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The Lymphatic Vessels of the Uterus during the Sexual Cycles of the Mice*

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Summary

Orthograde delineation and characterization of the lymph vascular system in the uterus of the mouse during the sexual cycle was achieved by absorption of Patent Blue Violet and Japan ink. The lymph vessels in the endometrium are dilated by about 8–10 times and of varying calibre during oestrus. A reticular arrangement is characteristic of the subsequent stages, while the picture during pre-oestrus resembles that of oestrus. The dye is carried away very rapidly through the larger lymph vessels in the mesometrium which have their typical string of pearls appearance.

The mouse is a particularly suitable research animal for demonstrating the uterine lymph vessels during the sexual cycle, because material can be obtained at a particular known stage without great expense in material and time.

Materials and Methods

Patent Blue Violet was chosen as a suitable dye for showing up the lymph vessels, because it has an affinity for the lymphatics (1, 7) and a particle size of 6 Å. Further Japan ink was used with a particle size of 10.8 Å (4).

The dyes were applied to the anaesthetized mouse and also post mortem. After opening the abdominal wall, 0.5 ml of a 2.5 % solution of Patent Blue Violet was injected into the cavity of the left uterine horn. The dye was carried away so rapidly that after about 10 seconds the lymph vessels in the mesometrium next to the V. utero-tubalis, after about 20 seconds the Ln. iliacus ext., after further 10–20 seconds the Ln. lumbo-aorticus and the Ductus thoracicus, were stained blue. Also Japan ink applied in the same way was carried into thoracic duct, but rather more slowly.

The investigation was carried out under technically difficult conditions:
1. The smallness of the objects. The uterine horn has a diameter of only 1.5 to 2.5 mm when fixed.
2. The necessity of working very, very quickly when and after the dye is applied.
3. The photographs of mm thick sections were made floating in oil of wintergreen, with the Zeiss Photomicroscope.

Results

As is known from humans and mammals, Preuss's comparative standard terminology (6) can also be applied to the sexual cycle of the mouse (5):

1. Oestrus,
2. Early post-oestrus,
3. Late post-oestrus,
4. Inter-oestrus,
5. Pre-oestrus.

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The following applied to all stages of the cycle:

After dropping the Japan ink on the uterine mucous membrane, a black mark was immediately seen on the surface, between the epithelium and subepithelium. Similar findings were also obtained in the intestinal villi in the dog, in the mouse and in various gallicaceous birds (2, 3).

In the subsequent course, simple contoured meshes of a capillary lymphatic reticulum formed, extending outwards from the surface of the uterine mucous membrane. This reticulum gives off fine branches into the depths of the mucous membrane, where they primarily extend along the ducts of the glands. The ink is found here in the orifices which are not filled with secretion, but then it spreads around the gland shortly behind the orifice.

Oestrus

In the mouse, the mucous membrane in oestrus is loosened by oedema and attains its maximum surface value.

It may be considered as a characteristic that the lymph vessels can reach an enormous calibre in this stage (Fig. 1). Here the ink is carried away subepithelially for a short distance, then turns at a right angle towards the base as a very fine vessel in the first third of the mucous membrane, increases by 8–10 times in the middle third of the mucous membrane, narrows again, and then at the base of the mucous membrane empties into larger efferent lymph vessels.

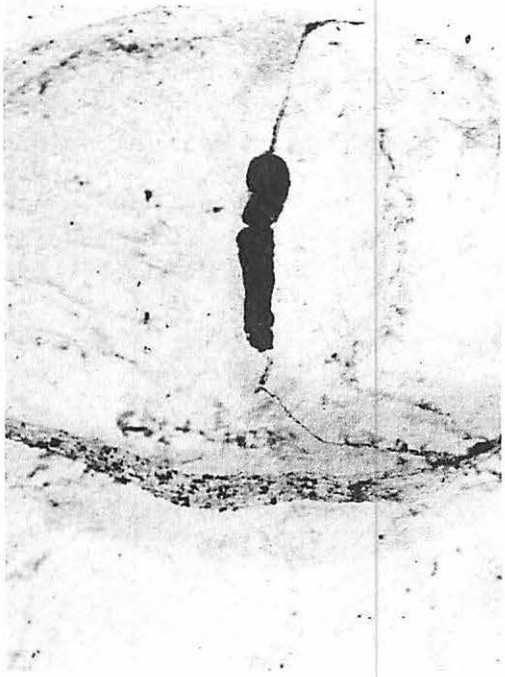

Fig. 1 Oestrus. The endometrium is loosened by oedema and the lymph capillary attain an enormous calibre. Absorption of Japan ink, cleared in Salicylsäuremethylester (oil of wintergreen). Negative enlargement 250 x, positive enlargement 832 x

Fig. 2 Early post-oestrus. Very wide-meshed reticulum of lymph capillaries in the first third of the endometrium. Fine network of lymph capillaries in the middle and lower third of the endometrium. Absorption of Japan ink, cleared in Salicylsäuremethylester. Negative enlargement 200 x, positive enlargement 666 x.

Early post-oestrus

In the next phase of the cycle, early post-oestrus, lasting 30 hours, the very loose stroma of the last stage has become much denser. The surface value of the mucous membrane is about 2 1/2 times less.

The lymph vessels (Fig. 2), quite contrary to the previous stage, show a very wide-meshed reticulum in the first third of the mucous membrane. Very fine branches run out from these meshes into the surrounding areas and form a fine network of lymph vessels in the middle and lower thirds of the mucous membrane, which can be particularly clearly seen in the base of the membrane.

