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## THE GLANDS OF THE ANAL CANAL IN MAN

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Interest in the existence and function of the glands of the anal region of man has existed for a long time. Today there are almost no differences of opinion about the glands located in the circumanal area. Less consistent are the investigative results on the glands of the anal canal proper, particularly those of the zona columnaris. Some authors deny glands in this area completely; others find them only occasionally; still others cannot decide whether they are glands or just epithelial lined spaces, whereas some authors refer to them as true glands with permanent secretion. Interest in the anal canal glands is increasing because of the assumption that they play a definite role in the genesis of some ano-rectal diseases, lesions, and even malignant tumors.

The present study of this region was undertaken to verify or disprove certain statements relating to the existence, individual variation, position, number, type, course, and possible significance of these glands. Another motivating factor for this investigation was whether the glands of the anal canal in man have a definite function or whether they are vestigial remains.

### REVIEW OF THE LITERATURE

It is well-known that the anal region of animals, particularly the mammals, is rich in different glands. According to their openings they are called rectal, proctodeal, paraproctic, anal, or circumanal glands. Most of them are modified skin glands. However, some animals possess in this area specific glands, which can be monoptychic or polyptychic; eccrine, apocrine, holocrine or meroholocrine secreting. In the animal kingdom these specific or modified skin glands are so different in position, arrangement, structure and function, that even closely related species may show variations. The secretion of most of the glands plays an important role in the sexual life of the animals, whereas the secretion of others are designated for identification of species or sex, and still others produce odoriferous or poisonous substances for defense or offense.

In man, the area just outside the anal orifice, the immediate neighborhood of the anus, is known as the circumanal or perianal skin. Here are located the so-called circumanal glands which are large sebaceous glands associated with hairs, and the sweat glands. Some of the latter are of the apocrine type and even larger than those of the axillary region (Gay, 1871; Szent-Györgyi, 1913; Schaffer, 1924; Hamperl, 1925; Patzelt, 1931, 1936; Sperling, 1935; Peter and Horn, 1935; Kratzer and Dockerty, 1947).

The zona cutanea of the anal canal is characterized by Johnson (1914) as being lined with stratified squamous distinctly hornified epithelium, with numerous papillae, hair follicles and sebaceous glands. Schaffer (1924), Hamperl (1925) and Patzelt (1931, 1936) describe sebaceous, sweat and large apocrine glands as being common in this zone, just as they are in the circumanal region. Kirkman (1951), however, has seen a few modified "sudoriparous" glands only in the very distal part of the cutaneous zone, whereas Gay (1871) in this area found only sebaceous glands.

The zona intermedia of the anal canal seems to be poor in glands. Robin and Cadiat (1874) emphasize that this zone is lacking entirely in hairs and glands, whereas Koelliker (1850), Romiti (1899), Braun (1901), Stieda (1902), and Johnson (1914) did observe a few sebaceous glands.

ous glands in some individuals but never any hairs in this zone. Szent-Györgyi (1913) and Hamperl (1925), however, have shown that in the *zona intermedia* are found both types of sebaceous glands: "free" and those attached to the hair follicles. Hamperl states that the free sebaceous glands are very rare, but Szent-Györgyi found them in about 50 percent of the investigated material. Tucker and Hellwig (1933) and Tucker (1935) described the *zona intermedia* as being lined by "transitional epithelium" and the area from which "anal ducts" originate.

The main interest of investigators of this region has been and still is concentrated in the *zona columnaris* of the anal canal because of the peculiar glandlike structures found in this area. Generally these structures are called "anal glands" but they have many other names, almost as many names as there are authors who have investigated them. These structures are of investigative interest because they do not look like the other glands of the body and because they are of practical, clinical importance. Many years ago Morgagni (1719) described secondary grooves originating from the rectal sinuses and leading into wide cystlike cavities. Haller (1765) mentioned that large mucous glands open into the *sinus rectales*. To Herrmann (1880) and Herrmann and Desfosses (1880) we owe the first good description of these glandlike structures. They state that from the bottoms of the rectal sinuses irregular canals or slitlike spaces extend into the submucosa, some of them showing sacklike dilatations. The latter authors call them secondary type Morgagni sinuses. From these dilatations branch off tertiary "sinuses" in the form of simple or branched tubules. Some of these terminal tubules penetrate the internal sphincter muscle. These third type of tubules and the dilatations are supposed to be quite similar to glands. Herrmann (1880) and Herrmann and Desfosses (1880) called them "special acinous glands" or "intramuscular sinuses." However, these investigators were not certain whether these structures should be classified as glands or not because they were not able to find any secretory characteristics in them. Braun (1901) has seen Herrmann's (1880) "secondary sinuses" but could not find the "special acinous glands" or "intramuscular sinuses" and therefore denied their presence. Szent-Györgyi (1913) is also of the opinion that these channels are not glands but recesses of the mucosa whose terminal ends are dilated. But only a year later, Johnson (1914) demonstrated, in the *zona columnaris* area, the existence of what he calls "anal ducts" and "anal glands" in human embryos in various stages of development. He describes them as simple tubules arising from the rectal sinuses. In some cases they extend only as far as the submucosa, while in others the gland enters the internal sphincter muscle and dilates in an ampullalike structure which he calls "intramuscular gland." He also states that it is claimed that the evidences of secretory cells are wanting in the adult although in his material (fetus and neonate) such cells are present. The first good information of the *zona columnaris* glands in the adult is provided by Hamperl (1925). In general the description of the glands resembles that given by Johnson (1914). Because these structures open into the proctodeum, Hamperl calls them "proctodeal glands." He characterized them as simple or branched tubular glands which terminate in the submucosa or pierce the muscle layers. Except for a few mucus secreting cells, he could not find any other secretory characteristics. Hamperl considered these glands as being rudimentary. Petersen (1931) states that he could not find any secretory cells in these structures. Pope (1933) demonstrated acinuslike buds in them. As reported by Tucker and Hellwig (1933) and Tucker (1935), the "anal ducts" originate only from the *zona intermedia*. In man these ducts, according to these authors, are vestigial remnants. Also Gordon-Watson and Dodd (1935) consider the "anal glands" as vestigial structures which often lose their connection with the lumen of the anal canal because of the obliteration of the ducts during development. Morgan (1936) has observed that most of the "anal ducts" had their orifices in the posterior portion of the anal canal. Bremer (1936) noted the postnatal disappearance of secretory cells from the "anal ducts." As reported by Hill, Shryock and ReBell (1943), the "anal glands" only occasionally invade the internal sphincter muscle. They suggest the glands are not vestigial as some authors emphasize, but structures which function throughout life. Kratzer and Dockerty (1947) found "anal ducts" in about 50 percent of human anal canals. According to these authors the proximal parts of the ducts are lined by "transitional epithelium," the more distal ones by a double layer of cuboidal cells or even by simple squamous epithelium. Definite mucus producing cells may be demonstrated

