Despite the great interest in the structure and more particularly, in the vascularization of lymphoid formations within the small intestine mucosa, the problem remains insufficiently clarified as yet. The available literature data are sporadic and refer to single aspects of the general problem only, while systematic investigations have not been performed practically hitherto. Our knowledge of the comparative anatomical differences is very scarce. T. Hellman (1930), B. V. Ognev (1939), F. P. Markizov (1959); A. V. Borisov (1961), I. N. Hilkova (1961) describe a network of fine radial capillaries within the follicles. According to H. Frey (1877) and V. Patzelt (1936) these capillaries somewhere in the middle become merged between each other in a loop-like fashion, and thus the central part remains free of vessels. We observed (S. Bakardzhieva, R. Mesut — 1972) the formation of a central vascular coil of dilated and twisted capillaries. All this led us to undertake a more systematic research into laboratory animals most frequently employed in the practice, and differing in terms of mode of alimentation and type of food ingested.

Material and Method

The study covers five species of grown up laboratory animals — 12 white rats, 10 guinea pigs, 5 rabbits, 5 cats and 5 dogs. The intramural vessels are demonstrated through India ink — gelatin contrast matter injection, with subsequent working out of cleared preparations and histological sections, stained with hematoxylin eosin and according to van Gieson.

Results

The white rat submucosa (Fig. 1) consists of a very thin layer of loose connective tissue, poor in cellular elements and vessels. The vessels are situated mainly within the boundaries of the proper mucosal layer. The findings show abundant lymphoid infiltration of the entire layer, occupying the spaces between the glands and penetrating the stroma of the villi; some of the latter are completely infiltrated. Despite the presence also of single, more concentrated accumulations, the diffuse lymphoid tissue is characteristic of this animal. It is devoid of differentiated proper vessels, and is supplied by the mucosal capillary network.

In the guinea pig (Fig. 2) apart from the diffuse lymphoid tissue in the propria, lymphoid aggregations manifested in a varying degree are detectable
at the borderline between mucosa and submucosa. Also well shaped lymph follicles and lymph infiltrates occur in close contact with the glandular ductules. Usually they are located within the confines of the propria, and in some places aggregate into plaques. In these cases a thin connective tissue layer is formed around the follicles, contributing to their differentiation and containing a plexus of blood vessels. Thin capillaries penetrate the substance of follicles.

The above pattern of lymph elements' distribution is preserved in the rabbit (Fig. 3). In addition to the proper layer and villi, the submucosa is also occupied by diffuse lymphoid tissue. The piercing of glands across the muscularis mucosae into the submucosa is characteristic of the rabbit. Lymphoid ammassments are seen between the glands throughout the submucosa. The great thickness of glands precludes the formation of differentiated lymph follicles with a capsule. Their vascularization is accomplished by a common capillary network, and one is impressed by the poor vascularization of the lymphoid formations as compared to glands.

In the dog and cat as well the total thickness of mucosa and submucosa is much greater, and the lymphoid formations reach a higher level of development and organization. The diffused lymphoid tissue and the lymphoid aggregates are replaced by duely formed solitary lymph follicles and Peyer's plaques (Fig. 4). The varying in size solitary lymph follicles are mainly situated in the submucosa. In a great number of cases they pierce the muscularis mucosae and display a dome-shaped promination in the direction of the lumen.
Particularly strongly manifested Peyer's plaques are met with in the cat where they occupy the submucosa, the propria and some of the villi (Fig. 5). They are invariably well differentiated in the submucous part with a duely formed connective-tissue capsule and septa between the single follicles. The intense development of follicles leads to a certain two-plan layout, e.g. bilocular and trilocular follicles are established. A dense perifollicular network made up of arterioles and venules with different caliber is situated within the capsule and septa. It gives off thin and fine capillaries penetrating radially the substance of the follicles, with the central parts of the latter usually remaining avascular. The poor vascularization of the inner part of the follicles stands out against the dense vascularization of glands and villi, and perifollicular plexuses as well. The afferent vessels divide from glandular and villus arterioles before piercing the muscularis mucosae. The venous vessels' return flow is similarly effected in the direction of the mucosa draining venules. At the base of follicles vessels may eventually penetrate directly from the submucosal plexus.
Fig. 4. Circular section through the mucosa of dog small intestine. Lymph follicles occupying the mucosa and submucosa are seen. Hematoxylin-eosin. Microphotogr.: 4×10

Fig. 5. Circular section through the mucosa of cat small intestine. A large Peyer's plaque infiltrating the glandular layer and villi. Hematoxylin-eosin. Microphotogr.: 4×10.
Discussion

Our data prove the existence of an interrelationship between distribution and organization of lymphoid formations in the wall of the small intestine, and the developmental degree of the mucosa and submucosa layers. It is a well known fact that the latter, in turn, depends on the type of food received and processed — these particular layers are rather more strongly developed in carnivorous as compared to herbivorous. The diffuse lymphoid tissue is gradually replaced by adequately formed lymph follicles and Peyer’s plaques. The latter have dense perifollicular plexuses and thin, widely spaced fine capillaries in their substance. Usually the central parts are avascular, and it should be emphasized that central vascular plexuses, described in man, are discovered in none of the animals under study. Analogical and parallel studies on the vascularization of lymphoid formations in the large intestine mucosa, performed by G. Marinov and S. Bakardzhieva (1974) in the same laboratory animals, similarly failed to discover central vascular plexuses. The impression had is one of a poorer vascularization of the lymphoid formations, as compared to that of glands and villi.

REFERENCES

Исследования проведены на пяти видах лабораторных животных — крысе, морской свинке, кролике, собаке и кошке. У крысы лимфоидные элементы преимущественно диффузно рассеяны в собственном слое слизистой оболочки — как между железами, так и в ворсинках. У морской свинки кроме диффузной лимфоидной инфильтрации устанавливают оформленные лимфоидные фолликулы. У кролика отмечают различно выраженные лимфоидные скопления в субмукозе, в непосредственном контакте с располагающимися здесь железами. У собаки и кошки лимфоидные образования достигают наиболее сильного развития — встречаются как солитарные лимфоидные фолликулы, так и Пайеровы бляшки. Последние особенно сильно выражены у кошки, где занимают субмукозу, собственный слой, причем инфильтрируют и некоторые ворсинки. У всех исследованных животных васкуляризация лимфоидных образований беднее, чем васкуляризация желез и ворсинок. В субстанцию фолликулов проникают только единичные тонкие капилляры, отходящие от перифолликулярных сосудистых сплетений, а центральные части остаются аваскулярными.