

Zeitschrift: Schweizer Archiv für Tierheilkunde SAT : die Fachzeitschrift für Tierärztinnen und Tierärzte = Archives Suisses de Médecine Vétérinaire
ASMV : la revue professionnelle des vétérinaires

Herausgeber: Gesellschaft Schweizer Tierärztinnen und Tierärzte

Band: 139 (1997)

Heft: 11

Artikel: The prevalence of lung lesions in pigs at slaughter in Switzerland

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DOI: <https://doi.org/10.5169/seals-593380>

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The prevalence of lung lesions in pigs at slaughter in Switzerland

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Abstract

A survey of the prevalence of lung lesions in randomly selected slaughtered swine representative of the Swiss fattening pig population was carried out from May to September 1992 in six large abattoirs. In total 8921 lungs out of 561 herds were examined. Histological investigations were completed in every herd. No gross lesions could be found in 56% of the pigs. The most frequent lesions in individuals were bronchopneumonia (21%) and diffuse pleuritis (21%). Linear scars (9%), focal pleural fibrosis without any pneumonic lesion (2%), pleuropneumonia (1%) and abscesses (1%) were less prevalent. The prevalence of lesions at the herd level was completely different. The lungs of only 14% of the herds were free of any lesions. The main finding at the herd level was a diffuse pleuritis (75%), followed by bronchopneumonia (64%), linear scars (60%), focal pleural fibrosis (20%), abscesses (14%) and pleuropneumonia (9%). In 94% of the herd samples with macroscopically diagnosed bronchopneumonia, the histological lesions were consistent with enzootic pneumonia of pigs.

Key words: slaughter pigs – respiratory diseases – lung lesions – prevalence in individuals – prevalence at the herd level

Zur Prävalenz von Lungenläsionen bei Schlachtschweinen in der Schweiz

Anhand einer Untersuchung von Schlachtlungen, zwischen Mai und September 1992 in sechs grossen Schlachthöfen der Schweiz durchgeführt, wurde die Prävalenz von Lungenläsionen bei Mastschweinen sowohl bei den Einzeltieren als auch auf Betriebsniveau bestimmt. Aus statistischen Gründen wurde ein minimaler Stichprobenumfang von 384 Betrieben festgelegt. Pro Betrieb wurden 14 Lungen beurteilt. Beträgt die Prävalenz einer Lungenerkrankung im Betrieb 20%, so kann mit dieser Stichprobe mit einer statistischen Sicherheit von 95% mindestens eine veränderte Lunge nachgewiesen werden. Das einmalige Auftreten einer bestimmten Läsion hatte eine entsprechende Betriebsklassifizierung zur Folge. Aus jedem Betrieb wurden gezielt Lungenproben entnommen und histologisch beurteilt. Insgesamt wurden 8921 Lungen aus 561 Betrieben untersucht. 56% der kontrollierten Schweine zeigten keine Lungenveränderungen. Am häufigsten wurden Bronchopneumonien (21%) und generalisierte Pleuritiden (21%) beobachtet. Einziehungen (9%), herdförmige Pleuritiden (2%), Pleuropneumonien (1%) und Abszesse (1%) wurden selten festgestellt (Mehrfachnennungen möglich). Häufigster Befund auf Betriebsebene war eine generalisierte Pleuritis (75%), gefolgt von Bronchopneumonie (64%), Einziehungen (60%), herdförmiger Pleuritis (20%), Abszess (14%) und Pleuropneumonie (9%). Nur 14% der Betriebsstichproben wiesen keine Lungenläsionen auf. In 94% der Betriebsstichproben mit Bronchopneumonie ergaben die histologischen Untersuchungen Verdacht auf EP.

Schlüsselwörter: Mastschweine – Respirationskrankheiten – Läsionen bei Schlachtlungen – Prävalenz beim Einzeltier – Prävalenz auf Betriebsniveau

Respiratory diseases are common in swine rearing areas worldwide. Despite their mainly subclinical course lung affections are considered to be of great economic importance by not only reducing the growth rate and feed efficiency but also increasing the costs for treatment and prevention programs. The main etiologic agents are *Mycoplasma hyopneumoniae*, the primary agent of enzootic pneumonia producing bronchopneumonia in the cranio-ventral lobes of the lung and *Actinobacillus pleuropneumoniae* associated with pleuropneumonia mainly in the caudal lobes. In abattoir surveys from different countries the prevalence of lung lesions varied enormously. The prevalence of pneumonia ranged from approximately 6% to 81% (Flesjå and Ulvesæter, 1979; Wilson et al., 1986; Davies et al., 1992), pleuritis from 2% to 28% (Osborne et al., 1981; Hartley et al., 1988; Mousing et al., 1990), pleuropneumonia from 1% to 11% (Bahnsen et al., 1992; Wunderli and Leuzinger, 1993).