in 10 percent of the tubules. Hill, Small, Hunt and Richards (1949) studied fetal material and found "anal glands" in 53 percent of the specimens. Kirkman (1951) who examined the ano-rectal regions of monkeys and adult humans, stated that he has seen anal ducts only occasionally.

#### MATERIAL AND METHODS

Material was obtained from five adults (2 ♀, 3 ♂), ages 22 to 28 years, and from two newborn infants (♀, ♂), four to five hours after death, with no history of disease in this area. All material was embedded in celloidin. Complete sagittal serial sections of each of the entire ano-rectal regions were prepared. Most of the sections were stained routinely with hematoxylin and eosin; only occasionally Heidenhain's Azan stain, mucicarmin and Bismarck brown were employed.

#### OBSERVATIONS

The anal canal (*pars analis recti*) is the terminal portion of the large intestine (fig. 1). It begins where the rectum proper terminates (*linea ano-rectalis*) and it ends at the anal orifice (anus). Its length in the adult measures from 2.5 to 3.5 cm. In empty condition it presents the appearance of an anterior-posterior longitudinal slit. The upper part of the anal canal possesses six to ten permanent longitudinal folds of mucous membrane known as the rectal (anal) columns (*columnae rectales Morgagni*). At about 2 cm cranial to the anus each two adjacent columns are united by a semilunar fold. These little folds are the anal valves (*valvulae semilunares*) while the small fossae formed by them are known as the rectal or anal sinuses (*sinus rectales*). The sinuous or pectinate line formed by the margins of the anal valves and the corresponding portions of the intervening columns of Morgagni is known as the *linea sinuosa analis*.

Three zones can be distinguished in the anal canal: *z. columnaris*, *z. intermedia*, and *z. cutanea*. The proximal boundary of the *z. columnaris* is the *linea ano-rectalis*, a wavy line formed by the junction between the simple columnar epithelium with striated border of the rectal mucosa and the stratified epithelium of the *z. columnaris*. The distal boundary of this zone is the *linea sinuosa analis*. *Zona intermedia* is a transition zone between anal mucosa and the skin. It is bounded proximally by the *linea sinuosa* and distally by the *linea ano-cutanea*. The latter is rather an indistinct line formed by the junction of a thick stratified squamous non-keratinized epithelium of the *z. intermedia* and a thinner stratified squamous keratinized epithelium of the next zone. The *z. cutanea* of the anal canal is lined by stratified squamous keratinized epithelium and extends between the ano-cutaneous line and the anal orifice. Here, at the anus, the *z. cutanea* without demarcation passes over to the circumanal skin (fig. 1).

The main location of the glands of the anal canal is in a connective tissue zone between the sphincter ani muscles and the epithelial lining of the anal canal. In the anal region there are four different types of glands: (1) holocrine secreting sebaceous glands, (2) merocrine, eccrine secreting sweat glands, (3) merocrine, apocrine secreting scent-glands, and (4) specific *zona columnaris* eccrine glands.

1. *Sebaceous glands*.—Found mainly in the circumanal skin and in the *z. cutanea* of the anal canal. Less often they are seen in the *z. intermedia* and are never found in the *z. columnaris*. The circumanal sebaceous glands are the largest of the anal region. Even in the newborn they are strikingly large. They are richly branched and are all attached to hair follicles. They are numerous and not all are of the same size, the largest ones being located around the anus. Circumanal sebaceous glands differ from the common sebaceous glands of the skin only in being much larger and more branched. It has to be emphasized that the number and size of these glands vary considerably in individuals of the same age and sex. Sebaceous glands of the *z. cutanea* are smaller, however. They are less branched and limited to the subepithelial connective tissue. Each gland is associated with a short and thin hair follicle (fig. 3). Usually there are

many sebaceous glands in this zone, but there are also individuals with just a few small glands. In the *z. intermedia* the sebaceous glands are still smaller and not so common as in the previous areas. In this zone three kinds of holocrine secreting sebaceous glands occur: (1) with well-developed hairs, (2) with rudimentary hairs and (3) "free," "independent" or without hairs. The majority of the *z. intermedia* sebaceous glands are with rudimentary hairs and only a few glands are without hairs. The latter type is usually found in the cranial part of this zone. It has to be emphasized that in individuals with poorly developed circumanal and *z. cutanea* glands, the *z. intermedia* possesses sebaceous glands only occasionally (fig. 4).

