

# A Pathological Survey on Equine Viral Rhinopneumonitis Occurred in Korea

Ung-Bok Bak, D.V.M., Ph.D., Chang Hyeong Lim, D.V.M., Ph.D.  
and Bu Hyeon Kang, D.V.M., M.S.

*College of Veterinary Medicine, Seoul National University*

Shi Young Lee, D.V.M., M.P.H.

*Korean Horse Affairs Association*

## Introduction

Equine viral rhinopneumonitis (EVR) was first described as a specific syndromes, acute respiratory catarrh in young horses and abortion in pregnant mares in the United States by Dimock and Edwards<sup>5)</sup> in 1933. Since then the disease was confirmed in Germany, Yugoslavia, Australia, United Kingdom, Canada, Japan and South Africa. Epidemiological studies on the disease have been conducted by Dimock et al.,<sup>3,4)</sup> Doll and Bryans,<sup>6,7)</sup> Doll et al.<sup>8)</sup> and Jeffcott and Rossdale.<sup>9)</sup> Pathological studies of aborted fetuses have been reported by Westerfield and Dimock<sup>14)</sup>, Jeleff<sup>10)</sup>, Kawakami et al.<sup>13)</sup> or Corner et al.<sup>2)</sup>

The authors have surveyed a epizootic of transitory respiratory disease and abortion of the pregnant mares at Seoul race course which was the only place for horse breeding and racing in Korea from December 1978 to May 1979, and presented the results of the study on the cases of EVR outbreaks as the first report of the disease.

## Materials and Methods

### Clinical Examination

The 517 horses at Seoul race course were inspected for respiratory condition from December 1978 to January 1979. The home countries and ages of the horses were listed in Table 1.

**Table 1.** Inspected Horses for Respiratory Condition

Home Countries of the Horses	Number	Age	Number
Japan	251		
U. S. A.	126	2~5 Years	371
Australia	66	6~10 Years	146
Canada	60		
Korea	14		
Total	517		517

### Pathological Examination

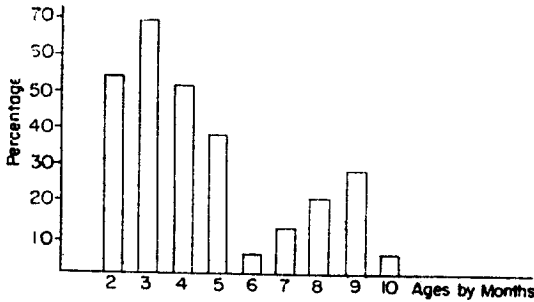
A total of seven aborted fetuses was obtained for pathological study. Six of them were subjected to necropsy. Tissue specimens were fixed in 10% buffered formalin, prepared into paraffin sections and stained with hematoxylin and eosin for microscopic observation.

## Results

### Clinical History

Respiratory symptoms were suddenly developed in 222 of the inspected horses from December 1978 to January 1979 with 42.9% of incidence rate. Age distribution of the clinical cases is shown in Fig. A representing higher incidence of the respiratory symptom in the younger horses Aged 2 to 5 years than in the older animals from 6 to 10 years. Young horses from 2 to 5 years old

showed typical upper respiratory signs, revealing slight hyperemia of nasal and conjunctival mucosae, dry cough, nasal discharge and mild transitory fever. The symptoms were recovered in a short period. Any complicated case with severe symptoms was not recognized throughout the epizootic.



**Fig. A.** Age distribution of clinical cases of the inspected horses.

Six of ten pregnant mares aborted dead fetuses without premonitory signs between January 26th, 1979 and mid May 1979. Two of them were enclosed within the fetal membranes. Abortion occurred between 7 months and 11 months gestations. Ages of the mares and the fetuses at the time of abortion and abortion date are shown in Table 2.

Since the last abortion on May 15th, 1979, no more abortion cases have been recorded in the herd. Within 4 months following the first outbreak of abortion, all the reproductive conditions of the mares returned to normal.

**Table 2.** The Mares Accompanied with Abortion and the Aborted Fetuses

Name of Mares	Home Country	Age by years	Age of Aborted Fetus by Months	Date of Abortion
Picnic	U. S. A.	7	7	Jan. 26, 1979
Jamboree	U. S. A.	7	9	Mar. 9, 1979
Choeumsok	Japan	4	9	Mar. 15, 1979
Julia	Japan	11	10	Mar. 17, 1979
Sevenexer	Japan	4	8	Apr. 18, 1979
Seoungsan	Japan	5	11	May. 14, 1979

### Gross Pathology of The Aborted Fetuses

All aborted fetuses showed characteristic and diagnostic lesions. Edematous thickening was noted at the conjunctiva of the eyes, mandibular, cervical, umbilical or prepuce regions of the skin (Fig. 1). Icteric discoloration was particularly evident in the skin of foot pads.

