for two reasons. First, in the 50 normal anal canals examined the anal glands were found confined within the external sphincter. Secondly, although the epithelium of these presacral cyst-hamartomata resembled that of the anal glands, the latter contained very much less mucus in all cases.

The anal glands in ulcerative colitis, Crohn's disease and carcinoma of the rectum

This study included 29 consecutive patients with rectal disease. There were nine cases of Crohn's disease and 14 cases of ulcerative colitis sufficiently severe to warrant excision of the rectum. These two diseases were chosen because they may be complicated by fistulae-in-ano and it was hoped to see some of the intermediate stage of fistula formation, such as cysts and small intersphincteric abscesses. Specimens removed for carcinoma of the rectum served as " controls " and, in fact, no abnormality was noted in the six anal canals excised for carcinoma. The 14 anal

canals excised for ulcerative colitis showed comparatively few changes and these were limited to the superficial layers. The mucosa and submucosa were infiltrated with inflammatory cells and the blood vessels were dilated in some cases. The anal glands were not involved.

The nine cases of Crohn's disease had quite a different picture. All layers of the anal canal, deep and superficial, were involved and contained lesions very similar to the tubercles of tuberculosis except that there was no caseation or evidence of tubercle bacillus. These changes were more pronounced in the deepest layer of the anal canal. The submucosa and intersphincteric region contained fat and grossly dilated blood vessels. The main features are shown in Figures 14 and 15*a*. In only three out of the nine cases of Crohn's disease were the anal glands involved in the disease process. Extensive infiltration of the internal sphincter did occur without evidence of diseased anal glands. Although it is conceivable that the absence of anal gland elements may be due to the destructive disease process, there is no evidence of this. Moreover, this infiltration of the internal sphincter, and the presence of inter-sphincteric abscesses without the participation of anal glands, emphasizes that these glands are not the only avenues for the spread of infection through the internal sphincter.

This study has drawn attention to the striking pathological differences in the anal canals of ulcerative colitis and Crohn's disease. In the former there were minimal changes in all 14 cases, while in the latter marked inflammatory changes were present in all nine cases.

Experimental study in dogs

This part of the study was an attempt to produce fistulae-in-ano in dogs by mimicking the aetiological mechanisms. The dog was chosen because its anal scent glands are believed to be the vestigial analogues of the human anal glands and because they are large enough to make operative interference feasible. As a result of the comparative anatomical study, however, the author concluded that the human anal glands are not analogous to scent glands and hence the basis of this experimental work was at fault. Nevertheless, the results did unexpectedly bring to light further evidence supporting an anal gland aetiology for fistulae-in-ano.

The basis of the experiment was to ligate and divide the outlet duct of one of the two scent glands, thus imitating the supposed aetiological mechanisms of fistula formation. To ensure that the outlet duct was the only exit from the gland, hypaque was injected up the duct and a radiograph taken (Fig. 15*b*); of the ten scent glands investigated in this way, all were found to have a single outlet duct.

Method. Twenty-two adult dogs had the outlet duct of one of their scent glands ligated. The experiment was not considered important enough to warrant the use of the dogs solely for this purpose, and therefore

most of them were also used by the thoracic and surgical units with the consent of the Home Office. There were nine females, five males, and the sex of the other eight was not recorded. A probe was passed into the outlet duct, which was exposed by incising the peri-anal skin, and then divided between ligatures. This procedure was performed in 14 dogs which were sacrificed at intervals of 1, 2, 4, 6, 8, 10 and 20 weeks. The same procedure was carried out in the other eight dogs which, in addition, had a pure culture of canine *E. coli* instilled into the scent gland before