Information on the prevalence of respiratory diseases in fattening pigs in Switzerland generally is lacking. One survey was conducted (Wunderli and Leuzinger, 1993) but because the animals were from a single abattoir these results could not be extrapolated to the entire Swiss fattening pig population. Since its foundation in 1965, the Swiss Pig Health Service (SGD) has aimed at the establishment of minimal disease herds. In particular the object has been to obtain herds free from enzootic pneumonia (EP) and actinobacillosis (APP). In 1992 about 40% of the growers were of SGD origin and therefore free from enzootic pneumonia and actinobacillosis in the beginning of the fattening period (SGD annual report, 1992; agricultural statistics of Switzerland, 1992) but there was no information on the disease prevalence in finishing pigs.

Therefore the aim of this investigation was to carry out a representative survey on fattening pigs to determine the type, extent and prevalence of lung lesions in randomly selected slaughtered swine. Particular interest was devoted to the evaluation of the extent of respiratory disease on the herd level.

Materials and methods

The sample size required to determine disease prevalence in a population depends on the expected prevalence of the disease, the confidence level desired and the size of the population (Cannon and Roe, 1982). If the prevalence of the disease is unknown, the required sample size should be based on an expected prevalence of 50%. We set the confidence level at 95%, the desired precision at 5% and having almost no information on the expected prevalence of diseased herds we set it at 50%. Hence the required sample size is 384 herds (Cannon and Roe, 1982). At slaughter we examined 14 animals per herd (= herd sample). This is sufficient to detect at least one diseased animal in a herd if the disease has a prevalence of 20% or more (Cannon and Roe, 1982).

The examinations were done in six large abattoirs (Bazenheid, Zurich, Berne, Basel, Courtepin, Lausanne) between May to September 1992. These were not randomly selected. The main criterion was a large number of slaughtered animals per day. Information on the origin of the herds and their size was ascertained in all cases.

The gross lesions were grouped as follows: none, bronchopneumonia, linear scars (indicating previous pneumonia), diffuse pleuritis, pleuropneumonia, focal pleural fibrosis (without visible lesion in the underlying tissue) and abscesses. The extent of pneumonic lesions was scored for every lung lobe. Score 0: none. Score 1: one or two small pneumonic areas. Score 2: less than half the lobe affected. Score 3: half to three quarters of the lobe affected. Score 4: more than three quarters affected. Every lung was given a total score (sum of the score-values of every lobe) which could be a maximum of 28 (Le Foll et al., 1985). Linear scars were scored in a similar way, but the score referred to the length of the scar not to its area. Diffuse pleuritis was graded as mild (mild adhesions between lung lobes), moderate (surface of several lobes affected) or severe (at least half of the lung surface affected).

A herd was graded as affected by a certain lesion if any lung of the herd sample showed this lesion. On the herd level the observed gross lesions were classified according to the most likely etiology. If any lung of a herd sample was affected by bronchopneumonia this was regarded as indicative of enzootic pneumonia. Pleuropneumonia in the caudal lobes was judged as APP.

Histological investigations were carried out on every herd to check the accuracy of the macroscopic diagnosis. At least two tissue samples per herd were taken, if possible each of a typical lesion in this herd. In the absence of macroscopic lesions tissue samples were collected from the right cardiac lobe, where pneumonic lesions are found frequently (Pointon and Sloane, 1984; Le Foll et al., 1985). The microscopic samples were evaluated without previous knowledge of the gross findings. Marked proliferation of all peribronchiolar lymphoreticular tissue in a lobule and varying changes according to the duration of the disease as described by Bertschinger et al. (1972) and Whittlestone (1972) were graded as indicative of enzootic pneumonia. Proliferation of lymphoreticular tissue not affecting all bronchi and bronchioli of a lobule was regarded as suspicious of enzootic pneumonia. The evaluation of lesions typical of APP was based on the descriptions given by Häni et al. (1973), Martin et al. (1977) and Sebunya and Saunders (1983). Conglomerates of spindle shaped, dark staining cells arranged into a swirling pattern (oat cells) were regarded as the main criteria if seen together with pleuropneumonia or well demarkated focal necrosis. Focal lesions without oat cells as well as severe focal pleural fibrosis with marked wedge shaped fibrotic tissue in the underlying tissue (= pleural scar) were graded as suspicious of APP. Häni et al. (1973) found this kind of lesion frequently in experimental and natural infections with *A. pleuropneumoniae*.