Excess accumulation of clear, yellow fluid in which the lung lobules were floated was found in the thoracic or peritoneal cavities (Fig. 3). Two of six fetuses showed excessive bloody fluid in the thoracic and peritoneal cavities (Fig. 4). Another two cases presented cloudy thickening of the peritoneum with villi like appearance of the surface.

The lungs were hyperemic and edematous with heavy and rubbery consistency. Edematous thickening was confined to the interlobular septa and subcapsular tissue with frequent petechiation or ecchymoses (Fig. 6). The pericardial sac was cloudy and edematous, and contained a little amount of clear fluid. Many hemorrhages, varying from petechiae to ecchymoses, were present subjacent to the epicardium, particularly in the ventricles at the coronary and in the left longitudinal grooves. The thymus was hyperemic and edematous especially at the capsule and interlobular septa and in the two cases creamy fluid exuded from the cut surface.

The spleen was enlarged with hyperemia, hemorrhages and unusual prominence of the follicles and showed soft consistency. The livers of all fetuses were hyperemic showing various numbers of necrotic foci up to 2mm in diameter on surfaces and in parenchyma (Fig. 5). Fundic mucosa of the stomach showed gelatinous thickening and hyperemia. In the two cases of the fetuses, the esophageal mucosa of the stomach beared multiple vesicles with blood clots (Fig. 7). The vesicles were variable in size ranging from 2 to 5mm in diameter. Small intestine was hyperemic and gelatinously thickened, and in the two cases fibrinonecrotic patches were recognized at the ileum mucosa showing petechiae, ecchymoses and the thickened peyer's patches (Fig. 8). The kidneys revealed

led cloudy and mottled appearance. The meninges of the brains were severely hyperemic and edematous, and revealed subdural ecchymoses at the bases or other parts of the cerebral hemispheres.

### Histopathology of the Aborted Fetuses

**Liver:** Marked hyperemia accompanied with hemorrhage and necrosis was confined to the livers of all the fetuses. Distinct dilation of the central vein, sinusoid and portal vein resulted in deformation and dissociation of the liver cells. Varying degrees of fatty degeneration at peripheral site of lobule were seen and interlobullar connective tissue was more prominent due to edematous change. All livers examined showed focal necrosis being characterized by varying degrees of karyorrhexis and no cellular infiltration (Fig. 9). Typical Cowdry type A, eosinophilic inclusion bodies were observed in the hepatic cell around or in the necrotic foci (Fig. 10). The inclusion body was demonstrated in five of the six fetuses. In two cases the inclusions were found in the bile duct epithelium.

**Lung:** Microscopically the lungs exhibited marked congestive edema and hemorrhage. Interlobular septa were greatly distended by loose arrangement of the connective tissue cells. In the bronchi and bronchioles proliferation and desquamation of the epithelium were prominent (Fig. 11). In two cases typical inclusions were found in the bronchiolar epithelium (Fig. 12).

**Spleen:** The spleen displayed marked hyperemia, hemorrhage and necrotic changes. In the red pulp various changes including pronounced hyperemia, proliferation and necrosis of the reticular cells made original architecture of the tissue obscure (Fig. 13). Lymphatic follicles were well defined with edematous enlargement and central necrosis showing karyorrhexis and pyknosis of the lymphatic cells (Fig. 14). In four cases the intranuclear inclusions were evident in the reticular cells of the red pulp (Fig. 14).

**Lymph node:** In the subcapsular space and the medullary cords there were distinct hyperemia and hemorrhage. Subcapsular and peritrabecular sinuses were distended by proliferated reticular

cells and lymphatic cells. Medullary and paracortical areas exhibited diffuse hyperplasia and swelling of the reticular cells accompanied with zonal necrosis (Fig. 17). Lymphatic follicles are hyperplastic, necrotic changes revealing loose texture of the tissue and cellular debris (Fig. 18). In the 4 cases of fetuses, the inclusion bodies were found in the reticular cells of paracortical or medullary areas (Fig. 19).

**Thymus:** The capsule and interlobular septa showed edematous thickening. Cortex or medullary areas of the lobules were accompanied with distinct hyperemia and hyperplasia of reticular cells, being infiltrated with many eosinophilic leukocytes (Fig. 20). Also in the cortex hyperplastic reticular cells and lymphatic cells revealed necrotic changes (Fig. 21). The inclusion bodies were found in a few reticular cells in the medullary area of the lobules (Fig. 22).

