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**On the bulbus olfactorius and bulbus olfactorius
accessorius of Some mammals**

**Bulbus olfactorius i bulbus olfactorius accessorius
niektórych ssaków**

**Bulbus olfactorius и bulbus olfactorius accessorius
некоторых млекопитающих**

In 1948 I have described differences linked with sex in the structure of the lobus olfactorius in *Blattariae* and *Hymenoptera*. (Insects). They concerned differences of size, or the characteristic concentration of the glomeruli, which appear exclusively in males. I have looked for similar differences in analogous organs of the bulbus olfactorius in mammals, but hitherto I did not succeed in finding them. In the course of the present studies, however, certain peculiarities of the structure of olfactory organs, hitherto little known, were revealed.

The bulbus olfactorius in mammals was studied by Ganser, Heric, Gurdjin and others. More extensive works on this organ were published by Crosby and Humphrey. Recently Allison reported more detailed and exhaustive data. However, there are relatively few informations on the distribution of the laminae glomerularis in the bulbus olfactorius and the bulbus olfactorius accessorius in mammals is known better only in rodents.

The present studies were conducted on some mammals of the Order: ungulates and carnivores. The olfactory centres were after

preparation fixed in a 96 per cent sol. of alcohol. The sections were made and cut in paraffin. The sections were 25 to 50 μ in thickness. They were stained with haematoxylin according to Heidenhain. In this study the lamina glomerularis in the bulbus olfactorius is described, whilst other laminae are only mentioned. A little more detailed data are given only in connection with the description of the bulbus olfactorius of the dog.

The subdivision into laminae and their terms are employed after Crosby and Humphrey, but they are designated by other letters. Synonyms of laminae, used by other authors can be found in Kreiner's work in the part concerning the description of the bulbus olfactorius in the rabbit.

The following ungulates were studied in this work: the sheep (*Ovis ovis* L.), the deer (*Capreolus capreolus* L.), the pig (*Sus domestica* L.) and the wild boar (*Sus scrofa* L.).

Sheep (*Ovis ovis* L.)

Seven specimens were examined. The bulbus olfactorius of the sheep has not been hitherto studied in detail, although hints have been made in the literature long since. In the enclosed schematic drawing (1) the bulbus olfactorius of the sheep is represented from the medial side. As shown, the lamina granularis takes here origin as a narrow band already at its extension from the olfactory bulb to the gyri olfactorii (fig. 2). In further portions of the bulbus the glomerular layer widens out and occupies an increasingly larger area. However, not the whole bulbus is covered by it. As shown in fig. 1, only a certain portion of the bulbus is on the medial side covered by the glomeruli. The largest number of smaller glomeruli appears also on the medial side, as may be supposed e. g. from one of the transverse sections, represented in fig. 3. This section, however, does not characterize the whole medial side, but only its portion near the one half of the bulbus. Nearer to the top of the olfactory bulb there appear more glomeruli of a larger size, as shown in fig. 4, and on the top of the bulb the difference between the lateral and medial side is not visible. The greatest concentration and the largest as to their size glomeruli appear above all on the lateral side and also nearer to the top of the olfactory bulb.

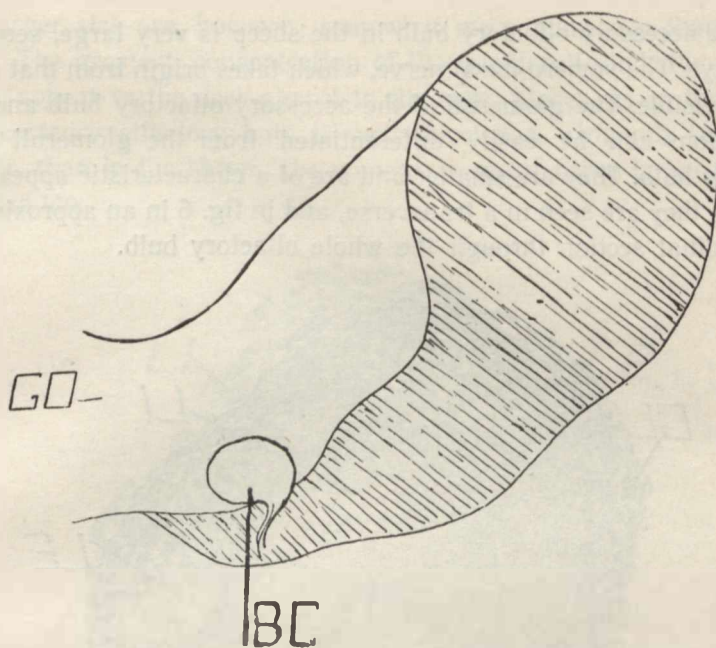


Fig. 1. Sheep (*Ovis ovis* L.). Scheme of the olfactory bulb. Medial side. Portion covered by the glomerular layer marked by lines.

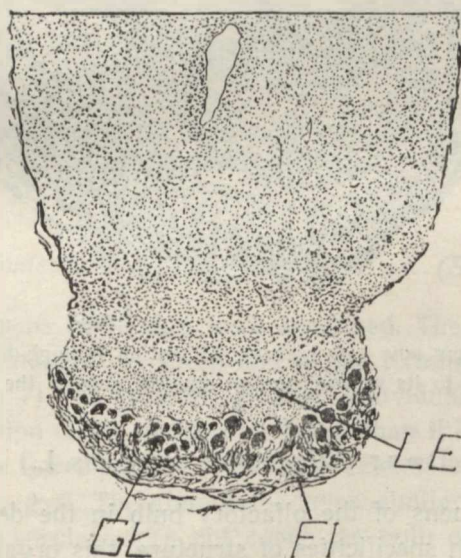


Fig. 2. Sheep (*Ovis ovis* L.) Transversal section through the olfactory bulb at the jointing place with the olfactory gyri.

The accessory olfactory bulb in the sheep is very large, seen with naked eye. The vomero-nasal nerve, which takes origin from that organ, is also visible. The glomeruli of the accessory olfactory bulb and their connections can be easily differentiated from the glomeruli of the olfactory bulb. They are smaller and are of a characteristic appearance. In fig. 5 they are seen in a transverse, and in fig. 6 in an approximately longitudinal section through the whole olfactory bulb.

