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**Pathological Lesions in the European Bison
Caused by Foot-and-Mouth Disease in Polish Reservations**

Bisoniana XXVI

[With 12 Figs. & 1 Table]

Thirty five European bisons died during the epizootic of foot-and-mouth disease in Polish reservations (1953—1954). The *post mortem* examinations revealed lesions characteristic for foot-and-mouth disease, namely: freshly burst secondary vesicles, surface erosions, and in case of secondary infection, extensive necrotic lesions. The above lesions were observed in the mucous membrane of the alimentary tract (oral cavity, esophagus, rumen) and on the skin of interdigital space. In 9 cases the primary process of foot-and-mouth disease was complicated by bronchial pneumonia, purulent broncho-pneumonia, fungal invasion, actinomycotic pneumonia, abscesses in different organs and tissues or bone fractures.

There is very little published data on foot-and-mouth disease in the European bison. Thoroughful work of Tomescu, Gheorghiu & Isopescu (1960) does not mention the foot-and-mouth disease in this species, while Skoromochow (1954) mentions only that similarly to many other species European bison are susceptible to the virus of foot-and-mouth disease.

This disease was observed in the European bison (Folmer, 1939; Jaczewski, 1959; 1960) in the American bison (Urbain, 1939; Hediger, 1940; Staśkiewicz, 1946) and in hybrids of the two species. Specially valuable are detailed observations of Jaczewski (1959; 1960) on the course of the foot-and-mouth disease epizootic of the European bison in 1953 and 1954 in Polish reservations. It is interesting that in natural conditions in the Białowieża Primeval Forest the foot-and-mouth disease was observed three times between 1906 and 1909 but the mortality of sick animals was only 5% (Wróblewski, 1927).

The above mentioned papers were concerned predominantly with the clinical and epizootic aspects of the disease.

During the epizootic of foot-and-mouth disease in the Polish reservations Ło-

puszna, Pszczyna and Niepołomice (1953—1954) a total of 35 bisons died¹⁾. As demonstrated in later studies the foot-and-mouth disease in Pszczyna and Niepołomice was caused by the A₅ variant of the virus (Baranowski, 1956).

In the Łopuszna reservation the first symptoms of foot-and-mouth disease were noticed on July 6, 1953. Eight days later (July 14, 1953) the female bison »Puma« died. During the following 15 day five more bisons died. About 5 months after the outbreak of the disease (December 18, 1953) female »Tatra« died and three months later »Pustak«, a male the last bison in the reservation died (Table 1). The latter two animals survived the disease but had serious complications of its primary process (Jaczewski, 1959) which were the indirect cause of death.

In the Pszczyna reservation the first symptoms of the disease (lack of appetite, slow rumination and sluggishness) were observed on December 20, 1953. Male bison »Platanek« died already on December 21, 1953. Sixteen bisons died in the seven following days. On January 4, 1954 female »Pleśnianka« died while the last bison from the herd, female »Plusia« died on January 19, 1954 (Table 1).

On April 19, 1954 in one of the three enclosures of the Niepołomice reservation the female bison »Puszcza« was noticed to be sad, without appetite and with slight salivation. Similar symptoms were noticed on April 21 in »Pura«, »Puzon« and »Purchawka«. During the following few days the disease attacked the remaining 2 bisons in this enclosure. »Puszcza« died on April 23 and 3 more bisons died during the following 8 days (»Puzon«, »Purchawka« and »Pura«). Three more animals succumbed between May 20 and May 28 (»Pustybór«, »Pułkownik« and »Pukajka«) and three months after the outbreak of the disease male »Pułan« died. The disease did not transfer to the remaining two enclosures (Table 1).

In 33 of 34 cases autopsy revealed pronounced lesions indicating infection with foot-and-mouth disease virus. The process of the disease was accompanied by more or less typically expressed lesions in the mucous membrane of the upper segment of the alimentary tract (mucous membrane of the tongue, the lips, the gums, the hard and soft palate) rarely in the mucous membrane of further parts of the alimentary tract (esophagus, rumen, abomasum) and in the skin of interdigital space.

In animals which died during the first few days of the disease, surface erosions in the mucous membrane of the dorsal and ventral surface of the tongue were found usually on the lateral edges and the tip. These erosions had uneven, shredded edge and a more or less bright red center, or else smooth edge and finely granular, brown-grey center. Appearance of the latter erosions was indicating a beginning of regenerative processes in the epithelium. In similar cases, in animals which died somewhat later, spots in which secondary vesicles burst were covered with completely regenerated epithelium (providing that there was no second-

¹⁾ This number also includes the female bison »Puma« which was autopsied by the staff of the local veterinary service; the results of the autopsy and additional tests were not available to the author and therefore this case is omitted in the listing of lesions.