**Table 3.** Summary of Histopathology for the Six Cases of Aborted Fetuses

Tissue	Histological Changes	No. of Cases with Changes	No. of Cases with Inclusions
Liver	Congestion, focal necrosis	6	5
Spleen	Congestion, hemorrhage, edema of follicle with necrosis, reticular hyperplasia and necrosis	6	4
Lymph node	Congestion, hemorrhage, lymphoid exhaustion, reticular hyperplasia and necrosis	6	4
Thymus	Reticular hyperplasia and necrosis with eosinophilic infiltration	6	5
Lung	Congestion, edema, hemorrhage hyperplasia and sloughing of bronchial epithelia	6	3
Kidney	Congestion, tubular degeneration	5	0
Testis	Congestion, edema, cytoplasmic vacuolation of interstitial cells	4	0
Brain	Congestion, edema	6	0

**Stomach:** Esophageal mucosa with multiple vesicles were microscopically observed with papillary projections of mucosa accompanied with epithelial proliferation and necrosis (Fig. 24).

**Small intestine:** Affected small intestine showed hyperplasia and sloughing off mucosal epithelium, and severe edema and hemorrhage of lamina propria or submucosa. In the ileum Peyer's patches were showed with necrosis of reticular cells and lymphatic cells, and the fibrino-necrotic membrane of the mucosa.

**Testis:** In the testis marked edematous change-induced thickening of septula testis and loose arrangement of interstitial cells (Fig. 23). Histological findings on the various organs of the aborted fetuses were summerized as (Table 3).

## Discussion

A respiratory disease accompanied with abortion occurred in the horses stabled in Seoul race course between December 1978 and May 1979, and was diagnosed as EVR by the results of epidemiological and pathological studies on the disease.

For four weeks from December of 1978 to January of 1979 42.9% of the inspected horses showed transitory respiratory symptom, and 60% of the pregnant mares aborted dead fetuses at the late gestation of pregnancy. The disease terminated within four months after the first outbreak of abortion. The obtained epidemiological data including seasonal incidence of rhinopneumonitis and, age distribution of the mares involved and the aborted fetuses were essentially similar to those reported by Doll and Bryans<sup>7)</sup> in the Kentucky State.

Jeffcott and Rossdale<sup>8)</sup> indicated that most cases of EVR in United Kingdom were sporadic and few abortion had been encountered since 1963. Platt<sup>13)</sup> gave an incidence of only 3 percent of all abortions between 1969 and 1971 in United Kingdom. Doll and Bryans<sup>7)</sup> reported infrequent occurrence of the abortion in comparison to the widespread dissemination of the disease in young horses in United States. Bagust et al<sup>1)</sup> reported that 83% of Australian horses had been exposed to

the infection but few abortion storned. In these countries most race horses might maintain a high level of immunity by frequent reinfections during their racing and after returning to farms.

The race horses in Korea have been under a unique circumstance in terms of management and breeding in particular. The Seoul race course has ever been the only place for horse breeding and racing in the country. Most of the horses have been imported from several countries like Australia, Canada, United States and Japan. Therefore, this horse colony of the country has been faced risks for infectious diseases introducing from foreign countries. Sixty horses were imported from Canada on late November 1978 and eleven of them showed respiratory symptom during the quarantine. After keeping them in the stables of Seoul race course, the respiratory signs and abortion were storned in most of the barns in he race course. Since the disease has neve been reported in Kerea, the authors consider that the disease might be introduced from overseas. Storming aspect of the epizootic might be suggestive of the first outbreaks of EVR in Korea.

The gross and histopathological findings in the six aborted fetuses examined were very similar to those reported by Westerfield and Dimock<sup>14)</sup>, Jeleff<sup>15)</sup>, Kawakami et al<sup>12)</sup>, and Corner et al<sup>21)</sup>. But incidences of the inclusion bodies in the organs were varied by these authors. Westerfield and Dimock<sup>14)</sup> observed the inclusions in liver cells, biliary epithelium, bronchiolar epithelium, alveolar epithelium, endothelium and smooth muscle fiber of the small vessels, reticular cell of the spleen, lymph node, thymus and Peyer's patches. Kawakami et al<sup>12)</sup>, detected the inclusions in live cell, biliary epithelium, Kupffer cell and reticular cells of the spleen but not in the lung and thymus. The highest incidence of inclusions was recorded by Corner et al<sup>2)</sup>, who demonstrated the inclusions even in myocardial fiber, pancreatic acinar cell, and mucosal epithelium of the small intestine. The incidence of the inclusions in the organs might be variable by the progressive stages of the disease.

## Conclusion

The authors inspected 517 horses from December, 1978 to January, 1979 at Seoul race courses which was the only place for horse breeding and race in the country, and found out many horses were suffered from a respiratory disease. By clinical examination for the horses incidence of the respiratory disease was defined as 42.9% of examined animals. Among the diseased horses 6 cases of 10 pregnant mares aborted dead fetuses at late gestation of pregnancy between the last decade of January of 1979 and mid May of 1979.

The aborted fetuses represented distinct gross lesions such as excess accumulation of thoracic fluid, congestive edema and hemorrhagic changes of the most organs.