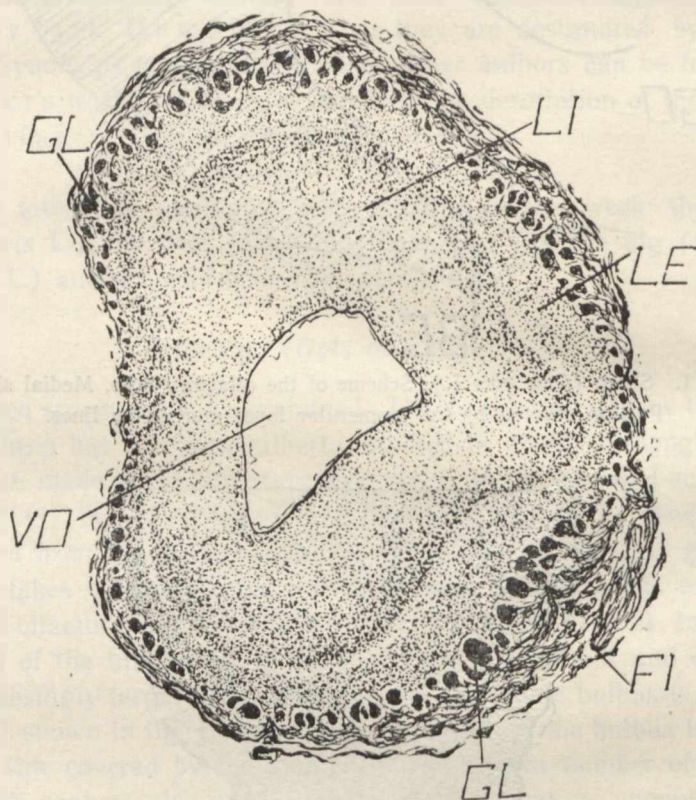


Fig. 3. Sheep (*Ovis ovis* L.). Transversal section through the olfactory bulb nearer to its central portion (medial side to the left).

Deer (*Capreolus capreolus* L.)

Three specimens of the olfactory bulb in the deer were studied. In spite of certain specificities of structure, this organ does not differ fundamentally from the olfactory bulb in the sheep. The medial side is also not covered by a layer of glomeruli on the whole area. Glomeruli

of a larger size are, however, somewhat more numerous than in the sheep. The greatest concentration of the glomeruli and the largest in size appear in the deer almost in the same places, as in the sheep. The accessory olfactory bulb is well developed, although somewhat smaller, than in the sheep. The vomero — nasal nerve is easily to be observed too.

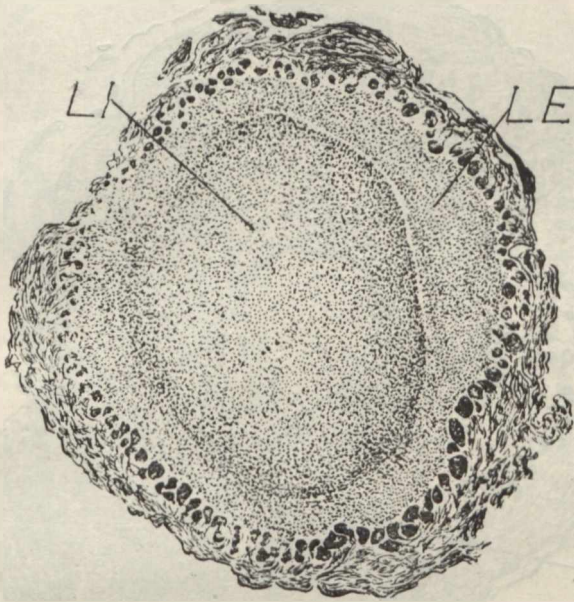


Fig. 4. Sheep (*Ovis ovis* L.). Transversal section through the olfactory bulb nearer its top.

Pig (*Sus domestica* L.) and wild boar (*Sus scrofa* L.)

Four specimens from pigs were examined. The olfactory bulb is more elongated than in the sheep and in the terminal part it is more cylindrical (fig. 7). It exhibits greater individual fluctuations as regards localization of the glomerular layer, than it has been observed in the sheep. The lower portion of the bulb extends beyond its passage into the olfactory gyri. The glomerular layer, similarly as in the other described above species, does not cover the bulb on its whole area. The portion not covered is not limited exclusively to the medial side and it is in the majority of specimens somewhat smaller, than in the

sheep. Fig. 8 represents an approximately transverse section of the olfactory bulb, which runs partly through the olfactory gyri.

Considerable differences have been observed as regards the arrangement of the glomerular layer and the external molecular layer. In one specimen, there appeared something of a kind of a double

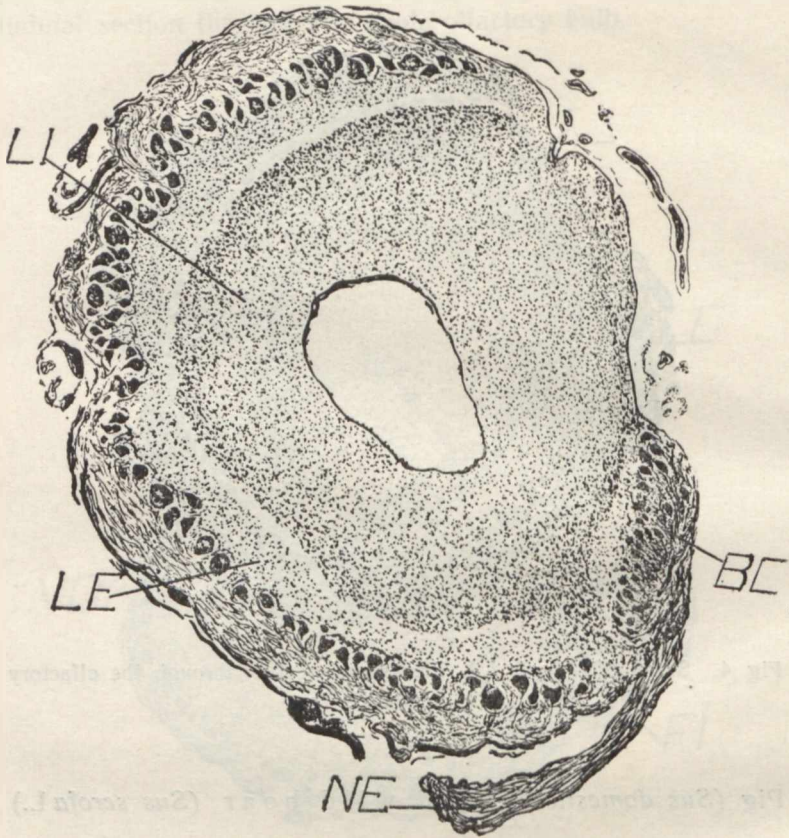


Fig. 5. Sheep (*Ovis ovis* L.). Transversal section of the olfactory bulb in the place where the accessory olfactory bulb is situated (medial side to the right).