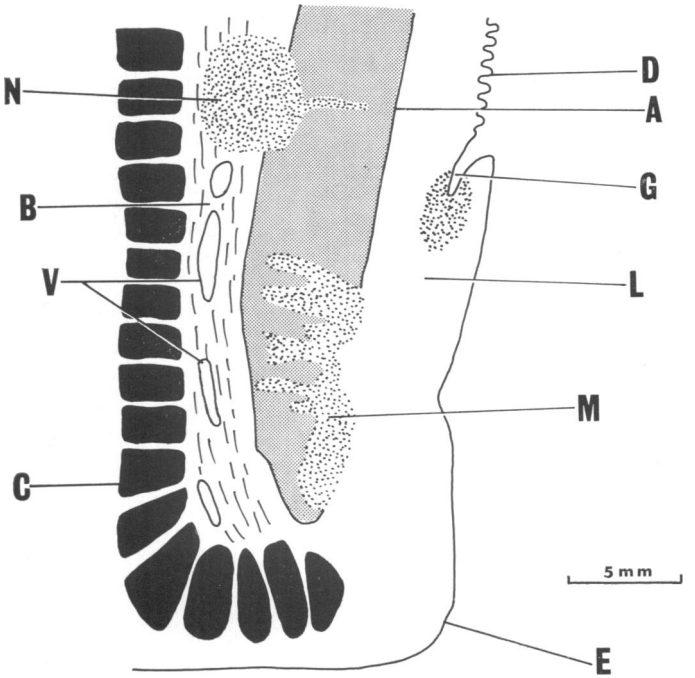

Fig. 14. Diagrammatic representation of an anal canal in Crohn's disease, illustrating the inflammatory changes (M, N) which were found infiltrating the internal sphincter (A), longitudinal layer (B) and anal gland (G). External sphincter (C), rectal mucosa (D), peri-anal skin (E), submucosa (L), pathologically enlarged blood vessels (V).

ligation of the duct. Two different strains of *E. coli* were used. Into four dogs were instilled 0.5 ml. of broth containing 3.65×10^8 smooth strain *E. coli*, and into the other four dogs 0.5 ml. of broth containing 3.6×10^8 mucoid strain *E. coli*. Half were sacrificed at two weeks, and half at four weeks.

Results. No sign of fistulae or infection in the anal scent gland was found in any of the specimens, all of which were examined macroscopically and microscopically. The only effect was that of distension of the anal scent sac. In one dog a diseased intramuscular anal gland (homologous to

the human anal gland) was found, with pathological cystic enlargement and infection. It seemed likely that these changes were due to the ligature of the outlet duct accidentally occluding the outlet of the anal intramuscular gland.

Conclusion

The anal scent glands of the dog are clearly very resistant to infection and this casts some doubt on the view (Coquot *et al.*, 1933) that anal

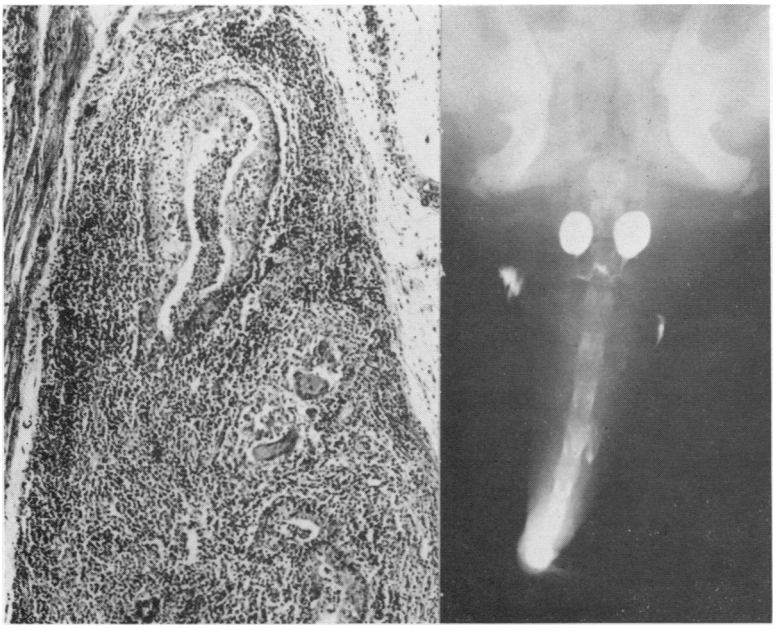

Fig. 15. (*a*) Photomicrograph of an anal gland of a male patient of 42 with Crohn's disease, showing inflammatory changes involving anal gland epithelium. Giant cells are seen in the lower right-hand corner and anal gland epithelium in the upper half of the picture which is infiltrated and partly destroyed. Haematoxylin and eosin × 114. (*b*) Radiograph of the hindquarters of an adult dog, showing the bony pelvis, the tail and both anal scent glands and outlet ducts outlined with hypaque.

fistulae in dogs are due to infection of the scent glands. Fistulae are certainly not uncommon in dogs and the author suggests they may be due to infection of the intramuscular anal glands. This suggestion would accord with the fact that fistulae-in-ano are virtually never seen in the cat and, as already indicated, the cat has scent glands like the dog, but no intramuscular glands. This experimental study has, therefore, possibly provided further evidence that intramuscular anal glands are important in the aetiology of anal fistulae.