2. *Sweat glands (gl. sudoriferae)*.—Found only in the circumanal skin, lateral to the musculus sphincter ani externus. They were never seen in the wall of the anal canal. All of the material showed sweat glands in this area; even in the newborn they appear to be functional. In structure and location the secretory portions and the ducts resemble the usual sweat glands. In some individuals the glands look very well developed, the secretory portions forming large balls.

3. *Apocrine glands or apocrine secreting glands*.—In the anal region two types of apocrine secreting glands are seen: the common ones and the modified, respectively those of the circumanal skin and those located in the wall of the anal canal.

a) In the circumanal skin, in the vicinity of the anus, deep in the subcutaneous layer are located typical tubular apocrine secreting glands resembling those of the axilla. The secretory portions are twisted in loose balls, some of them measuring 3.6 to 4 mm in diameter. Lumina are large and the walls are composed of a single layer of cuboidal or columnar epithelial cells of the apocrine type. Between the glandular cells and the basement membrane are seen highly developed myo-epithelial elements. The duct of the gland opens into the hair follicle above the orifice of the sebaceous gland. Not all individuals have the same number of glands; in our material it varies from 0 to 8. The average number of the circumanal apocrine scent glands is 4 to 5 and usually they are not located close to one another but are scattered (fig. 2).

b) In the *z. cutanea*, however, are seen modified apocrine glands. Craniad from the anus up to the *z. intermedia*, tubular glands of different length are seen. They are located in the connective tissue between the anal canal lining and the external sphincter muscle. The length and form of the tubules vary. The majority are 1 to 1.8 mm-long straight or tortuous tubules which open either into the duct of the sebaceous gland or independently into the anal canal. The latter condition obtains particularly in the more cranially located glands of this zone. Only on rare occasions is the terminal end of the tubule somewhat twisted. In each tubule a secretory and excretory portion can be distinguished. The secretory portion is lined with two layers of cells. The innermost cells are cuboidal and of the apocrine type while the outer ones are flattened and resemble myo-

#### EXPLANATION OF FIGURES IN PLATE I

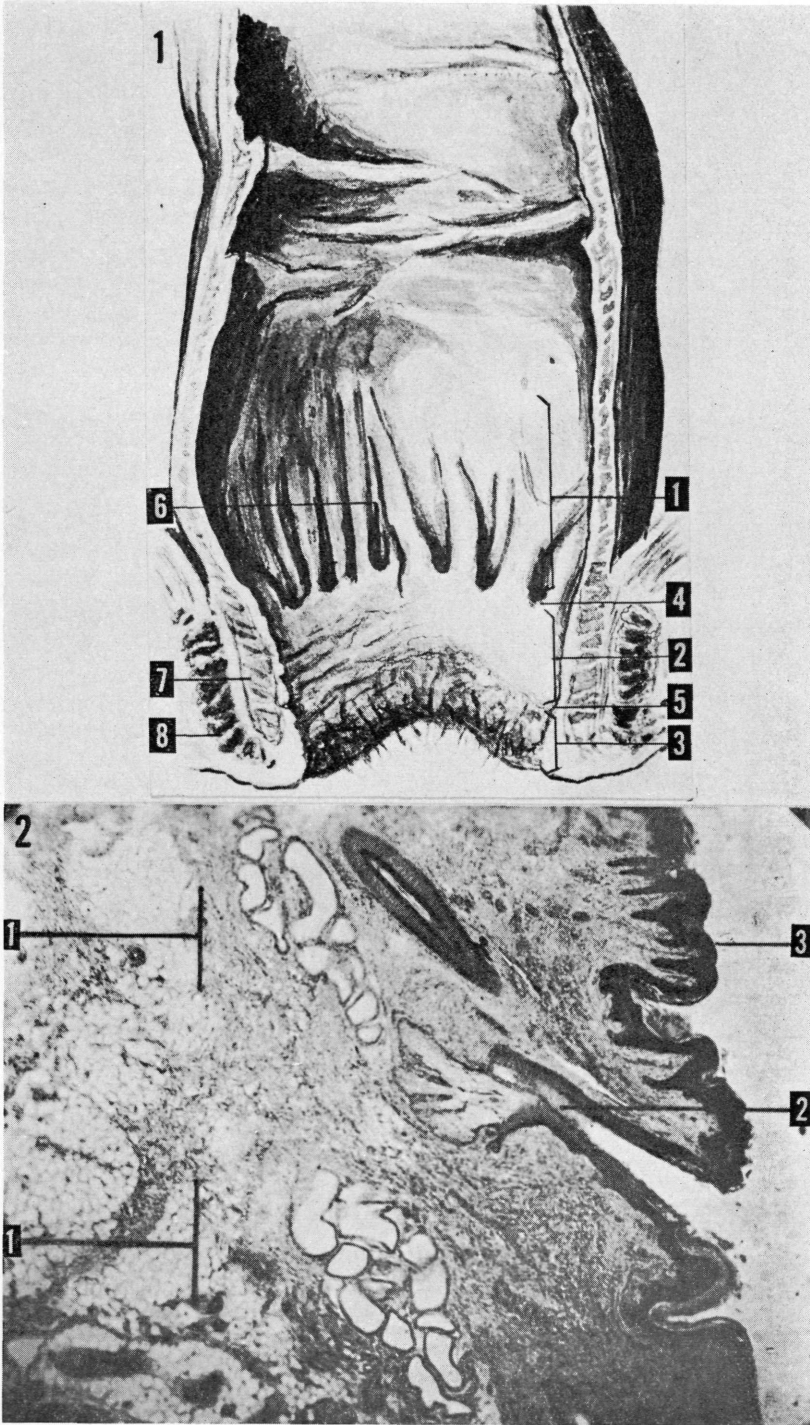
FIGURE 1. The anal canal of man (semi-schematic drawing).