„layer — fold” (fig. 9), which runs along the bulb on a certain distance. In other specimens of pigs, as can be seen in fig. 8, there is no such double layer in the corresponding place. Crosby reports as a very interesting phenomenon on the olfactory bulb in pigs of four thickened sectors of the glomerular layer.

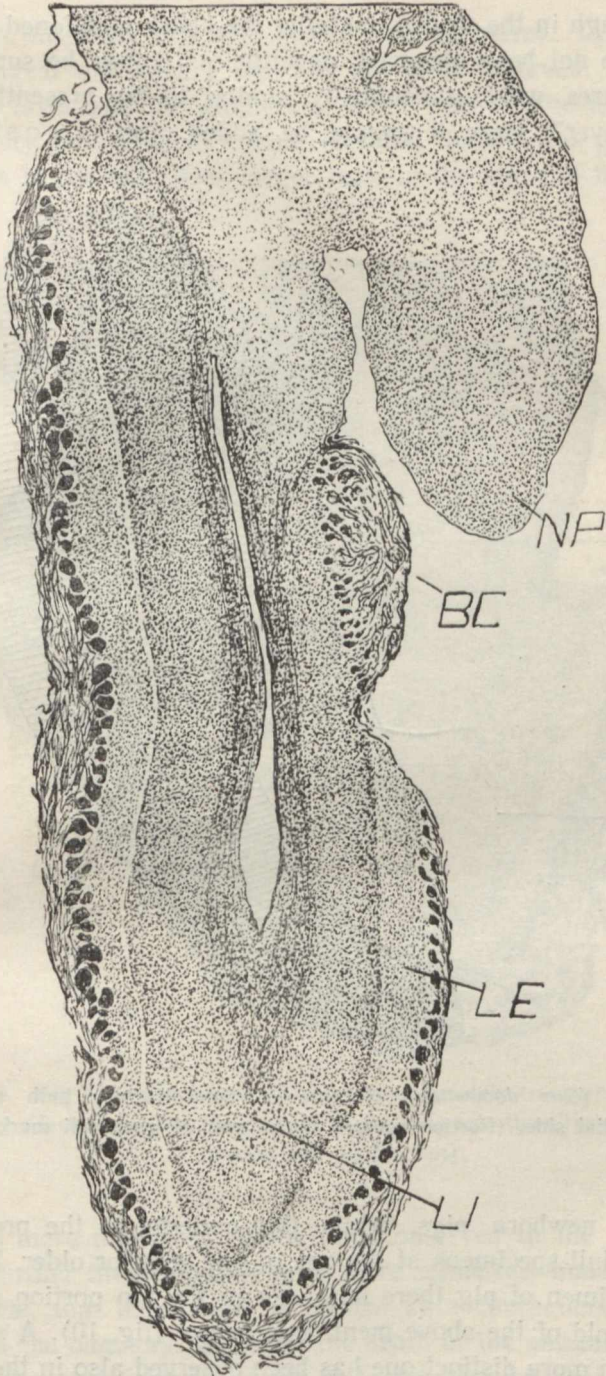


Fig. 6. Sheep (*Ovis ovis* L.). Section approximately longitudinal through the olfactory and accessory bulb, somewhat flattened (medial side to the right).

Although in the studied material the above mentioned four thickenings have not been observed, nevertheless it may be supposed, that the structures were undoubtedly similar to the presently described „double layer”. Here it should be added, that Crosby studied

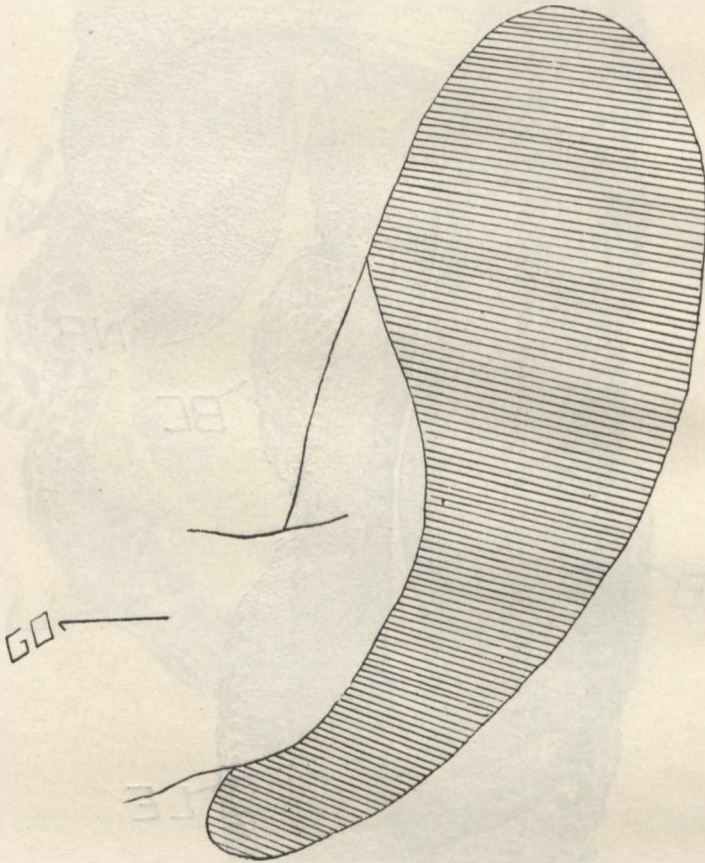


Fig. 7. Pig (*Sus domestica*). Scheme of the olfactory bulb approximately from the medial side. (Portion covered by a layer of glomeruli marked by lines).