Table 1.

The course of foot-and-mouth disease in reservation (1953—1954).

No.	Name	Sex	Pedigree book No.	Date of birth	Date of death	Period of the disease
Łopuszna Reservation						
1.	Puma	♂	242	1.V.1934	14.VII.1953	8 days
2.	Pużanka	♀	501	18.VII.1938	15.VII.1953	9 days
3.	Pupileczka	♀	786	6.V.1950	15.VII.1953	9 days
4.	Pupilka	♀	247	20.V.1935	17.VII.1953	11 days
5.	Tatrzancka	♀	904	30.VI.1953	19.VII.1953	13 days
6.	Puszek	♂	747	20.V.1948	21.VII.1953	15 days
7.	Tatra	♂	858	22.VII.1953	18.XII.1953	ca 5 month
8.	Pustak	♂	787	2.VI.1950	12.III.1954	ca 9 month
Pszczyna Reservation						
1.	Platanek	♂	892	10.V.1953	21.XII.1953	1 day
2.	Plete	♀	255	1.VI.1935	22.XII.1953	2 days
3.	Pletwa	♀	907	18.VII.1953	23.XII.1953	3 days
4.	Pleinze	♀	256	31.VIII.1935	24.XII.1953	4 days
5.	Pleban	♂	742	21.VIII.1948	24.XII.1953	4 days
6.	Plinka	♀	828	6.XI.1948	24.XII.1953	4 days
7.	Plisa	♀	701	7.XI.1946	24.XII.1953	4 days
8.	Plastuś	♂	863	7.VII.1952	25.XII.1953	5 days
9.	Platyna	♀	893	12.V.1953	25.XII.1953	5 days
10.	Pleśniak	♂	896	15.V.1953	25.XII.1953	5 days
11.	Plewa	♀	702	1.XII.1946	26.XII.1953	6 days
12.	Plazma	♀	900	25.V.1953	26.XII.1953	6 days
13.	Plotkarz	♂	717	28.V.1947	26.XII.1953	6 days
14.	Pleciuga	♀	719	6.XII.1947	27.XII.1953	7 days
15.	Plama	♀	721	21.X.1947	28.XII.1953	8 days
16.	Plech	♂	906	14.VII.1953	28.XII.1953	8 days
17.	Plennik	♂	813	10.V.1951	28.XII.1953	8 days
18.	Pleśnianka	♀	857	15.V.1952	4.I.1954	15 days
19.	Plusia	♀	796	24.IX.1950	19.I.1954	30 days
Niepołomice Reservation						
1.	Puszcza	♀	673	14.IV.1945	23.IV.1954	4 days
2.	Puzon	♂	542	21.V.1940	28.IV.1954	9 days
3.	Purchawka	♀	714	20.V.1947	1.V.1954	12 days
4.	Pura	♀	627	17.IX.1943	2.V.1954	13 days
5.	Pustybór	♂	905	3.VII.1953	20.V.1954	31 days
6.	Pułkownik	♂	864	8.VII.1952	23.V.1954	34 days
7.	Pukajka	♂	868	25.VII.1952	27.V.1954	38 days
8.	Pułań	♂	899	22.V.1953	27.VII.1954	99 days

ary infection of these vesicles). Lack of pigmentation in these spots of the mucous membrane and occurrence of taste buds less developed than in the surrounding area were indicating previous damage (Fig. 1, Pl. XIX).

In case of secondary infection of surface erosions by saprophytic micro-organisms necrotic lesions of various size were formed. Usually they

were round with a diameter of 3—4 cm and reaching deep into the muscles of the tongue (Fig. 2). The most pronounced lesions were observed in a male »Pułan« which died 99 days after the outbreak of the foot-and-mouth disease in the herd. The lesion covered about $\frac{1}{3}$ of the dorsal surface and both lateral margins as well as the underlying muscle of the tongue. On the dorsal part of the tongue there was a large (8 × 10 cm) and about 1 cm deep loss of tissue irregularly shaped with roll-like edges elevated above the surrounding undamaged surface of the mucous membrane with some scars. The center was mostly smooth, but in the middle where the erosion was H-shaped (Fig. 3) and deeper, reaching about half of the tongue's thickness, the center was rough covered with a necrotic spongy mass.