1. Zona columnaris
2. Zona intermedia
3. Zona cutanea
4. Linea sinuosa analis
5. Linea ano-cutanea
6. Sinus rectales Morgagni
7. Musc. sphincter ani int.
8. Musc. sphincter ani ext.

FIGURE 2. Apocrine secreting circumanal glands.

Transverse section of the anal region. 22-yr old ♂. ×30.

1. Secretory portion of the apocrine gland
2. Circumanal sebaceous gland
3. Epithelium of the circumanal skin



epithelial cells. Apparently they are very active glands because all the lumina are filled with fine granular secretion. Here and there around the glands are found more lymphocytes than is usual in the connective tissue. Approaching the lumen of the anal canal, the secretory portion passes over into the excretory duct with changes in the epithelium and the lumen. The tubule becomes slender, the epithelium thicker and consists of three cell layers which resembles stratified squamous epithelium. The lumen of the duct is very narrow scarcely visible.

The majority of the glands, then, are simple tubules of about uniform diameter such as have been described above and shown in figure 5. However, some remarkable variations occur. For instance, in addition to the described tubular form, occasionally are seen ampullalike forms where the secretory portion has a very wide (ca. 462  $\mu$ ) lumen. Suddenly the secretory portion passes over into a very thin excretory duct lined with stratified squamous epithelium. The diameter of the duct is about 55  $\mu$ , that of the lumen 25  $\mu$  and the caliber does not change until the outlet is reached. In the ampullar part, the epithelium is similar to that described in the secretory portions of the tubular glands, only somewhat lower (fig. 6). From the appearance, structure, secretion and the orifices one can conclude that these structures are modified simple tubular, merocrine, apocrine secreting glands. In the present material, such glands are found only in four adults and in one newborn, averaging 13 to 17 in number. In the one remaining adult and one newborn we could not find any apocrine glands in the anal region, either common or modified.

4. *Zona columnaris glands.*—The lining epithelium of this zone is stratified. On the more elevated parts (columns of Morgagni) it is stratified squamous non-keratinized, while in the depressions (between columns) which are not exposed to pressure and mechanical stress the epithelium is stratified columnar.

Three types of glands can be seen in this zone. Near the linea ano-rectalis are to be found a few intestinal glands of Lieberkühn and some goblet cells, whereas in the lower part of this zone are seen the orifices of specific, eccrine secreting glands. The latter ones are structures which most authors call the "anal glands" and which are the most interesting features of the zona columnaris.

Arising either between the columns, from them or, as is more common, from the bottoms of the rectal sinuses, are found tubular ductlike structures extending into the subepithelial connective tissue and often called "anal crypts." These ducts or crypts very often give off secondary and tertiary tubular branches which end blindly in the submucosa or may penetrate into, or pierce through the muscularis of the anal canal. The central crypt (main duct) and its larger side branches seem to be the excretory passageways, whereas some of the tubules which branch off from the duct resemble the secretory units of the gland. We observed that most of the ducts had their outlets in the posterior side of the anal canal. The direction of the ducts and their terminal portions usually is caudo-lateral or caudal, rarely straight lateral (outwards) or cranial.

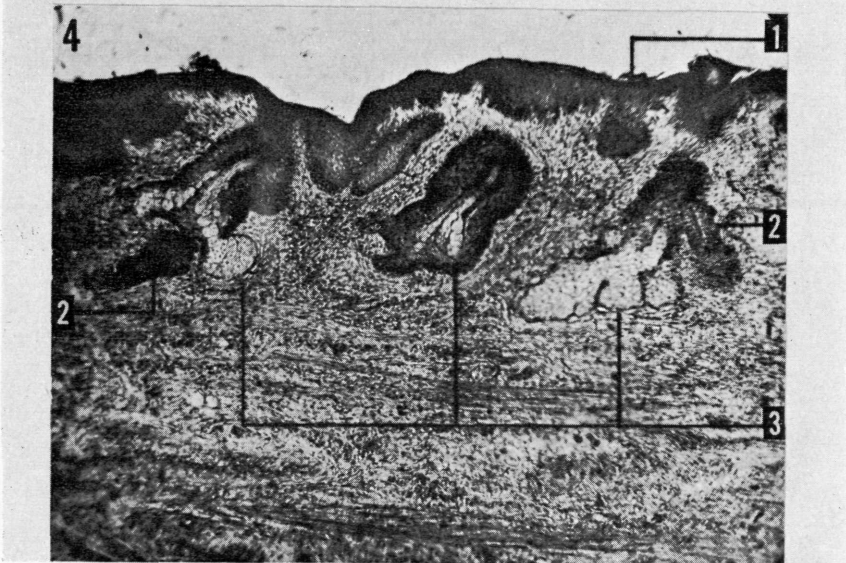
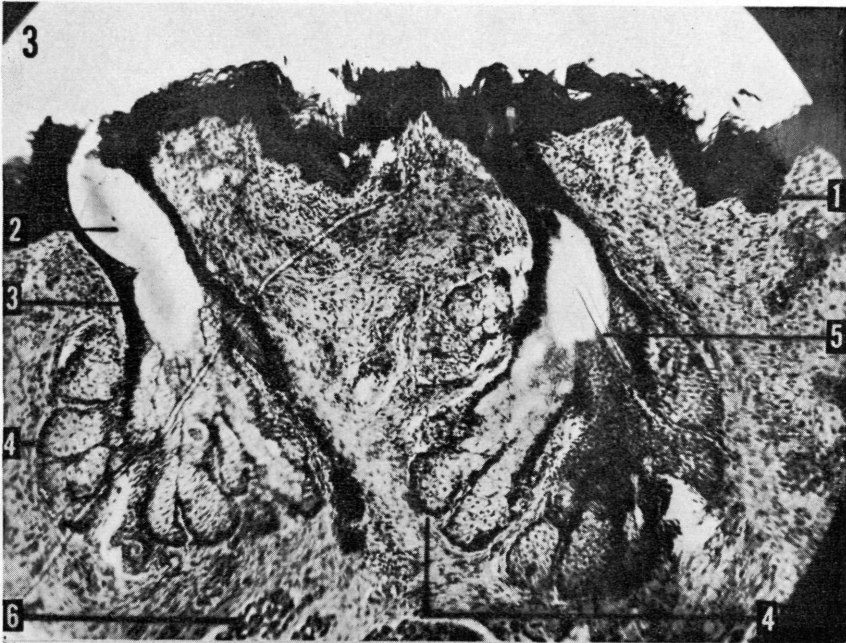
Each duct has one to six slender tubular end portions, some of which occasion-