Histological lesions of the fetuses revealed multiple focal necrosis of the liver, proliferation and sloughing of the bronchiolar epithelium, extensive hyperplasia and necrosis of reticular cells of the spleen, lymph nodes, Peyer's patches and thymus. The typical inclusions belonging to Cowdry type A were found in the liver cells in the periphery of focal necrosis, epithelium of the bronchiolar epithelium, and reticular cells of the spleen, lymph nodes and thymus. It was determined that these findings of the aborted fetuses would be histological evidence for equine viral rhinopneumonitis. Storming aspect of the disease among the horses might be suggestive of the first outbreak of equine viral rhinopneumonitis in Korea.

## Legends for Figures

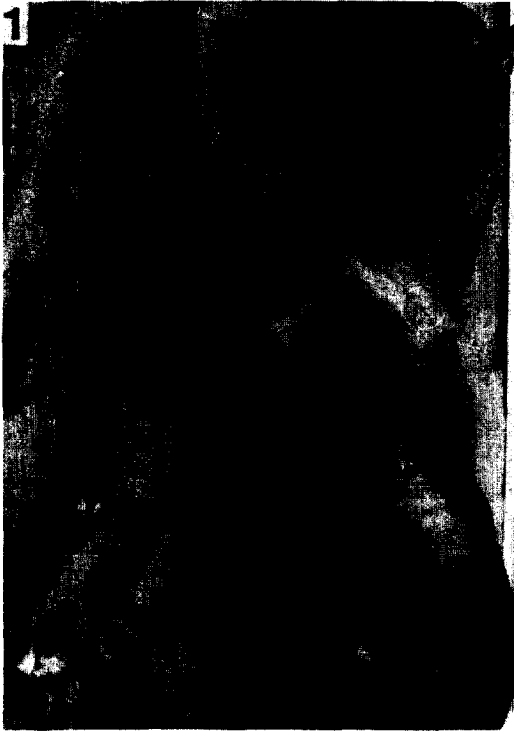
### Gross appearances of the aborted fetuses

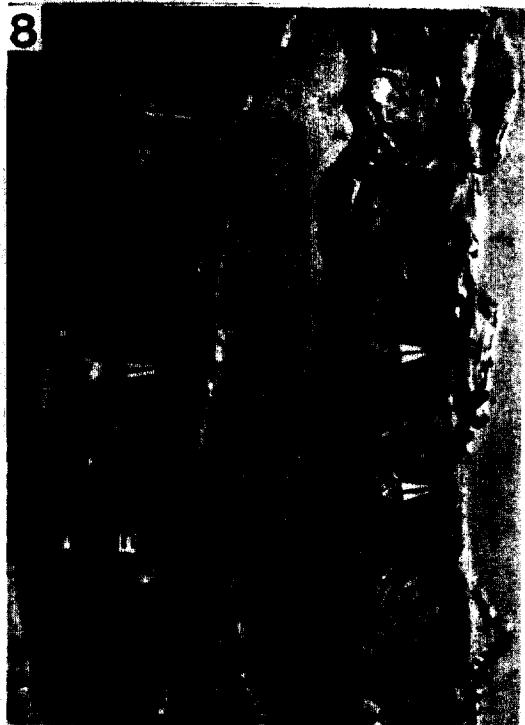
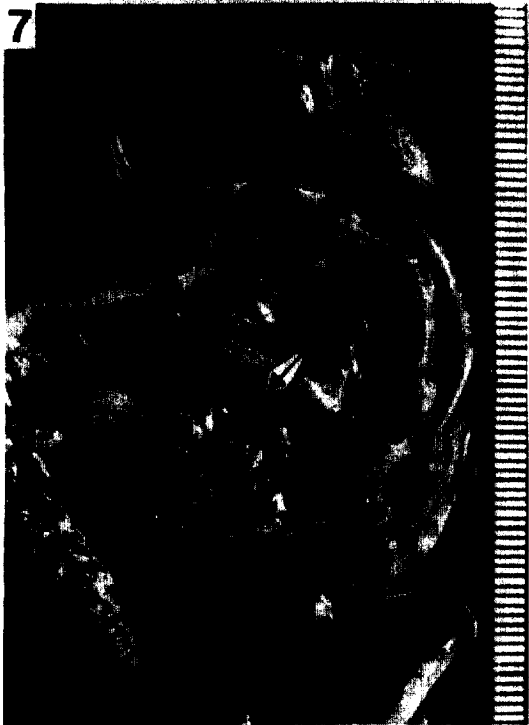
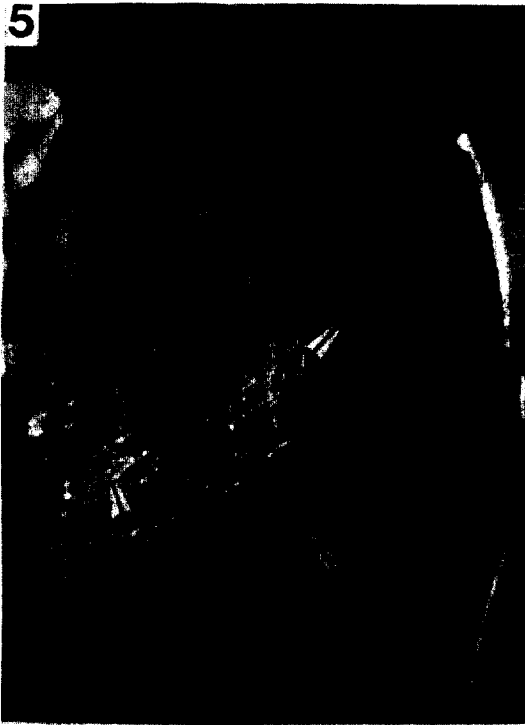
- Fig. 1.** The aborted fetus at 9th month of gestation showing edema and jaundic discoloration of the skin and foot pads.
- Fig. 2.** The aborted twin fetuses at 7th month of gestation.
- Fig. 3.** Excess accumulation of clear fluid in the thoracic cavity of an aborted fetus (arrows). Lobes of the lung (1) are floated in the fluid.
- Fig. 4.** Dark hemorrhagic fluid in the thoracic cavity of an aborted fetus (arrows).
- Fig. 5.** Surface of the liver from an aborted fetus showing multiple focal spots of necrosis (arrows).
- Fig. 6.** Swelled, edematous lobe of the lung from an aborted fetus shows petechiae and echymoses (arrows).
- Fig. 7.** Esophageal region of the gastric mucous membrane bears multiple vesicles with hemorrhage (arrows).
- Fig. 8.** Congestive and hemorrhagic mucous membrane of the ileum from an Peyer's patches (arrows) and crust formation (n).