Freshly burst secondary vesicles, surface erosions, or traces of healed erosions, or else (in case of complications) deep ulcerations were found in the mucous membrane of the lips with similar frequency. Similar changes were relatively rare in the mucous membrane of the hard and soft palate (»Plisa«, »Plewa«, »Puszcza«, »Pustybór«, »Purchawka«), of the gums (»Pliete«, »Pleciuga«, »Puszcza«, »Pustybór«), or of the nares (»Puszek«, »Plewa«, »Plazma«, »Pleciuga«, »Pura«, »Pustybór«) there were numerous and relatively deep erosions on the tops of the folds in the mucous membrane of the thoracic portion of the esophagus. These erosions had roll-like and elevated edges and a grey-brown, relatively dry, scab-like mass deep at the center. One of the erosions measured 3 × 1.5 cm and was covered by dry thick scab, easy to separate from the surface (Fig. 4).

In five bisons (»Pleśnianka«, »Puszcza«, »Puzon«, »Pura«, »Pustybór«) lesions similar to those observed in the mouth were found in the mucous membrane of the ruminal pillars. In »Puszcza« which died on the fourth day of the disease, the ruminal pillars were covered with numerous round or irregular shallow erosions measuring from 0.3 to 2.0 cm. Their edges were uneven shredded with remnants of burst vesicles. Some of the erosions were covered with thin brown-grey or brown-red scabs tightly adhering to the membrane. In the animals which died later during the disease (»Pleśnianka«, »Pura«) the process of epithelium regeneration was well pronounced. The edges of the erosions were smooth and even; the surface of the erosions usually free from scabs, smooth or finely granular ranging from pink to bluish red in colour. Lesions in the mucous membrane of the ruminal pillars were much more pronounced in »Pustybór« which died a month after the outbreak of the foot-and-mouth disease in the reservation. Besides round small erosions not exceeding 1 cm of diameter, there were vast (3 × 4 cm) deep ulcerations reaching the muscle layer (Fig. 5).

Lesions in the skin of the interdigital space were observed in 30 of 34 cases, in both front and hind limbs. There were either fresh erosions with brown scabs covering red foci without epithelium, or older erosions in the stage of regenerating the epithelium or else scars after healed erosions. Similar changes were much less common in the coronary region. In four cases («Plusia», «Pukajka», «Pułan», «Pustybór») complications of the primary process of the disease were observed on the skin of interdigital space, namely deep ulcerations and abscesses. «Pukajka» had an abscess the size of a walnut in connective tissue, between second digits above the interdigital space of the right hind limb. This abscess did not have a tendency to encyst itself (Fig. 6 — Plate XIX).

Edema, congestion and extravasation were relatively frequently observed in the mucous membrane of abomasum (18 cases) and small intestine (7 cases).

In the heart muscle autopsy revealed indications of cloudy swelling in the majority of the cases. In two cases («Tatrzanek», «Pleśniak») there was a simultaneous occurrence of cloudy swelling and fatty degeneration, the so called tigre heart. In some cases small extravasations were observed under epicard especially in the region of vascular grooves. Also an increased amount of serous fluid in the pericardial sac was observed.

Fatty degeneration of the liver was frequent and in six bisons («Pupileczka», «Pupilka», «Tatra», «Puszcza», «Purchawka», «Pura») this process was so advanced that even quite large fragments of the liver did not sink when placed in water.

In the 7 months old «Platanek» which died in the Pszczyna reservation on the second day of the disease no lesions characteristic of the foot-and-mouth disease were detected. In the mucous membrane of the oral cavity and in the skin of interdigital space there were no vesicles and no resulting erosion. *Post mortem* examination revealed only congestion of the mucous membrane of the lips, the presence of numerous petechiae in the tracheal mucosa, under the visceral pleura, under the epicard and in the mesentery as well as catarrhal gastritis. Advanced processes of *post mortem* autolysis (autopsy was done 3 days after death) made any histopathologic studies impossible. The above described picture of lesions indicated an acute course of the disease without vesicle formation. This is known to occur in the course of the malignant form of foot-and-mouth disease in cattle and especially in calves.

Frequently, namely in 9 cases, the primary process of the disease was complicated by bronchial pneumonia or purulent bronch-pneumonia («Tatra», «Pułkownik», «Pułan», «Pukajka», «Pustybór», «Pleśnianka»), purulent broncho-pneumonia caused by mycotic organisms from the *gen. Aspergillus* («Plusia» — Podgurniak, 1962), by an abscess in

the subcutaneous connective tissue and in the muscles («Pułan») and by bone fracture («Pustak», «Tatra»).