exclusively newborn pigs, while the material of the present study included adult specimens at the age of one year, or older. In one examined specimen of pig there has been in the top portion of the bulb a distinct fold of the above mentioned layers (fig. 10). A similar fold and an even more distinct one has been observed also in the wild boar

4—5 years old. Only two wild boars were examined. In the second boar, one year old, such a fold has not been observed. The external molecular layer and the glomerular layer were in the top portion of the olfactory bulb (fig. 11) more elevated than in the pig. The glomeruli are in the wild boar larger than in the pig and the fila olfac-

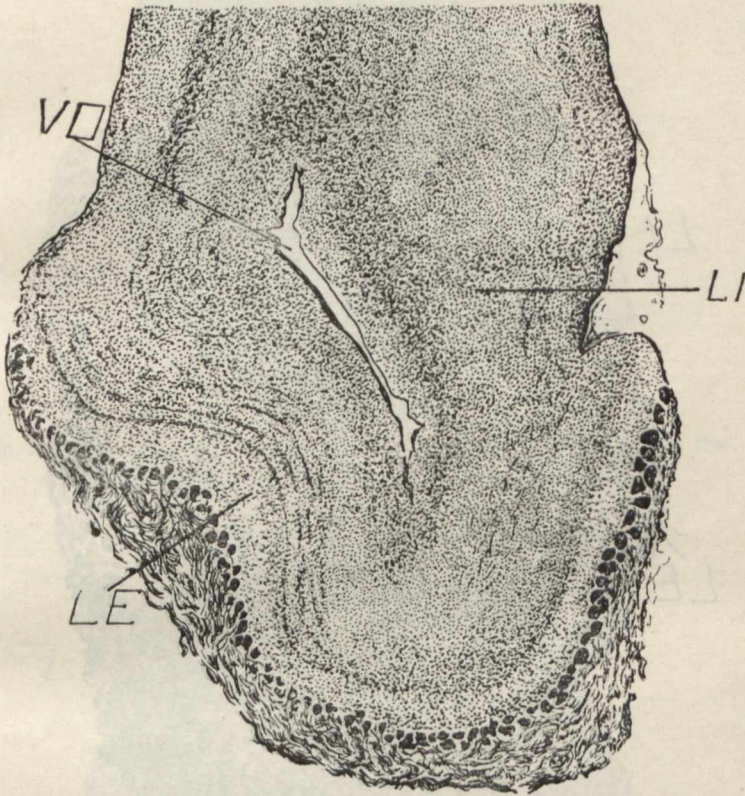


Fig. 8. Pig (*Sus domestica*). Section approximately transversal through the olfactory bulb at the passage of the bulb into the olfactory gyri (medial side to the left).

toria are more numerous. These folds observed in the present study require further investigations on a more numerous material. It seems improbable, that they could be formed as a consequence of a deformation of the olfactory bulb after the death of the animal. In the sheep and the deer such folds could not be found. May be, that there is some

relation of these structures to the superior or inferior olfactory faculties in pigs or wild boars.

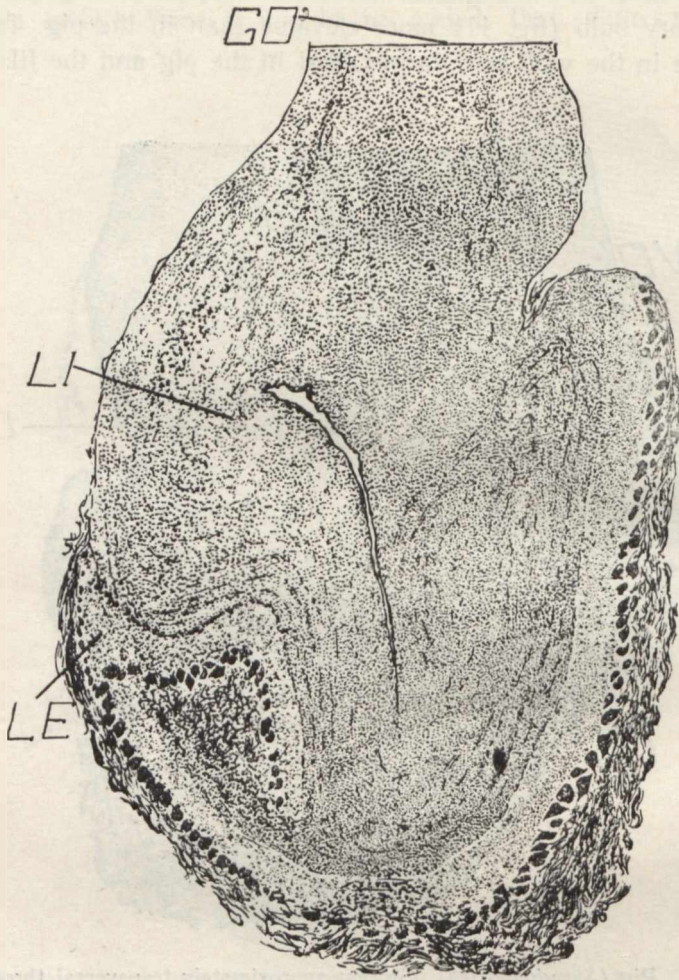


Fig. 9. Pig (*Sus domestica*). Section approximately transversal through the olfactory bulb at the passage into the olfactory gyri in another specimen than in fig 8 (medial side to the left).

In the studied material it was impossible to find the accessory olfactory bulb in pigs. Even if it is present, it must be of small dimensions, considerably smaller, than it is in the sheep or in the deer. Neither could the accessory bulb be found in the wild boar. However,

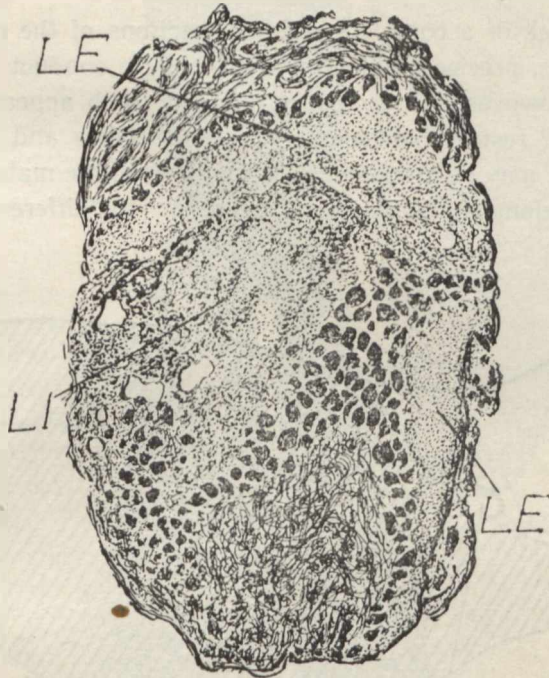


Fig. 10. Pig (*Sus domestica*). Section through the top portion of the olfactory bulb of another specimen than in fig. 8 and 9.