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#### EXPLANATION OF FIGURES IN PLATE II

- FIGURE 3. Sebaceous glands of the circumanal area.  
Sagittal section of the anal region. Newborn (♀).  $\times 79$ .
1. Epithelium of the circumanal skin
  2. Duct of the gland
  3. Stratified squamous epithelium of the duct
  4. Holocrine end portion
  5. Hair follicle with the associated gland
  6. Musc. sphincter ani externus
- FIGURE 4. Sebaceous glands of the zona intermedia.  
Sagittal section of the anal region. 22-yr old ♂.  $\times 54$
1. Stratified squamous epithelium of the zona intermedia
  2. Rudimentary hair
  3. Holocrine end portion





ally show knoblike protuberances which resemble alveoli. In some instances the end portions extend only as far as the *z. columnaris lamina propria* or submucosa, because the terminal tubules of some glands are short and seem to be undeveloped. A typical picture of so-called anal crypts or ducts with few tiny secretory end portions is seen in figure 7. The caliber, the number of side branches and the diameter of the ducts, as seen in figure 7, varies considerably: in some places the lumen is only  $7\ \mu$  in others  $70\ \mu$  or more in diameter. The usual length of the main crypt (central duct) is 1.5 to 2 mm and only occasionally they reach 4 mm. Some of the terminal tubules reaching the submucosa at times become distended into small caeca. Others reach the submucosa of the *z. intermedia*, still others pierce the internal sphincter muscle and occasionally also the longitudinal muscle coat, or even reach as far cephalad as the ano-rectal line. Sometimes the glandular tubules inside the internal sphincter dilate into ampullalike structures which traverse the whole sphincter and penetrate the longitudinal muscle layer as seen in figure 8. From these enlargements branch off several small terminal tubules which penetrate still further laterally and end blindly in the connective tissue or, penetrating the longitudinal muscle coat, reach the area of the ischio-rectal fossa. Scattered along the ducts and particularly about their terminal ramifications are found accumulations of lymphocytes. One of the intramuscular secretory portions of a *z. columnaris* gland seen in figure 8 is a rather large structure which can be seen macroscopically. It measures  $0.91 \times 1.28 \times 2.1$  mm. The distance from the opening in the anal canal to the apex of the ampulla is 6 mm.

The walls of the main ducts (crypts) are made up of stratified epithelium similar to that lining the *z. columnaris* from which the ducts arise, i.e., stratified squamous or stratified columnar type. The former, however, soon passes over into a stratified columnar epithelium which gradually becomes lower so that the secretory branches (terminal tubules, alveoli and ampullae) are lined by low cuboidal epithelium composed of two cell layers.

Epithelial channels which resemble glands were found in all our investigated *z. columnaris* regions. A wide individual variation, however, was noted in the number of glands, in their structural plan, mode of ramification, size, shape, location and in the depth to which they invaded the other tissues. Some individuals have many, well-developed and richly branched glands, others have only a few. For instance, the number of the specific, eccrine secreting *z. columnaris* glands present in a single individual varied from two to eleven; the average number of glands was three to five (a gland is considered being composed of one crypt with all the primary, secondary and terminal branches).

Considering the possible function of these above mentioned *z. columnaris* structures, it has to be emphasized that at least some of them are definitely glandular in nature, particularly those tubular or ampullar structures which are better developed and penetrate the muscularis. They are merocrine glands where the surface lining cells are eccrine secreting and in the lumina of which the secretion

#### EXPLANATION OF FIGURES IN PLATE III

- FIGURE 5. Tubular apocrine glands of the zona cutanea.  
Sagittal section of the anal region. 22-yr old ♂.  $\times 54$ .
1. Lumen of the anal canal
  2. Stratified squamous epithelium
  3. Secretory portion of the apocrine gland; lumen filled with secretion
  4. Excretory duct of the apocrine gland
- FIGURE 6. Ampullalike apocrine gland of the zona cutanea.  
Sagittal section of the anal region. 22-yr old ♂.  $\times 79$ .
1. Lumen of the anal canal
  2. Stratified squamous epithelium
  3. Secretory portion of the apocrine gland which suddenly passes into narrow excretory duct (4)
  5. Lumen of the gland filled with secretion





is seen (fig. 8). Some of these lining cells give a positive reaction for mucus. The very few saccular outpouchings which show secretory characteristics, and those tubules the sprouts of which finally branch and resemble the end portions of a tubular gland should also be considered as secretory portions. In general, however, the epithelial channels of the *z. columnaris* should be considered as rudimentary structures which have lost most of their secretory portions and the secretory characteristics in their phylogenetic development. No sex difference was observed in relation to incidence or location of these structures.