Secondary vesicle formation in the epithelium of the mouth and ruminal pillars (Fig. 7) was observed in the histopathologic picture of animals which died after the first few days of the disease, similar to the situation sometimes found in cattle. The vesicles contained serous fluid with dead epithelial cells, neutrophilic polymorphonuclear granulocytes and single red blood cells. The prickle cells of the epithelium immediately adjacent to the secondary vesicle were subject to the so called «ballooning degeneration» (Fig. 8, Pl. XX).

Serous exudation appears among the cells of this layer causing their loosening and manifestation of bridges between cells. Subsequently the prickle cells swell, become more or less round, the links between them disappear and the cells are transformed into spherical bodies (ballooning degeneration). Serous exudation and neutrophilic polymorphonuclear granulocytes fill the spaces formed between degenerated cells. Accumulation of fluid increases the pressure in the vesicle; the cornified layer becomes thin and eventually breaks. An erosion partially covered by shreds of necrotic epithelium is formed in place of the burst vesicle. The surface of the erosion is later covered with a yellowish-brown scab formed from dried exudation. The epithelium starts to heal beneath the scab and after 5—8 days is completely regenerated. However, fibrinous and purulent inflammation of deeper layers of the mucous membrane occurs in case of a secondary infection. A relatively deeper erosion is formed which, under favourable conditions, can heal in some two weeks (Fig. 9); or else, the necrotic process spreads to surrounding tissue causing for example the above described lesions of the tongue («Pustybór», «Pułan»).

In animals which died during the first few days of the disease cloudy swelling of muscle fibres was the most common lesion of the heart muscle. However, it was often accompanied by leucocytic infiltration and perivascular proliferation of cells from the adventitia of vessels (Fig. 10). In animals which died in the later course of the disease degenerative changes were accompanied by exudations of variable size composed of lymphoid cells, histiocytes and plasma cells with concomitant degeneration of muscle fibers and the proliferation of connective tissue (Fig. 11). The character of these exudations indicates an advanced stage of phagocytosis and the beginning of regeneration processes. In four bisons which died 13—39 days after the outbreak of foot-and-mouth disease in the Niepołomice reservation («Pura», «Pustybór», «Pułkownik», «Pukajka») small deposits of calcium salts were

found in fibers of the heart muscle showing hyaline degeneration. These foci (centers) were surrounded with either young fibers of connective tissue or with elements of non specific granulation (Fig. 12 — Plate XX).

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OBRAZ ZMIAN ANATOMOPATOLOGICZNYCH U ŻUBRÓW W PRZEBIEGU PRYSZCZYCY W POLSKICH REZERWATACH

Streszczenie

W okresie (1953—1954) epizootii pryszczycy w 3 rezerwatach żubra w Polsce (Łopuszna, Pszczyna, Niepołomice) padło ogółem 35 sztuk. Wyginął cały stan pogłowa żubrów w rezerwatach Łopuszna (8 sztuk) i Pszczyna (19 sztuk), zaś w jednej

z trzech zagród w Niepołomicach, w której przebywało do czasu choroby 14 żubrów, zostało przy życiu zaledwie 3 sztuki.

W 32 przypadkach stwierdzono sekcyjnie charakterystyczne dla pryszczycy zmiany w górnym odcinku przewodu pokarmowego (w błonie śluzowej języka, warg, dziąseł, policzków), rzadko w błonie śluzowej dalszych odcinków przewodu pokarmowego (przełyk, żwacz) oraz w skórze szpar międzyracicowych. W zależności od czasu jaki upłynął od zakażenia do śmierci zwierzęcia obserwowano albo świeżo pęknięte pęcherzyki wtórne, powierzchowne nadżerki i miejsca po ich wygojeniu, albo w przypadku wtórnego ich zakażenia mniej lub bardziej rozległe głębokie ogniska martwicy. W mięśniu sercowym w większości przypadków występowało zwyrodnienie mięśniowe, w dwóch przypadkach t.zw. serce tygrysie, wybroczyny pod nasierdziem, w worku osierdziowym zwiększona ilość płynu surowiczego. Histologicznie obserwowano w mięśniu sercowym obok zmian wstecznych (zwyrodnienie mięśniowe, szkliste, ogniska martwicy) procesy zapalne z występowaniem nacieków drobnokomórkowych.