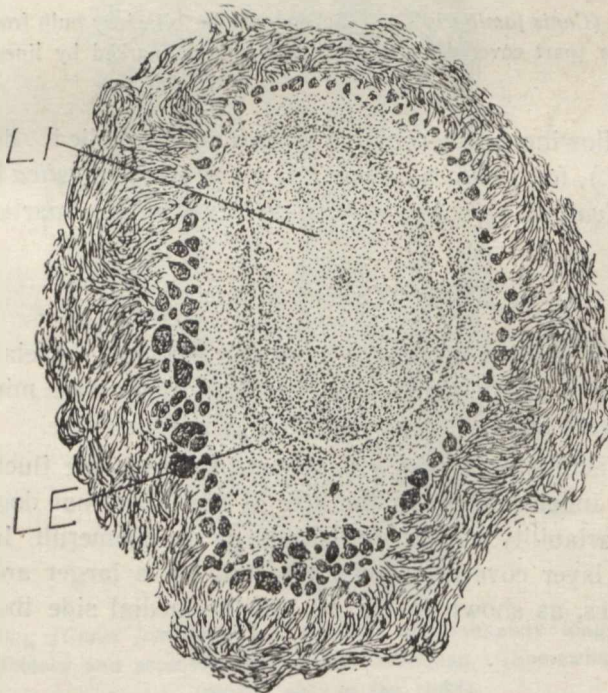


Fig. 11. Wild boar (*Sus scrofa* L.). Transversal section through the top portion of the olfactory bulb.

because of lack of a complete series of sections of the olfactory bulb of this species, precise studies were difficult to conduct. According to Crosby, however, the accessory olfactory bulb appears in the pig. Differences of results between the present studies and that obtained by Crosby may be attributed to differences of the material, collected from pigs belonging to various races, or to different methods of staining.

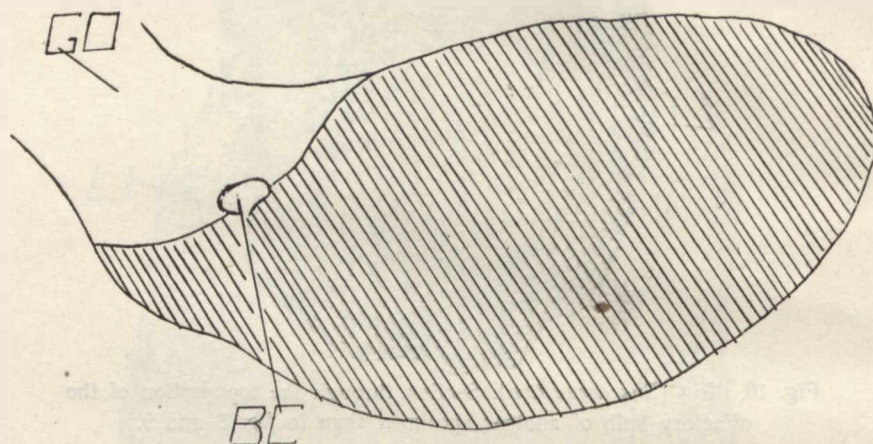


Fig. 12. Dog (*Canis familiaris* L.). Scheme of the olfactory bulb from the medial side (part covered by a layer of glomeruli, marked by lines).

The following species of carnivores were studied: dog (*Canis familiaris* L.), fox (*Vulpes vulpes* L.), cat (*Felis domestica* L.), weasel (*Mustela nivalis* L.), polecat (*Mustela putorius* L.), marten (*Martes martes* L.).

Dog (*Canis familiaris* L.)

Of the 4 studied dogs only one was of pure, or relatively pure breed. It was a „Doberman”. The remaining dogs were mixed breeds. Two dogs were small animals, and one of medium size.

The olfactory bulb (fig. 12) shows in dogs some fluctuations as to the size, independently of the size of the individual dog, and also a certain variability in the localization of the glomeruli. In dogs the glomerular layer covers the olfactory bulb on a larger area, than in the ungulates, as shown in fig. 12. On the medial side the glomeruli