The investigated material of the newborn shows, in general, the same distribution, branching and some ampullalike dilatations of these glandular structures as do the adult specimens. Some terminal portions are seen intramuscularly and a few cells show secretory characteristics. The length of the glands from the orifice till the terminal ends varies from 0.42 mm to 2.38 mm. It is our impression that in the newborn as in the adults these structures appear to be rudimentary.

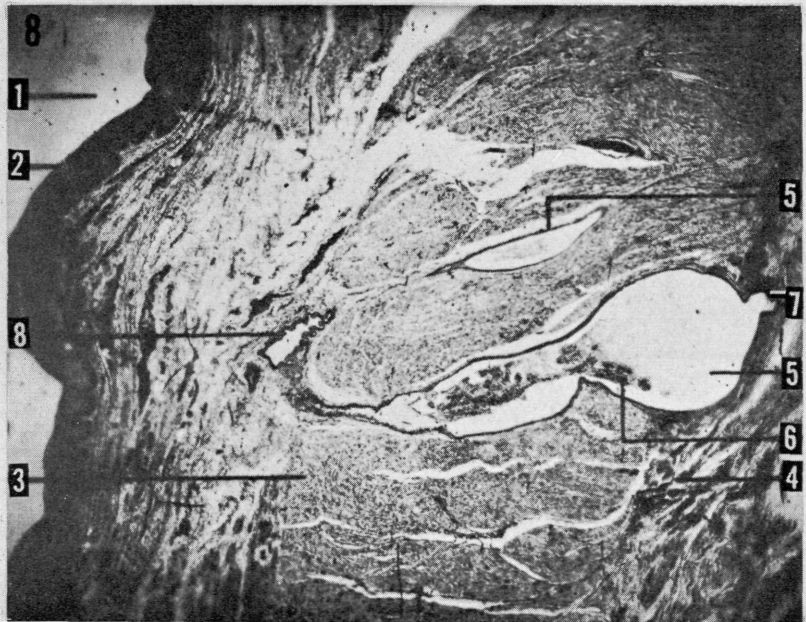
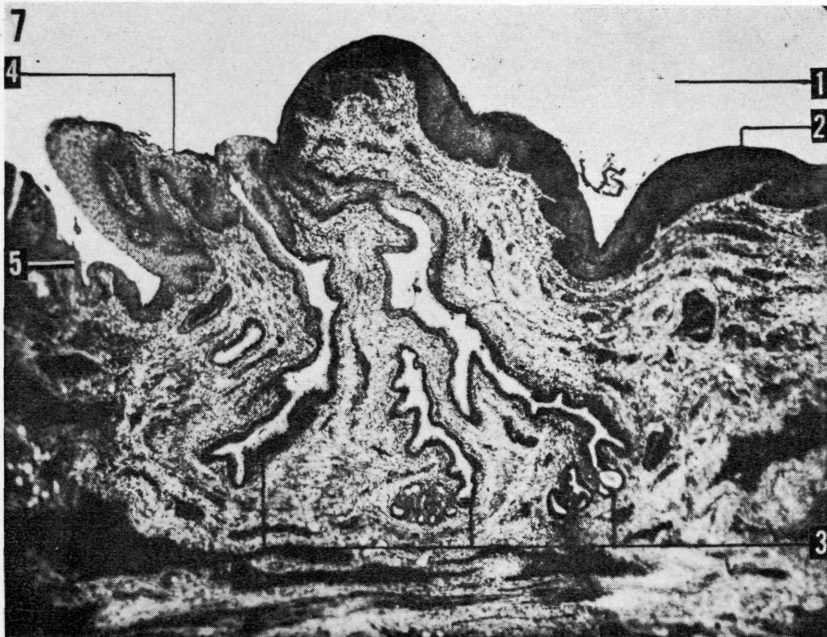
#### DISCUSSION

Sebaceous glands in the anal region have been seen by various authors who have investigated this area. They have been found circumanally, in the *z. cutanea* and the *z. intermedia*. However, there is some disagreement about the sebaceous glands of the *z. intermedia*. We cannot accept the findings of Robin and Cadiat (1874) that this zone is lacking entirely in hairs and glands. We also cannot agree with the observations of Koelliker (1850), Romiti (1899), Braun (1901) and Stieda (1902) that the sebaceous glands of this zone do not possess hairs. Our observations are in agreement with those of Szent-Györgyi (1913) and Hamperl (1925) who have reported two kinds of glands, with and without hair. Our findings, furthermore show that the majority of the *z. intermedia* sebaceous glands have rudimentary, undeveloped hairs which never reach the lumen of the canal. Accurate are the observations of Hamperl (1925) that "free" sebaceous glands in the *z. intermedia* are few in number. However, we are unable to confirm the report of Szent-Györgyi (1913) that "free" sebaceous glands reach full development only at the time of puberty. Our preparations show that the sebaceous glands of the adults are not much larger than those of the newborn.