SUMMARY

As infected anal glands are recognized as a cause of fistulae-in-ano, it was considered worthwhile to investigate their anatomy and to look for further evidence to support the view that they can cause fistulae. The object of this work was therefore to determine:

1. The relationship of anal glands to the internal sphincter.
2. Their capacity to secrete mucus.
3. Whether they are analogous to scent glands.
4. Whether further evidence could be found supporting this generally accepted view that anal glands cause fistulae. This constituted:

(*a*) a search for intermediate stages in fistula formation in patients with peri-anal cystic lesions, ulcerative colitis, Crohn's disease or carcinoma of the rectum, and

(*b*) an attempt to produce fistulae-in-ano experimentally in dogs by obstructing the outlet of their anal scent glands.

Results

Half of the 50 normal anal canals had anal gland extensions traversing the internal sphincter. The average number of these extensions was four per canal, but in some there were as many as 16. Sixty per cent of the glands were mucus-secreting. As anal glands may cause fistulae, the author's findings suggest:

1. That anatomically there may be a congenital predisposition to fistulae. Those who are born with mucus-producing anal glands extending through the sphincter may be more prone to infection, and the more extensions there are in the internal sphincter the greater the possibility of infection.

2. The human anal glands are not the vestigial analogues of the scent glands of other mammals. This conclusion was based upon the following findings:

(*a*) Human anal glands are merocrine, whereas scent glands are sebaceous or apocrine, or a combination of the two.

(*b*) The two kinds of glands occupy different sites.

(*c*) Both types are present in some species.

(*d*) There are remnants of scent glands in man in the form of apocrine glands in the axilla and at the anal margin.

3. Intermediate stages of fistula formation were found in the form of peri-anal cysts, and in Crohn's disease.

4. In cases of Crohn's disease and ulcerative colitis sufficiently severe to warrant excision of the rectum and anal canal, marked inflammatory changes were found in the anal glands and deeper tissues of the canal in Crohn's disease. In ulcerative colitis, however, the picture was quite different; only slight inflammation was noted in the mucosa and submucosa and the anal glands were not involved.

5. No evidence was found to incriminate anal glands in the aetiology of pre-sacral cysts.

6. Although a fistula in a dog is not an uncommon condition, the attempt to produce fistulae in the dog's scent gland failed. This suggests that fistulae may not arise from scent glands, as commonly believed, but may possibly arise from the anal glands in the internal sphincter which are homologues of the human anal glands. This suggestion is supported by the fact that cats have scent glands but no human type of anal gland in their internal sphincter, and very rarely develop fistulae.

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REFERENCES

ALDRICH, T. B. (1896) *J. exp. Med.* **1**, 323.
———— and JONES, W. (1897) *J. exp. Med.* **2**, 439.
BLACKMANN, M. W. (1911) *Anat. Rec.* **5**, 491.
BONSER, G. M., RAPER, F. P., and SHUCKSMITH, H. S. (1950) *Brit. J. Surg.* **37**, 303.
BOURLIÈRE, F. (1955) *The Natural History of Mammals.* London, Harrap.
BRAUN, W. O. (1901) *Untersuchungen über das Ingegument der Analöffnung.* Konigsberg, Diss.
BRENNER, J. L. (1930) *Textbook of Histology*, 4th edit., p. 290. Philadelphia.
BURKE, R. M., ZANELA, D., and KAUMP, D. H. (1951) *Amer. J. Surg.* **82**, 659.
CHATIN, J. (1874) *Annl. Sci. nat.*, Sér. 5, **19**, 106.
CHIARI, H. (1878) *Med. Jahrbücher.* **8**, 419.
CLARK, W. T. (1951) *Am. Midl. Nat.* **46**, 337.
CLOSE, A. S., and SCHWAB, R. L. (1955) *Cancer*, **8**, 979.
COOPER, Z. K. (1930) *Amer. J. Anat.* **45**, 1.
COQUOT, A., BRESSOU, C., and MONET, M. J. (1933) *Rec. Méd. vet.* **109**, 385.
CORNES, J. S., and STECHER, M. (1961) *Gut*, **2**, 189.
DAVIS, D. E. (1945) *J. Mammal.* **26**, 119.
DUTHIE, H. L., and GAIRNS, F. W. (1960) *Brit. J. Surg.* **47**, 585.
EDWARDS, M. (1961) *Dis. Colon Rect.* **4**, 103.
FITCHET, S. M. (1928) *New Engl. J. Med.* **199**, 766.