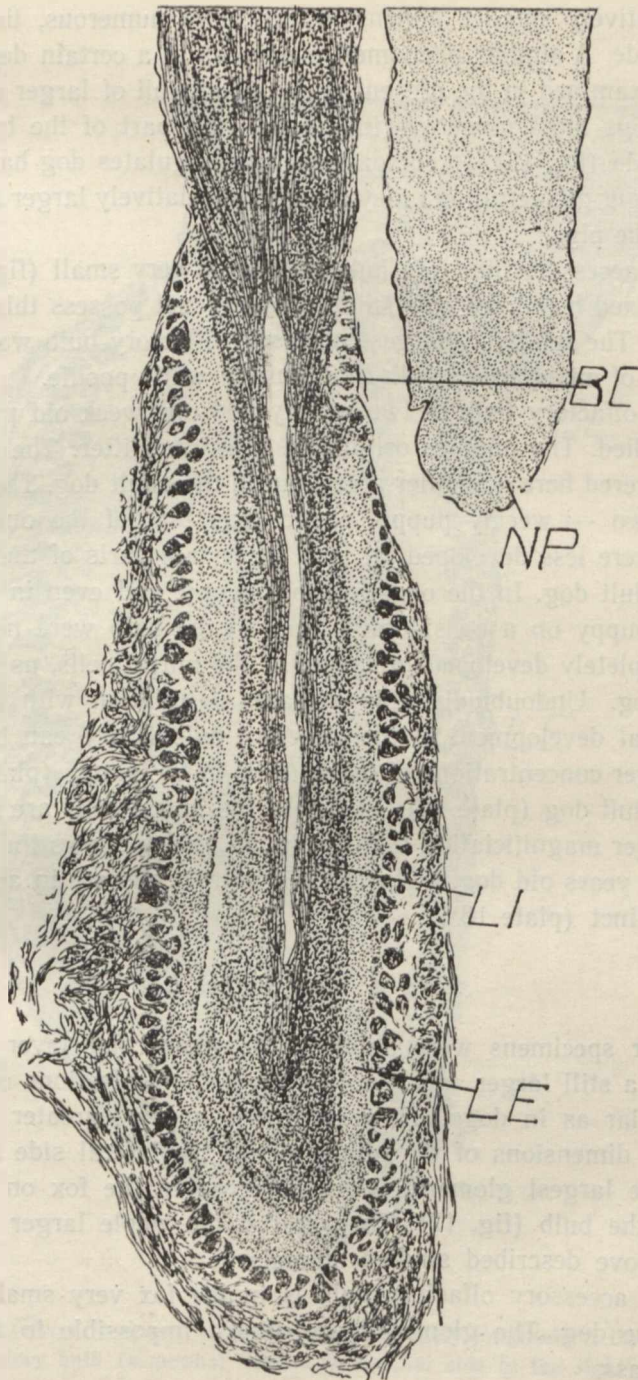


Fig. 13. Dog (*Canis familiaris* L.). Section approximately longitudinal through the olfactory and accessory bulb. Race Doberman. (Somewhat flattened). (medial side to the right).

of a relatively smaller dimension are more numerous, than on the lateral side. A similar phenomenon appears to a certain degree in all species examined in the present study. Glomeruli of larger dimensions are in dogs most numerous in the one half part of the bulb on the lateral side (fig. 13). In comparison with ungulates dog has the more of the larger glomeruli and they are also of relatively larger dimensions than in the pig.

— The accessory olfactory bulb in dogs is very small (fig. 13). One of the mixed breed dogs (a small one) did not possess this organ altogether. The relatively largest accessory olfactory bulb was observed in a dog of mixed breed with a mixture of white poodle.

The olfactory bulb in two weekly and one week old puppies was also studied. The puppies originated from one litter. The glomerular layer covered here a smaller area than in the adult dog. The glomeruli of the two — weekly puppy, particularly that of the one week old puppy, were less developed, at least in certain parts of the bulb, than in the adult dog. In the one week old puppy, and even in the two — weekly puppy on a considerable area of the bulb were not observed any completely developed processes of the mitral cells, as seen in the adult dog. Undoubtedly this remains in relation with the post — embryonal development of the olfactory bulb. There can be observed also larger concentrations of mitral cells in the puppy (plate 14) than in the adult dog (plate 15). In fig. 14 the mitral cells are represented in a larger magnification than in fig. 15, which shows the same cells in a two years old dog. Outwandered mitral cells are in an adult dog very distinct (plate 16).

Fox (*Vulpes vulpes* L.)

Four specimens were studied. The glomerular layer covers the bulb on a still larger area than in dogs. Concentrations of glomeruli are similar as in dogs. However, here appear greater differences between dimensions of the glomeruli on the lateral side and medial side. The largest glomeruli were observed in the fox on the lateral side of the bulb (fig. 17). They are on the whole larger than in all other above described studied animals.

The accessory olfactory bulb is in the fox very small, similarly as in the dog. The glomeruli are almost impossible to differentiate in its mass.

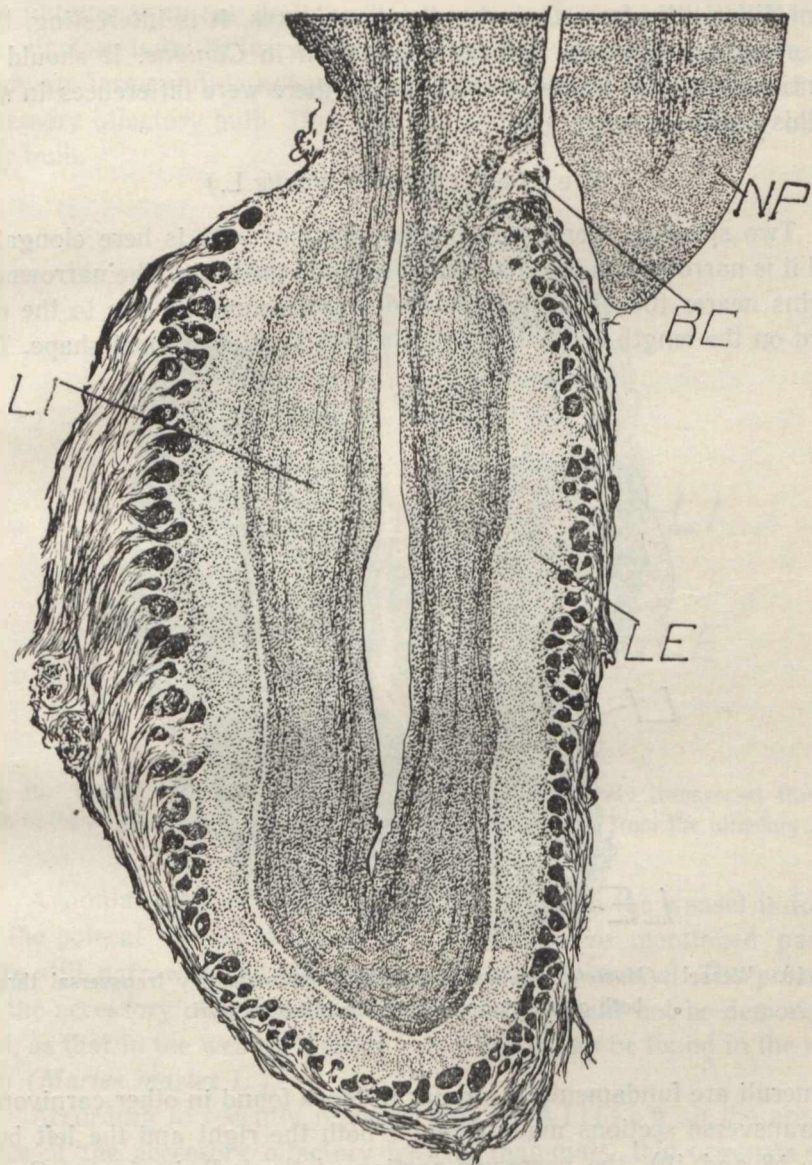


Fig. 17. Fox (*Vulpes vulpes* L.). Section approximately longitudinal through the olfactory bulb (somewhat flattened) (medial side to the right).