### Histological lesions of the aborted fetuses

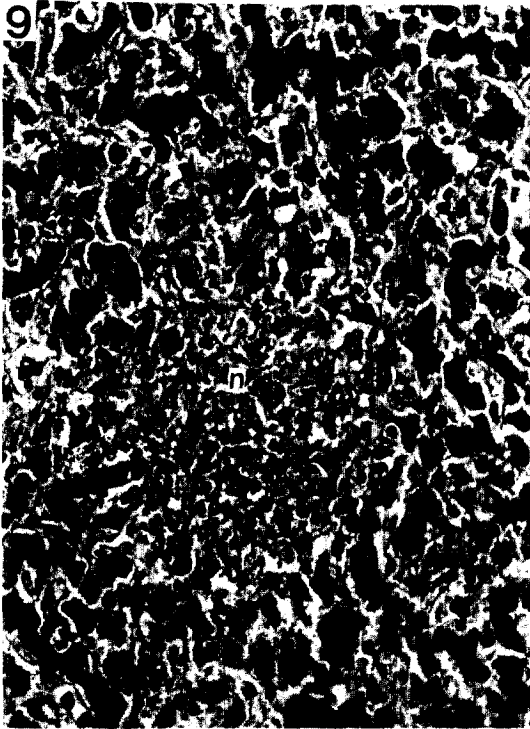
- Fig. 9.** Focal necrosis (n) in the hepatic lobule.
- Fig. 10.** Higher magnification of Fig. 9 presents typical eosinophilic inclusions (arrows) in the nuclei of the liver cells with margination of nuclear chromatin. Hematoxylin and eosin (H. E.) Stain,  $\times 500$ .
- Fig. 11.** The lung lobules from an aborted fetus present sloughing of proliferated epithelium of the bronchioles (arrows) and edematous changes of the alveoli. H. E. stain,  $\times 6.5$ .
- Fig. 12.** Intranuclear inclusions in the bronchiolar epithelium (arrows). H. E. stain,  $\times 500$ .