FOWLER, R. (1957) *Aust. N.Z. J. Surg.* **27,** 1.
GABRIEL, W. B. (1945) *The Principles and Practice of Rectal Surgery.* London, Lewis.
GAY, A. (1871) *S.-B. Akad. Wiss. Wien,* **63** (2), 329.
GILLMAN, T. (1958) *Med. Proc.* **4,** 751.
GOLIGHER, J. C. (1961) *Surgery of the Anus, Rectum and Colon.* London, Cassell.
GORDON-WATSON, SIR C., and DODD, H. (1935) *Brit. J. Surg.* **22,** 703.
GRASSÉ, P. P. (1955) *Traité de Zoologie,* **17:** *Mammifères.* Paris, Masson.
GRINVALSKY, H. T., and HELWIG, E. B. (1953) *Amer. J. Path.* **29,** 610.
GROSY, S. (1904) *Z. wiss. Zool.* **78,** 261.
GUPTA, S. C. (1952) *Indian J. Surg.* **14,** 185.
HALLER, A. von (1751) *Primae lineae physiologiae,* p. 486. Gottingae, Vandenhoeck.
HAMPEREL, H. (1925) *Z. wiss. Zool.* **124,** 542.
HARRIS, H. A. (1929) *Proc. Roy. Soc. Med.* **22,** 1341.
HATT, R. T. (1926) *Anat. Rec.* **32,** 209.
HAYNES, J. F., and ENDERS, A. C. (1961) *Amer. J. Anat.* **108,** 295.
HEBRANT, G. (1899) *Ann. Méd. vét.* **48,** 633.
HERRMANN, G. (1880) *J. Anat. Physiol.* **16,** 434.
———— and DESFOSSES, L. (1880) *C.R. Acad. Sci., Paris,* **90,** 1301.
HILL, M. R., SHRYOCK, E. H., and REBELL, F. G. (1943) *J. Amer. med. Ass.* **121,** 742.
———— SMALL, C. S., HUNT, G. M., jnr., and RICHARDS, L. J. (1949) *Arch. Path.* **47,** 350.
HIRSCHMANN, L. J. (1931) *J. Amer. med. Ass.* **97,** 1609.
HOLMES, A. M. (1961) *J. Anat., Lond.* **95,** 416.
JOHNSON, C. E. (1921) *J. Mammal.* **2,** 87.
JOHNSON, F. P. (1914) *Amer. J. Anat.* **16,** 7.
JOHNSON, F. R., and ANDERSON, J. C. (1953) *J. Path. Bact.* **66,** 39.
KAY, S. (1954) *Cancer,* **7,** 359.
KIRKMAN, H. (1951) *Amer. J. Anat.* **88,** 177.
KLINE, R. J., SPENCER, R. J., and HARRISON, E. G. (1964) *Surgery,* **89,** 989.
KRATZER, G. L. (1950) *Amer. J. Surg.* **79,** 32.
———— and DOCKERTY, M. B. (1947) *Surg. Gynec. Obstet.* **84,** 333.
LE GROS CLARK, W. E. (1952) *The Tissues of the Body.* Oxford, Clarendon Press.
LINSDALE—quoted by BOURLIÈRE, F. (1955) *The Natural History of Mammals,* p. 230. London, Harrap.
LOCKHART-MUMMERY, J. P. (1929) *Proc. Roy. Soc. Med.* **22,** 1331.
MCCOLL, I. (1963) *Proc. Roy. Soc. Med.* **56,** 797.
———— (1965) *Proc. Roy. Soc. Med.* **58,** 709.
———— (1966) M.S. Thesis, University of London.
MOON, L. E. (1926) *Nebraska State med. J.* **11,** 396.
MORGAN, C. N. (1936) *Postgrad. med. J.* **12,** 287.
———— and THOMPSON, H. R. (1956) *Ann. Roy. Coll. Surg. Engl.* **19,** 88.
NIELSON, S. W. (1964) *J. Amer. Vet. Ass.* **144,** 127.
OPPENHEIM, A., and O'BRIEN, J. P. (1950) *Amer. J. Surg.* **79,** 320.
ORTMANN, R. (1960) *Z. Anat. Entwick.* **121,** 459.
OWEN, R. (1868) *Anatomy of Vertebrates,* **3,** 632. London, Longmans Green.
PACHT, J. (1952) *Experimentia,* **8,** 464.
PARKS, A. G. (1956) *Brit. J. Surg.* **43,** 337.
———— (1958) *Postgrad. med. J.* **34,** 360.
———— (1961) *Brit. med. J.* **1,** 463.
———— and MORSON, B. C. (1962) *Proc. Roy. Soc. Med.* **55,** 751.
PENNINGTON, J. R. (1917) *J. Amer. med. Ass.* **69,** 1501.
POCOCK, R. I. (1910) *Proc. Zool. Soc. London,* p. 840.
RANKIN, F. W., BARGEN, J. A., and BUIE, L. A. (1932) *The Colon, Rectum and Anus.* Philadelphia, Saunders.
ROSSER, C. (1934) *Trans. Amer. proctol. Soc.* **35,** 65.
ROWLANDS, I. W., and BRAMBELL, F. W. R. (1936) *Phil. Trans. B,* **226,** 99 and 71.
SCARBOROUGH, R. A. (1941) *Trans. Amer. proctol. Soc.* **42,** 172.
SCHAFFER, J. (1924) *Z. wiss. Zool.* **129,** 79.
———— (1940) *Die Hautdrüsenorgane der Säugetiere.* Berlin, Urban und Schwarzenberg.
SLEGGS, G. F. (1926) *Anat. Rec.* **32,** 1.