Cat (*Felis domestica* L.)

The glomerular layer, the size of the glomeruli and their arrangement differ little from those in other carnivores. It is interesting, that the accessory olfactory bulb is larger than in *Canidae*. It should be mentioned, that in the three studied cats there were differences in size of this organ.

Weasel (*Mustela nivalis* L.)

Two specimens were studied. The olfactory bulb is here elongated and it is narrowed on the side turned towards the brain. The narrowness begins nearer the olfactory gyri and extends more or less to the one third on the length of the bulb. Further on, it is of an oval shape. The

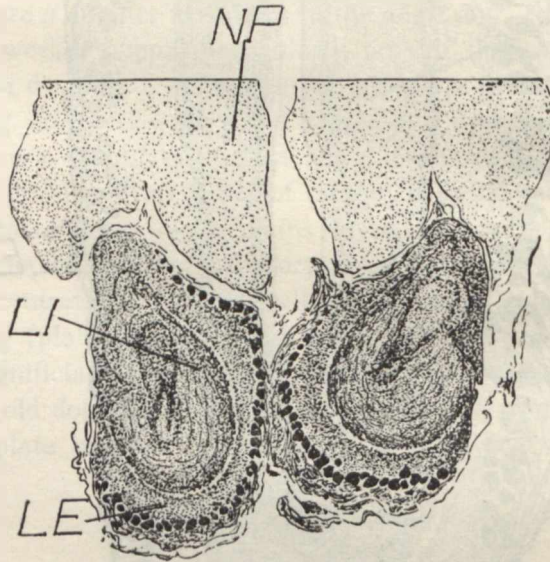


Fig. 18. Weasel (*Mustela nivalis* L.). Section approximately transversal through both olfactory bulbs near the olfactory gyri.

glomeruli are fundamentally similar to those found in other carnivores. In transverse sections made through both the right and the left bulb (fig. 18 and 19), the narrowed portion of the bulb is shown. Cross-sections presented in this work are similar to the analogous cross-section of one of the bulbs, given by Crosby for *Mustela novoboracensis* (fig. 1 c. 4).

No accessory olfactory bulb in the weasel could be found. According to Crosby, however, in *Mustela novoboracensis* this organ is present and judging from her drawing it appears in the narrowed portion of the olfactory bulb. In the weasel the glomeruli observed in the present study are large and do not possess the characteristic appearance of the accessory olfactory bulb. They are undoubtedly glomeruli of the olfactory bulb.

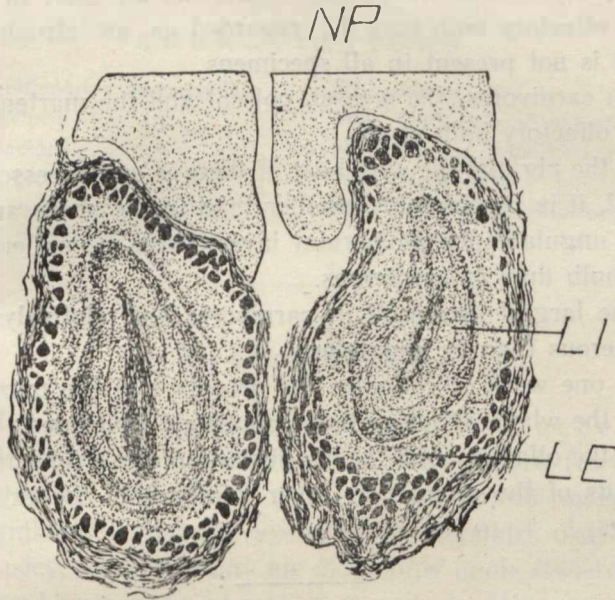


Fig. 19. Weasel (*Mustela nivalis* L.). Section approximately transversal through both bulbs of the same series as in fig. 18 but more remote from the olfactory gyri

A similar structure of the olfactory bulb as in the weasel is found in the polecat (*Mustela putorius* L.). The above mentioned part is here still narrower and more curved than in the weasel. The presence of the accessory olfactory bulb in this species could not be demonstrated, as that in the weasel. Neither could this organ be found in the marten (*Martes martes* L.).

According to recently reported data by Allison on the appearance of the accessory olfactory bulb in mammals, this organ is well developed in rodents, it is of moderate size in ungulates and in carnivores, and it is absent in many bats and primates. Results obtained in the present study, however, differ to a certain degree from the data reported by Allison.

As the function of the accessory olfactory bulb is not yet explained, it is extremely difficult to draw any conclusions as to the causes conditioning its presence or absence in a given species.

RESULTS OF STUDIES

1. In carnivores — dogs and foxes — the accessory olfactory bulb is considerably smaller than in the sheep and the deer. In the dog the accessory olfactory bulb may be regarded as an atrophying organ, because it is not present in all specimens.

2. In carnivores, the weasel, polecat and the marten there is no accessory olfactory bulb at all.

3. In the pig and the wild boar, if there is any accessory olfactory bulb at all, it is considerably smaller than in the sheep and the deer.

4. In ungulates the glomerular layer covers a smaller area of the olfactory bulb than in carnivores.

5. The largest glomeruli in carnivores are relatively larger and more numerous than in ungulates.

6. In one week old puppies the processes of the mitral cells are not yet in the whole olfactory bulb completely developed.

7. In the olfactory bulb of the pig and of the wild boar there can appear folds of the glomerular layer jointly with the external molecular layer.

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EXPLANATIONS OF THE PLATES IN THE TABL)

Dog (*Canis familiaris* L.)

Phot. 14. Mitral cells of a puppy of small breed two weeks old. Circa x 300.

Phot. 15. Mitral cells of a dog two years old. Race Doberman. Circa x 200.

Phot. 16. Outwandered mitral cells of a dog two years old. Race Doberman.

Circa x 250.