Gay (1871) and Szent-Györgyi (1913) have observed sweat glands also in the *z. cutanea* of the anal canal but in our slides they are seen only circumanally. Moreover, Szent-Györgyi has reported the complete absence of sweat glands in the circumanal region of some individuals. Apparently the author may have had reference to the "large sweat glands," i.e., apocrine scent glands, because all humans possess eccrine glands in this particular area. Our observations con-

#### EXPLANATION OF FIGURES IN PLATE IV

- FIGURE 7. Anal ducts (channels or crypts) of the *zona columnaris*.  
Sagittal section of the anal region. 28-yr old ♂. ×30.
1. Lumen of the anal canal
  2. Stratified squamous epithelium
  3. Anal ducts
  4. Rectal (anal) column
  5. Transitional zone of the epithelium
- FIGURE 8. Eccrine glands of the *zona columnaris* penetrating sphincter ani muscle.  
Sagittal section of the anal region. 28-yr old ♂. ×24.
1. Lumen of the anal canal
  2. Stratified squamous epithelium
  3. Musc. sphincter ani int.
  4. Stratum longitudinale recti
  5. Ampulla of the eccrine gland
  6. Secretion
  7. Branch of the gland
  8. Excretory portion of the gland



cerning the circumanal glands support the results of the investigations of Hamperl (1925), Petersen (1931), Sperling (1935), and Peter and Horn (1935) that in this area two types of tubular glands exist: eccrine and apocrine secreting. In addition we have demonstrated in the *z. cutanea* of some individuals modified, apocrine secreting glands whose secretory portions are not coiled (figs. 5 and 6).

There is much more confusion about the epithelial channels of the *z. columnaris*. Some authors (Morgagni, 1719; Haller, 1765; Herrmann, 1880; Johnson, 1914; Hamperl, 1925) believe that these tubes are glands; among others, however, Szent-Györgyi (1913) and Braun (1901) deny this. Our own observations on serially sectioned material from both the adult and the newborn lead us to confirm the view that these peculiar looking tubules and ampullae are glands.

We cannot accept the point of view of Szent-Györgyi (1913) that the *z. columnaris* ducts are nothing else than deeper sinus rectales "recesses of the mucosa." We also cannot approve the opinion of Herrmann (1880) and Herrmann and Desfosses (1880) that they are acinous glands, because in our preparations they are tubular. It is not feasible to designate these glands as "intramuscular glands" as does Johnson (1914) because the tubules do not always penetrate into the muscle tissue. More often they terminate in the submucosa of the anal canal. Hamperl (1925) wrote that he, as Morgagni (1719), had seen a large sacklike structure lined with epithelium in the *z. columnaris* but could not trace it because he had only one section of it.

We were also able to find such dilated secretory portions, and observe them in serial sections as shown in figure 8. Tucker and Hellwig (1933) and Tucker (1935) described the *z. columnaris* as being lined by transitional epithelium and Kratzer and Dockerty (1947) saw transitional epithelium in the proximal parts of the *z. columnaris* ducts. It is not advisable to call the stratified columnar or the stratified squamous epithelium of this zone transitional epithelium even though it lines a transitional zone.

Tucker and Hellwig (1933) and Tucker (1935) reported that the "anal ducts" originated from the *z. intermedia*. Our preparations show that they are *z. columnaris* derivatives. We do not agree with Johnson (1914) and Hamperl (1925) that the specific glands of the *z. columnaris* are entodermal derivatives. Johnson believed that the *z. columnaris* and the *z. intermedia* develop from entoderm and that the *linea anocutanea* is the demarcation line between ento- and ectoderm. Our opinion is that the anal ducts of the *z. columnaris* are of ectodermal origin and that there is no doubt that the *z. intermedia* is derived from ectoderm simply because it possesses sebaceous glands and hairs. The exact line of demarcation cannot be definitely located in our preparations of newborns and adults but it is somewhere in the neighborhood of the *linea sinuosa analis* as accepted by such authors as Herrmann (1880), Retterer (1890), Chwalla (1927), Pernkopf (1928), Politzer (1931), and Patzelt (1931, 1936). According to Berenberg-Gossler (1913, 1914), whose investigative results are based on teratologic findings, the whole anal canal is of ectodermal origin.

We are not in a position to discuss the development of the anal region glands because our material did not include embryos and because in the newborn the glands do not differ much from the adult glands. According to Johnson (1914), Patzelt (1931), and Hill (1949) and his associates the "anal" or "proctodeal" glands arise as epithelial buds and cords in the fourth month of gestation from the rectal sinuses, whereas the *z. intermedia* and *z. cutanea* glandular primordia appear in the twentieth week of intrauterine life.

Various names have been given to the specific merocrine, eccrine secreting glands of the *z. columnaris*. These are called: special acinous glands, secondary and tertiary Morgagni sinuses, glandular ducts, intramuscular glands, intramuscular sinuses, anal grooves, glandlike structures, anal glands, anal crypts, proctodeal glands and anal ducts.

In certain descriptions in the literature, there is confusion as to whether the

author is describing the duct or the secretory portion of the gland. Since these are vestigial structures, it is to be expected that the epithelium would be a typical secretory type only in scattered instances. As a result, delimiting duct from secretory unit may therefore be difficult and hence subject to personal interpretation.

A question arises as to what is the best name for these structures. Frequently they are called "anal glands", but this is confusing because there are different types of glands in the anal canal wall (see figs. 4-8). The name "anal glands" does not point out a specific type of gland nor does it indicate the exact location or the type of secretion. It simply designates all the glands which open into the anal canal. Also the name "z. columnaris glands" does not adequately characterize them, because occasionally in the most cranial part of this zone some Lieberkühn glands and goblet cells are found. A suitable name is "specific z. columnaris glands" but it seems to be too long. To avoid long designation and still retain the popular term "anal," we feel that the specific, merocrine, eccrine secreting glands of the z. columnaris could be called the "anal ducts." They are true glands; however, they appear as ducts because of their vestigial condition.