STELYNER, F. (1960) *Z. Anat. Entwickl.-Gesch.* **121,** 525.
STROUD, B. B. (1896) *Ann. Surg.* **24,** 1.
TENCH, E. M. (1936) *Amer. J. Anat,* **59,** 333.
TUCKER, C. C., and HELLWIG, C. A. (1933) *Trans. Amer. proctol. Soc.* **34,** 47.
——————————— (1934) *Surg. Gynec. Obstet.* **58,** 145.
——————————— (1935) *Arch. Surg., Chicago,* **31,** 521.
——————————— (1938) *J. Amer. med. Ass.* **111,** 1270.
VRTIS, V. (1929) *Biol. Spisy Acad. Veter. Brno,* **8,** 11.
WALLS, E. W. (1958) *Brit. J. Surg.* **45,** 504.
——————— (1963) *Scientific Basis of Med. Annual Reviews.*
WERNER, H. J., DALQUEST, W. W., and ROBERTS, J. H. (1952) *Anat. Rec.* **113,** 71.
WILLIS, R. A. (1962) *The Borderland of Embryology and Pathology.* London, Butterworth.
WYNNE-EDWARDS, V. C. (1962) *Animal Dispersion in Relation to Social Behaviour.* Edinburgh, Oliver and Boyd.
YOUNG. J. Z. (1957) *The Life of Mammals.* Oxford, Clarendon Press.

THE THOMAS VICARY COMMEMORATION

THE ANNUAL THOMAS VICARY commemoration was held on 27th October 1966, when the Vicary Lecture was delivered in the College by Dr. G. G. Macdonald. This is reproduced in full on page 1 of this issue of the *Annals.*

In the evening members of the Council of the College were entertained to dinner by the Court of the Barber's Company at Innholder's Hall, with the Master of the Barbers' Company, the Rev. E. G. Turner, in the Chair. The toast of the Vicary Lecturer was proposed by Mr. H. R. Thompson, F.R.C.S., a past-Master of the Company. When replying to the toast,

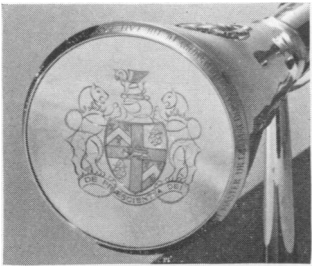

Fig. 1. The top plate of the Mace showing the 1569 coat of arms.

Dr. Macdonald, also a past-Master of the Barbers' Company, presented to the Company a new Mace in memory of his father, the late Dr. G. G. Macdonald, who had also been a past-Master of the Barbers' Company. The Mace was designed and made by the donor's eighteen-year-old son, who is a student at the Sir John Cass College and School of Art, and was engraved by Mr. D. McQuoid.

The Mace is silver with three silver-gilt panels in the head. It is 2 ft. 6 in. long and weighs about 70 oz. On the top plate is the 1569 coat of arms of the Worshipful Company of Barber Surgeons drawn in a modern style (Fig. 1). Silver models of St. Cosmo and St. Damian, the