- Fig.13.** The lesion of the spleen from an aborted fetus reveals edematous lymphatic follicle (f) and zonal necrosis of reticular cells in the red pulp (n). H.E. stain,  $\times 10$ .
- Fig.14.** Higher magnification of Fig.13 presents nuclear debris in the edematous lymphatic follicle H.E. stain,  $\times 50$ .
- Fig.15.** Higher magnification of Fig. 13. showing extensive necrosis of the reticular cells(n) and intranuclear inclusions in the enlarged reticular cells (arrows). H.E. stain,  $\times 66$ .
- Fig.16.** Intranuclear inclusions in a reticular cell of red pulp of the spleen (arrow).H.E. stain,  $\times 33$ .
- Fig.17.** The lesion of the lymph node from an aborted fetus represents marked congestion in the capsule (arrows) and follicular necrosis with edema(f) and necrosis of paracortical area(n) H.E. stain,  $\times 6.5$ .
- Fig.18.** Higher magnification of Fig. 17 showing numerous nuclear debris in the follicle. H.E.stain,  $\times 50$ .
- Fig.19.** Intranuclear inclusions in the reticular cells of medullary cord of the lymph node. H.E. stain,  $\times 330$ .
- Fig.20.** The medullary resion of the thymus lobule represents distinct swelling of the pro liferated reticular cell (arrows) and infiltration of eosinophils(e). H.E. stain,  $\times 200$ .
- Fig.21.** The medullary resion of the thymus lobule shows massive necrosis of reticular cells(n) with pyknotic nuclei (arrows). H.E. stain,  $\times 100$ .
- Fig.22.** Intranuclear inclusion in the reticular cell of the thymus.H.E. stain,  $\times 500$ .
- Fig.23.** The lesion of the testis from an aborted fetus presents marked congestion(arrows) and edema between the interstitial cells(j). H.E. stain,  $\times 500$ .
- Fig.24.** Vesicular lesion of the gastric mocosae presents zonal subepithelial hemorrhage(h). vacuola-  
tion of epithelial cells (arrow) and necrosis of the proliferated epithelium(n). H.E. stain,  
 $\times 100$

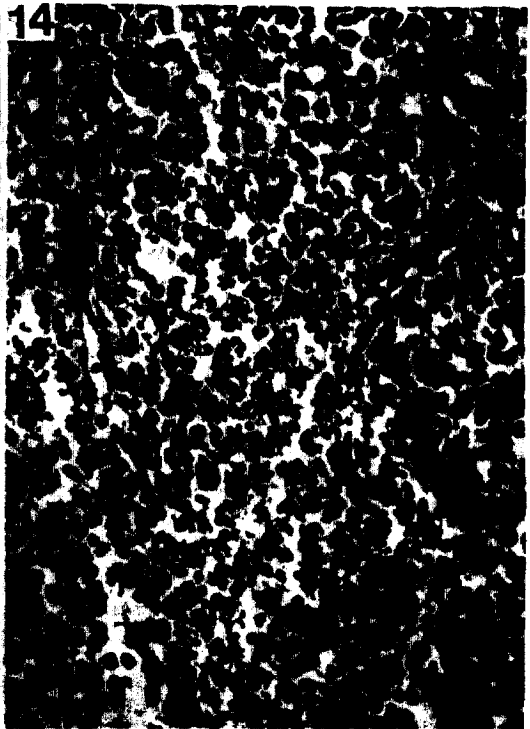
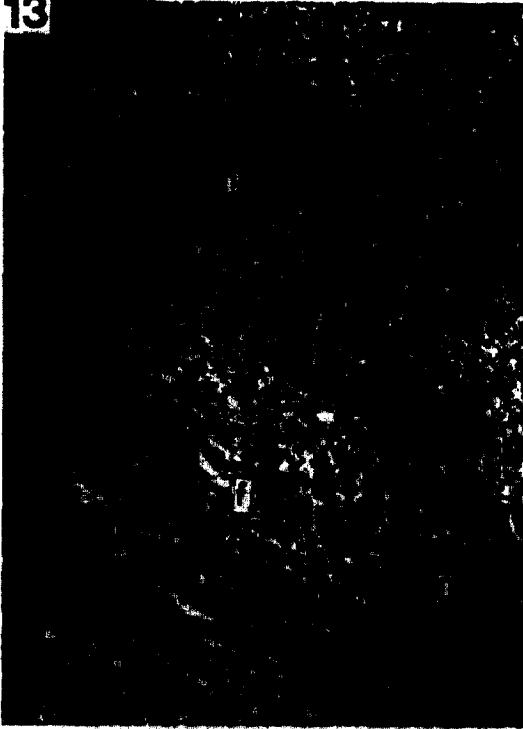