The dye is also carried away into the larger efferent lymph vessels through the circular muscle layer into the vascular stratum formed in the mouse.

Late post-oestrus

The late post-oestrus has only a short duration of 12 hours and shows no important changes in the surface value of the mucous membrane compared with the previous stage.

The lymph capillaries form a dense network in the subepithelium (Fig. 3) in the late post-oestrus, between two neighbouring ring vessels. It is to be assumed that in the pregnant animal, there is a relationship between the angio-architecture-and the site of nidation in this corpus luteum stage, because the placenta does in fact lie between two neighbouring ring arteries.

The middle third of the mucous membrane shows no such clear lymph capillary reticulum, but perhaps a denser reticulum at the base, where efferent lymph vessels also run.

Inter-oestrus

The inter-oestrus lasts about 2 days and also shows no significant changes in the surface value of the mucous membrane compared with the previous phase.

During this time, the lymph capillaries in the middle and lower thirds of the mucous membrane form a regularly arranged network (Fig. 4). The upper third is traversed by very fine lymph capillaries, which begin in the subepithelium and end in the lymph capillary reticulum in the middle third of the mucous membrane.

As in the previous stage of the cycle, the dye is carried away into the larger lymph vessels in the base of the mucous membrane.

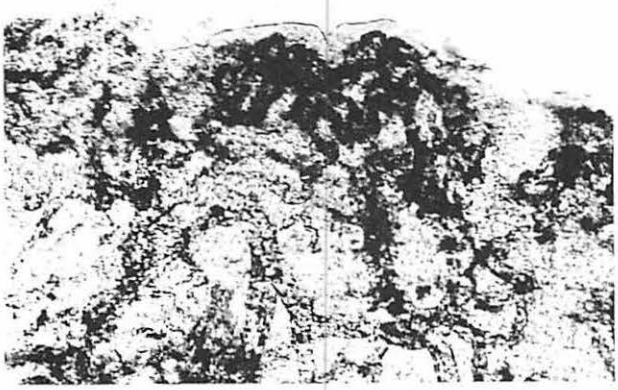

Fig. 3 Late post-oestrus. Lymph capillaries reticulum in the subepithelium of the endometrium between two neighbouring ring vessels. Absorption of Japan ink, cleared in Salicylsäuremethylester. Negative enlargement 400 x, positive enlargement 1320 x.

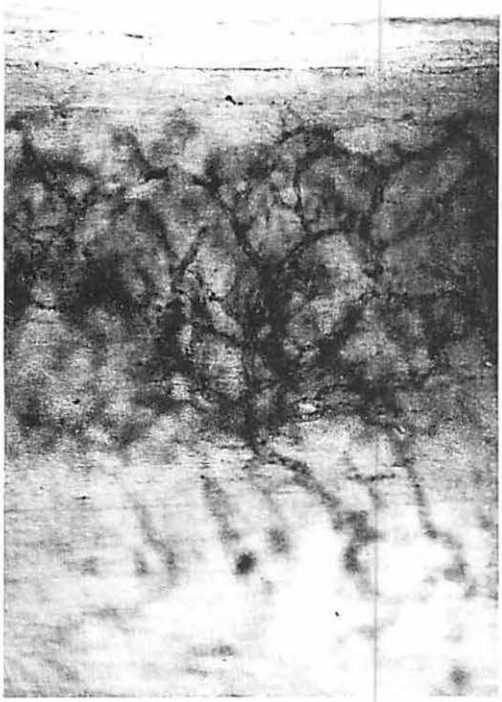

Fig. 4 Inter-oestrus. Regulary arranged network of lymph capillaries in the middle and lower thirds of the endometrium. Absorption of Japan ink, cleared in Salicylsäuremethylester.
Negative enlargement 160 x, positive enlargement 533 x.

Pre-oestrus

The pre-oestrus follows, as the 5th and last stage of the cycle, also with a short duration of 12 hours as in the late post-oestrus.

The mucous membrane is here loosened by oedema and acquires a surface value up to half as much as in the previous stage.

The lymph vessels resemble the picture in oestrus. Here, too, they begin in the subepithelium and attain an enormous calibre (Fig. 5). They give off very fine branches which measure up to 2 μm.

As in the previous stage, the lymph capillaries form a dense and regularly arranged reticulum in the middle and lower thirds of the mucous membrane.

The dye is carried away through the larger lymph vessels in the mesometrium next to the V. utero-tubalis. The lymph vessels here have their typical string of pearls appearance. They run into the lymph nodes mentioned in the beginning, and into the thoracic duct.

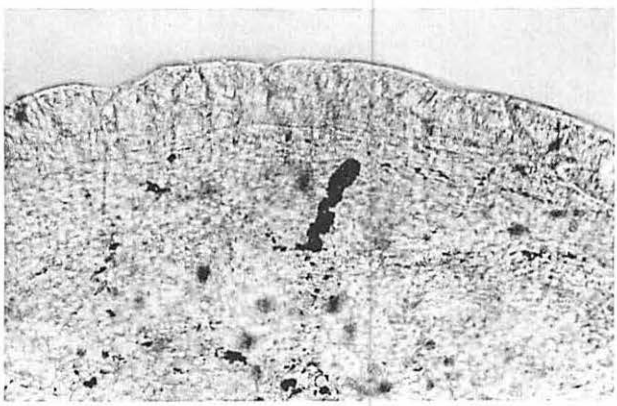

Fig. 5 Pre-oestrus. Lymph capillary in the subepithelium of the endometrium showing an anormous calibre. Absorption of Japan ink, cleared in Salicylsäuremethylester. Negative enlargement 400 x, positive enlargement 1320 x.

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