Stosunkowo często stwierdzano powikłania pierwotnego procesu pryszczycowego (nieżytowe, nieżytowo-ropne zapalenie płuc, grzybica i promienica płuc, ropnie w różnych tkankach i narządach, złamania kości).

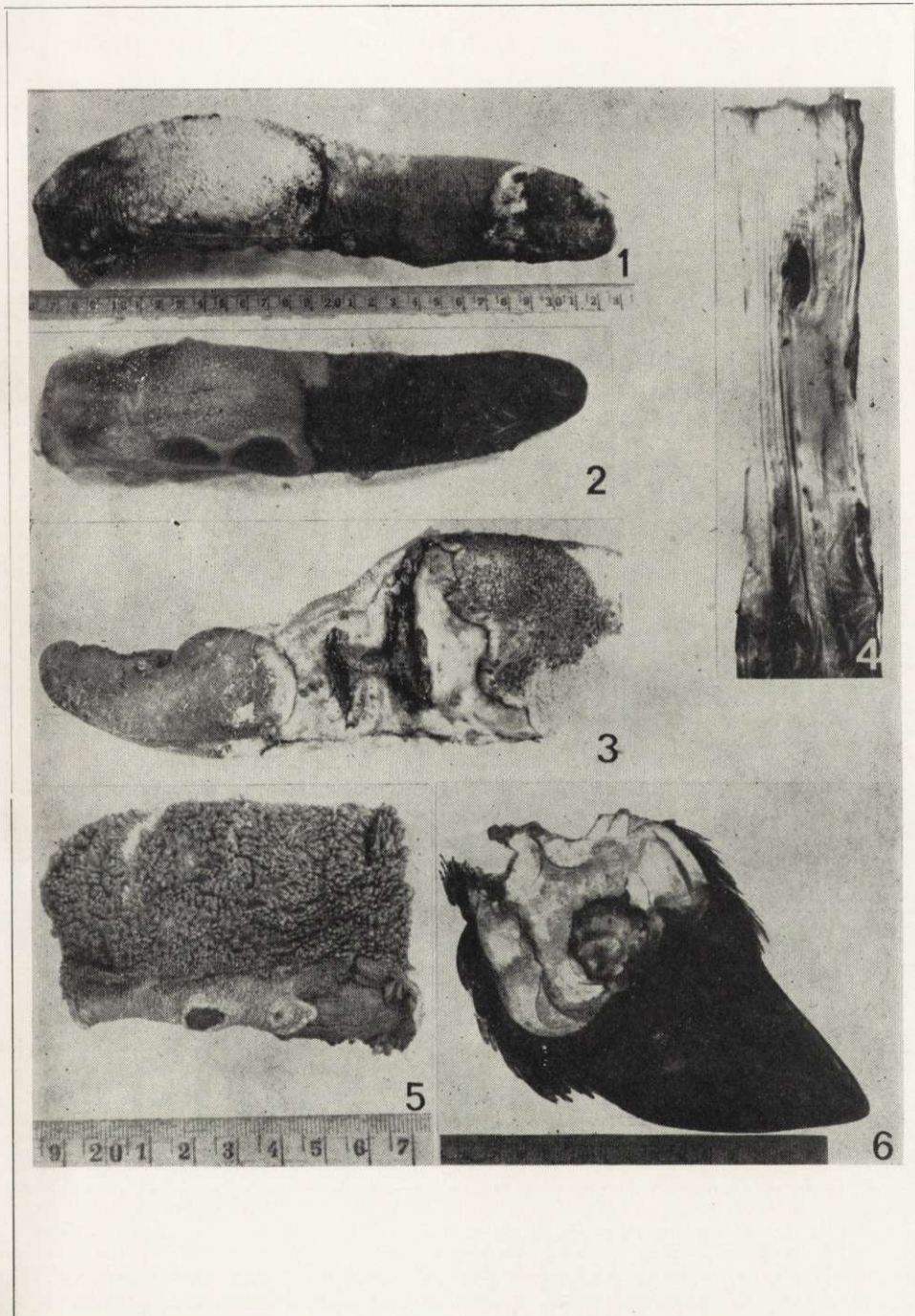
EXPLANATION OF PLATES

Plate XIX.