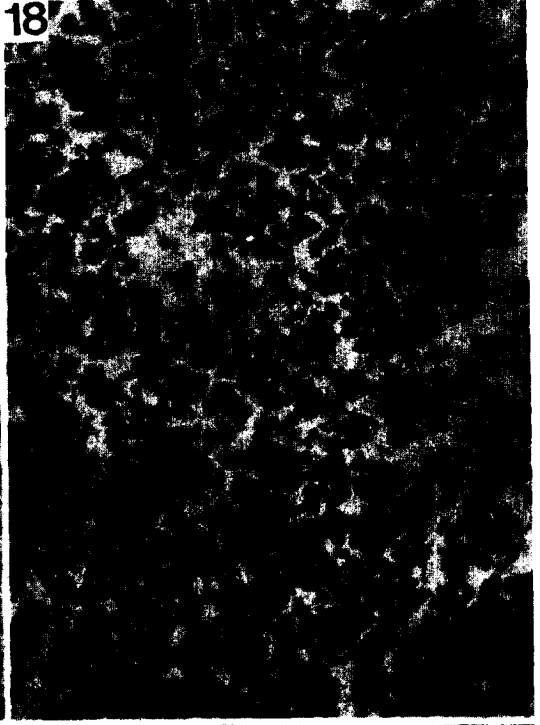
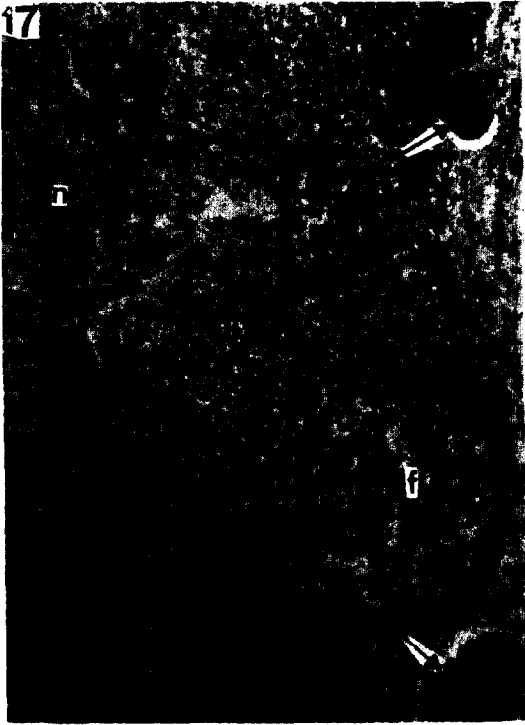


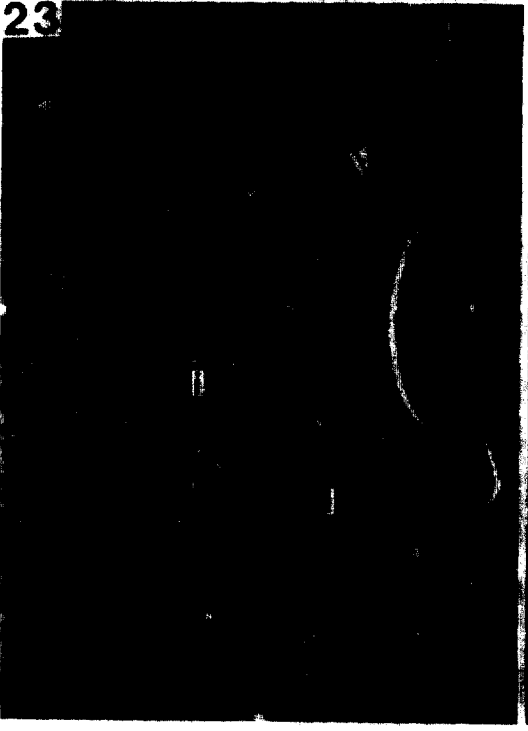
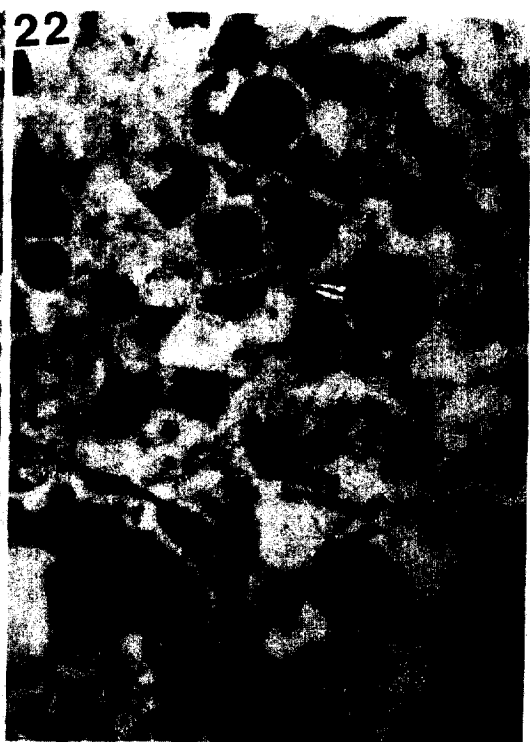
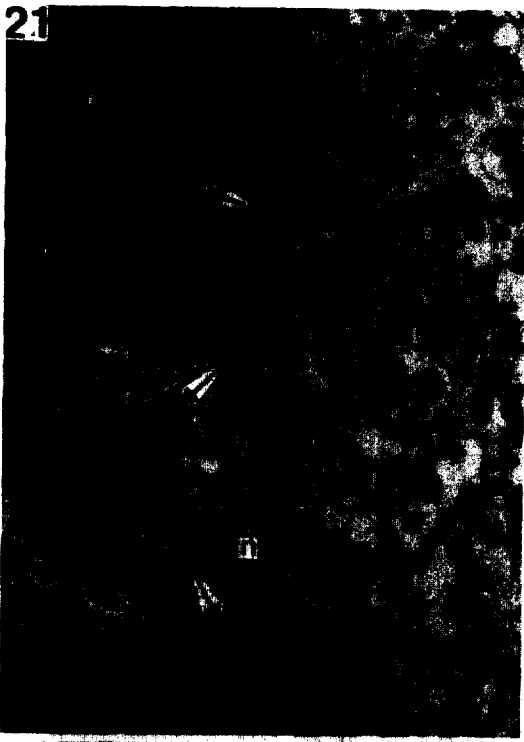
13