To compare and to get some concept of the possible biological function of the glands of the human anal region, we have also investigated this region in certain animals. Although the results will be discussed in a subsequent publication, we can state here that Leporidae (*Lepus cuniculus*, *L. varronis*, *L. europaeus*) and Myoxidae (*Eliomys quercinus*) possess glands some of which open in the most cranial part of the proctodeum and resemble the anal ducts of man. However, in these animals the glands are much better developed and appear very active. Some of the ducts and their terminal portions are located in or pierce through the muscularis of the alimentary canal as in man. The secretions of the different types of glands located in the anal region of animals cannot be designated as a lubricant of the anal canal; this could be a secondary task. The chief mission of these structures, however, seems to be the production of odoriferous substances which have meaning in the identification of the animal species, perhaps in its sexual life and in defense or offense. In behalf of the favorable location of the glands, when the sphincter muscle contracts, the secretion is discharged into the anal canal, at the anus or circumanally and covers the hairs and also anoints the feces.

In regard to the human scent-glands Schiefferdecker (1922) says that after man had assumed the vertical position and changed his form of life, the olfactory organ and the scent-glands of the skin gradually perished. However, even now, on certain occasions, the specific odor of the secretion of some skin glands serves as a sexual stimulus on some individuals. In regard to the skin glands of the anal region of man, there is no doubt that somewhere in the past they had important biological function, perhaps one as the lower mammals possess at the present time. However, now in the anal canal wall are seen only perishable glands, vestigial remnants such as the z. columnaris specific eccrine and the z. cutanea apocrine secreting glands. The histopathological importance of anal ducts has been assumed by certain pioneer investigators and recently once more emphasized by Tucker (1935), Kratzer and Dockerty (1947), and Hill et al. (1949). These structures have been considered as routes by which infection may be transmitted to the deeper tissues of the anal region, structures which may be responsible for cryptitis, periproctitis and ischioanal abscesses, cysts and tumors of this region. Therein lies their main interest, since this study has not attributed to them any useful function in man. In order to understand the possible importance of the anal ducts, and anal canal glands in general, as potential avenues for the spread of anorectal infection, one must realize the fact of their existence (see figs. 4-8). It is well known that the intestinal tract acts as a natural lodging for some pathogenic and nonpathogenic organisms which under certain stresses and strains may invade the adjacent tissues. Any irritation, trauma or alteration in bowel habit provides more favorable conditions for the spread of infections. Particularly

vulnerable are vestigial structures such as the vermiform appendix and the rudimentary anal canal glands.

It is obvious that after infection has started in a glandular duct it could continue to spread along all the branches of this gland. It was mentioned before that some terminal portions of the specific glands of the *z. columnaris* extend into the subepithelial connective tissue of the *z. intermedia*, others reach the rectal submucosa and still others extend outwards, penetrate the muscularis and occasionally reach the ischiorectal fossa. Moreover, in the *z. cutanea* are found modified apocrine secreting glands which only some individuals possess. All these locations of vestigial structures offer a logical explanation of abscesses and fistulas encountered occasionally in these areas. In observing the glands of figures 6 and 8 one can imagine the possibility of how easily the narrow duct of the gland may become obstructed and a cyst may develop.

It has always been difficult to explain the etiology of primary carcinoma when found in the perianal tissue. Scarborough (1941) has shown that the anal canal glands are not free from primary malignancy. He describes a primary carcinoma originating from "rudimentary remains of the anal glands." Such findings again have stimulated investigators to focus their attention to the glandular structures of the anal canal. Martin (1935) observed that in gonorrheal infection of women the anal canal also becomes infected in about half the cases. Tucker and Hellwig (1933) pointed out that in 22.1 percent of their material of infected anal ducts the infection was caused by the Neisser coccus. They emphasized that the anal ducts play an important part in gonorrheal reinfection by harboring the gonococcus.

In the descriptive part of this paper we have noticed that in man the number of anal ducts and also the other types of glands of the anal canal varies considerably from case to case. Some individuals have few, others many. It is believed that those persons with a relatively large number of glands have a greater predisposition to perianal complications than those with few glands.

#### SUMMARY

The glands of the anal region have been reinvestigated. Normal adult and newborn material was obtained shortly after death. The entire anorectal regions were examined in serial celloidin sections.

In the anal region there are four different types of glands: (1) holocrine secreting sebaceous glands, (2) merocrine, eccrine secreting sweat glands, (3) merocrine, apocrine secreting scent-glands, and (4) specific *zona columnaris* eccrine glands.

Sebaceous glands are found circumanally and in the *z. cutanea* and *z. intermedia* of the anal canal. In the *z. intermedia* three kinds of sebaceous glands occur: (1) with well developed hairs (2) with rudimentary hairs and (3) "free" or without hairs. Sweat glands are found only circumanally. Apocrine scent-glands are located circumanally and in the *z. cutanea* of the canal. Circumanal apocrine glands resemble those of the axillary region, whereas those of the *z. cutanea* are modified: some are simple tubules whose secretory portions are not coiled, in others the secretory portions are ampullalike sacks. In the *z. columnaris*, tubular structures arise from the crypts of the rectal sinuses. Some of the tubules branch in the submucosa, others penetrate the internal sphincter muscle or even reach the ischiorectal fossa. The intramuscular portions of these glands are usually distended in pear shaped sacks some of which measure 0.91 x 1.28 x 2.1 mm. These appear to be glands of the eccrine type.

All glands of the anal canal vary considerably among individuals in number, form and size. Although vestigial in man, these glands are yet clinically significant as pathologic sites.

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