- Fig. 1. »Pleśnianka« — Tongue — traces of healed surface erosions.
 Fig. 2. »Pustybór«. Tongue — deep round necrotic lesion on the edge.
 Fig. 3. »Pułan«. Tongue — extensive erosion on the dorsal surface of the tongue with roll-like edges. In the middle H-shaped necrosis reaching down to half of the tongues thickness.
 Fig. 4. »Pustybór«. Esophagus — deep ulceration of mucous membrane reaching the muscle layer.
 Fig. 5. »Pustybór«. Rumen — extensive deep ulceration of mucous membrane reaching the muscle layer and smaller erosion, 1 cm in diameter.
 Fig. 6. »Pukajka«. Hoof — interdigital space abscess in the connective tissue (size of a walnut).

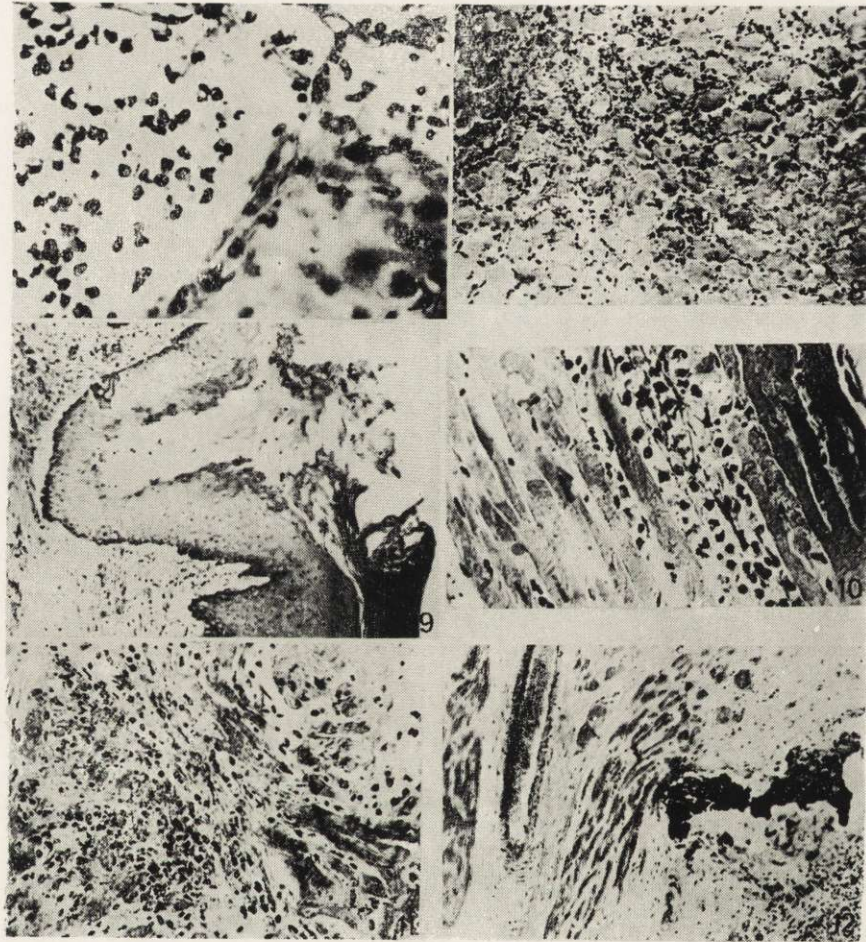
Plate XX.

- Fig. 7. »Puszcza«. Rumen — fragments of two secondary vesicular lesions in the mucous membrane of the ruminal pillars. Neutrophilic polymorphonuclear granulocytes, single red blood cells and prickly cells of epithelium are seen; magnif. oc. — 4 ×, ob. — 40 ×.
 Fig. 8. »Pliet«. Tongue — so called ballooning degeneration of prickly cells in the mucous membrane. Cells become loosened and round. Exudation of neutrophilic polymorphonuclear granulocytes between the cells. Magnif. oc. — 4 ×, ob. — 16 ×.
 Fig. 9. »Purchawka«. Tongue — healed erosion in the mucous membrane. Magnif. oc. — 4 ×, ob. — 6.3 ×.
 Fig. 10. »Plazma«. Heart muscle — cloudy swelling. Leucocytic infiltration and perivascular proliferation of cells from the vascular adventitia. Magnif. oc. — 4 ×, ob. — 40 ×.
 Fig. 11. »Tatra«. Heart muscle — extensive infiltrations of limphoidal cells, histiocytes and plasma cells. Atrophy of muscle fibers. Magnif. oc. 2.5 ×, ob. — 40 ×.
 Fig. 12. »Pukajka«. Heart muscle — small deposits of calcium salts in hyaline degenerated muscle fibers and extensive lymphocytic infiltration. Magnif. oc. — 2.5 ×, ob. — 16 ×.



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