15







## References

1. Bagust, T.J.: A review of viral infections in horses. Aust. Vet. J. (1970) 48: 520.
2. Corner, A.H., Mitchell, D. and Meads, E.B.: Equine virus abortion in Canada. I. pathological studies on aborted fetuses. Cornell Vet. (1963) 53: 78.
3. Dimock, W.W., Edwards, P.R. and Bruner, D.W.: Equine virus abortion. Kentucky Agric. Exper. Sta. Bull. 426, June, 1942.
4. Dimock, W.W., Edwards, P.R. and Bruner, D.W.: Infections of fetuses and foals. Kentucky Agric. Exper. Sta. Bull. 509, Sept., 1947.
5. Dimock, W.W. and Edwards, P.R.: Is there a filterable virus of abortion in mares. Supplement, Kentucky Agric. Exper. Sta. Bull. (1933) 333.
6. Doll, E.R. and Bryans, J.T.: Incubation periods for abortion in equine viral rhinopneumonitis. Jour. Amer. Vet. Med. Assoc. (1962) 141: 351.
7. Doll, E.R. and Bryans, J.T.: Epizootiology of equine viral rhinopneumonitis. Jour. Amer. Vet. Med. Assoc. (1963): 142
8. Doll, E.R., Crowe, M.E.W., Bryans, J.T. and McCollum, W.H.: Infection immunity in equine virus abortion. Cornell Vet. (1955) 45: 387.
9. Jeffcott, L.B. and Rosedale, P.D.: Practical aspects of equine virus abortion in the United Kingdom. Vet. Rec. (1976) 98: 153.
10. Jeleff, W.: Beitrag zur fötalen Histopathologie des Virusaborts der Stute mit besonderer Berücksichtigung der Differentialdiagnose. Arch. Exp. Vet. Med. (1959) 11: 906.
11. Jones, T.C., Doll, E.R. and Bryans, J.T.: The lesions of equine viral arteritis. Cornell Vet. (1957) 47: 52.
12. Kawami, G., Kaji, T., Sugimura, K., Ishitani, R., Shimizu, T. and Matumoto, M.: Histopathological study of aborted fetuses naturally infected with equine virus with somispidemiological findings. Jap. Jour. Expt. Med. (1959) 29: 635.
13. Plat, H.: Etiological aspect of abortion in the Thoroughbredmares. J. Comp. Path. (1973) 83: 199.
14. Westerfield, C. and Dimock, W.W.: The pathology of equine virus abortion. Jour. Amer. Vet. Med. Assoc. (1946) 109: 101.

## 말 바이러스성 鼻肺炎에 관한 病理學의 研究

朴 應 鎭 · 林 昌 亨 · 姜 富 鉉

서울대학교 獸醫科大學

李 始 永

韓國馬事會

抄 錄

서은 競馬場의 競走馬 517두를 대상으로 呼吸器症狀를 관찰하여 1978년 12월 中旬부터 1979년 1월 初旬 까지 42.9%의 呼吸器症狀發生率을 보았고 1979년 1월 下旬부터 5월 中旬까지 妊娠馬의 60%가 死産을 일으켰다. 死産된 胎仔는 肉眼的으로 胸腔水液의 貯留, 各 臟器의 鬱血性水腫, 出血性病變과 肝臟의 巢狀壞死를 나타내었고, 組織學的으로는 肝臟의 限局性壞死巢, 脾臟, 淋巴節, 胸腺과 Peyer板에서의 細網細胞의 增殖性, 壞死性變化和 淋巴樣細胞의 崩壞를 示顯하였다.

여기서 肝細胞, 膽管上皮細胞, 小氣管支上皮細胞 및 脾臟, 淋巴節, 胸腺의 細網細胞에서 Cowdry type A 封入體를 확인하였다. 이상의 疫學的 및 病理學的 所見에 의하여 本 馬流産症을 말 바이러스성 鼻肺炎이라고 診斷할 수 있었으며 本 發病例가 韓國에서 初發生인 것으로 推定되었다.