A B B R E V I A T I O N S

BC	Bulbus olfactorius accessorius	MI	Mitral cells
FI	Fila olfactoria	MO	Outwandered mitral cells
GO	Gyri olfactorii	NE	Nervus vomero-nasalis
GL	Lamina glomerularis	NP	Neopalium
LE	Lamina molecularis externa	VO	Ventriculus olfactorius
LI	Lamina granularis interna		

Wyniki badań

1. U X psa i lisa bulbus olfactorius accessorius jest znacznie mniejszy niż u kopytnych przeżuujących (owca, sarna). U psów bulbus olfactorius accessorius można uważać za organ zanikający, gdyż nie występuje u wszystkich okazów.

2. U łasicy, tchórza i kuny nie mogłem w ogóle stwierdzić występowania bulbus olfactorius accessorius.

3. U świni i dzika jeżeli w ogóle występuje bulbus olfactorius accessorius, to w każdym razie jest znacznie mniejszy, niż u owcy i sarny.

4. U kopytnych warstwa kłąbków pokrywa mniejszą przestrzeń bulbus olfactorius, niż u drapieżnych.

5. U drapieżnych, największe co do rozmiarów kłąbki, są stosunkowo większe, a także liczniejsze niż u kopytnych.

6. U tygodniowych szczeniaków, wyrostki komórek mitralnych nie są jeszcze całkowicie wykształcone w całym bulbus olfactorius.

7. W bulbus olfactorius u świni i dzika mogą występować sfaldowaia warstwy kłąbków wraz z warstwą molekularną zewnętrzną.

РЕЗЮМЕ

1. У собак и лисиц *bulbus olfactorius accessorius* значительно меньшей величины чем у овцы и козули. У собак по всей вероятности это орган исчезающий так, как он не выступает всех особей.

2. У ласки, хорька и куницы *bulbus olfactorius accessorius* вообще не был обнаружен.

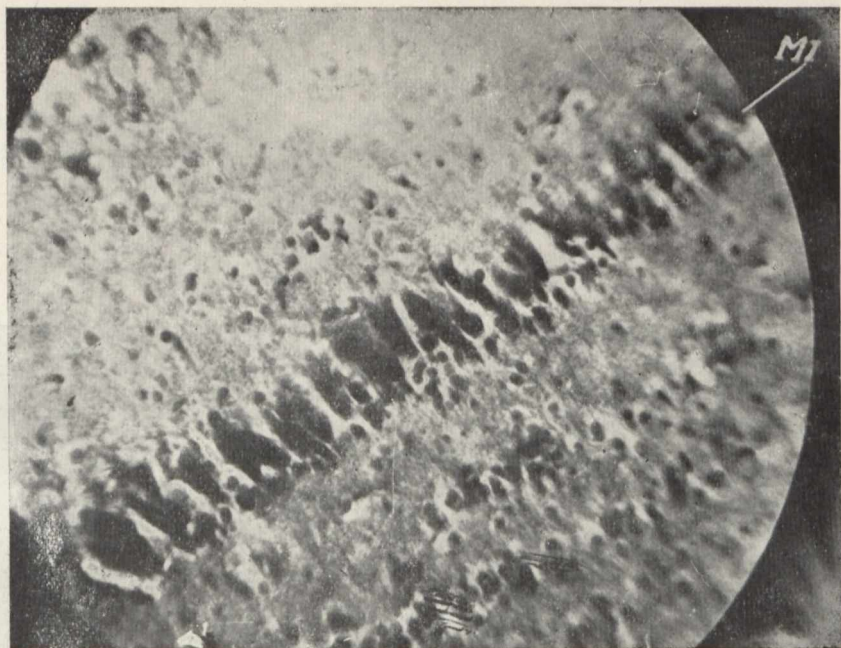
3. У домашних и диких свиней если и находится *bulbus olfactorius accessorius*, то во всяком случае величина его меньше чем у овцы и козули.

4. У копытных слой клубочков занимает меньшее пространство в *bulbus olfactorius* чем у хищных.

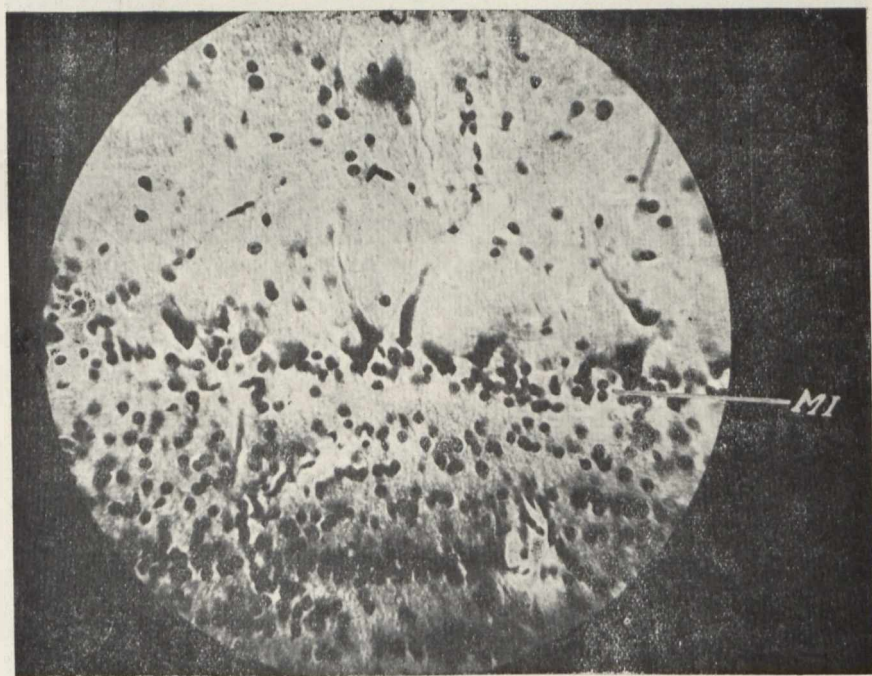
5. У хищных самые большие клубочки (*glomerulae*), сравнительно больше, чем у копытных и кроме того, этих больших клубочков больше.

6. У семидневных щенят еще не на всем *bulbus olfactorius* вполне сформированы отростки митральных клеток.

7. У домашней и дикой свиньи *lamina glomerularis* и *lamina molecularis externa* могут образовать фалды.



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