Results

A total of 8921 lungs from 561 herds were macroscopically examined. The origin of the herds was not fully representative for the regional distribution of herds in Switzerland. Herds from the canton Bern were underrepresented whereas herds from the cantons Thurgau, Freiburg and Luzern were overrepresented.

Swiss pig production is mainly an agricultural sideline. Herds comprising less than 50 animals are most common (79.0%) and were underrepresented in our material (11.8%) while herds comprising more than 100 animals (10.9%) were overrepresented (70.0%).

Prevalence of macroscopic lung lesions in individual animals

Gross lesions were found in 3896 (43.7%) lungs of the 8921 examined (Tab.1). The most frequent finding was bronchopneumonia (21.1%). About half of these were scored as mild (lung-score 1 to 5), a quarter moderate (score 6 to 10) and the 4th quarter severe (score > 10). Diffuse pleuritis was seen in 20.5% of the lungs. Approximately a fifth of these pleuritic lesions were scored as severe. All other lesions were clearly less prevalent.

Table 1: Prevalence of lung lesions in individual animals (multiple classification possible)

gross diagnosis	number of lungs	% (n = 8921)	95% confidence interval
no gross lesion	5025	56.3	55.3–57.3
bronchopneumonia	1885	21.1	20.3–20.9
linear scars	786	8.8	8.2– 9.4
diffuse pleuritis	1831	20.5	19.7–21.3
pleuropneumonia	83	0.9	0.7– 1.1
focal pleural fibrosis	200	2.2	1.9– 2.5
abscesses	112	1.3	1.1– 1.5

Prevalence of macroscopic lung lesions at the herd level

The prevalence of lesions at the herd level (Tab. 2) differed strongly from that in individual animals (Tab.1). The main finding at the herd level was diffuse pleuritis which was seen in 74.9% of the herd samples. The preva-

Table 2: Prevalence of lung lesions at the herd level (multiple classification possible)

gross diagnosis	number of herds	% (n = 561)	95% confidence interval
no gross lesion	76	13.5	10.7–16.3
bronchopneumonia	356	63.5	59.5–67.5
linear scars	333	59.4	55.3–63.5
diffuse pleuritis	420	74.9	71.3–78.5
pleuropneumonia	50	8.9	6.5–11.3
focal pleural fibrosis	113	20.1	16.8–23.4
abscesses	79	14.1	11.2–17.0

lence of pleuropneumonia, focal pleural fibrosis and abscesses ranged from 8.9% to 20.1%. In total any one of these focal lesions was seen in 32% of the herds.

There was a positive correlation between the prevalence of affected herds and the herd size (Fig.1). The chance of finding bronchopneumonia was significantly increased in herds of over 50 animals compared to those with less (χ^2 -test, $P \leq 0.05$). The prevalence of diffuse pleuritis at the herd level increased significantly in herds of over 100 animals (χ^2 -test, $P \leq 0.05$). The samples unaffected by gross lesions decreased from 30% in the smallest herds (< 50) to 2% in herds of over 500 animals. This decrease was significant in herds of over 100 animals (χ^2 -test, $P \leq 0.05$).

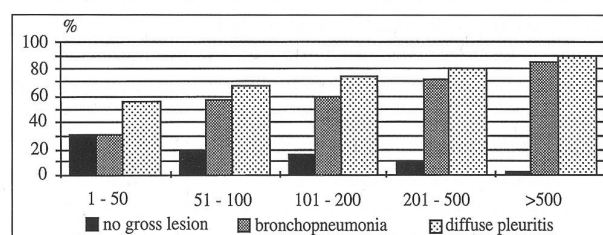


Figure 1: Prevalence of herds with no gross lesions, with bronchopneumonia and with diffuse pleuritis (grouped according to herd size)

Results of the histological investigations

Histological findings in herd samples with macroscopic bronchopneumonia: Tissue samples from 326 herds were examined of which 93.6% were typical of EP. Lesions not allowing EP to be ruled out were seen in 4.6% of the samples. We found no indication of enzootic pneumonia in 6 herds (1.8%), in 5 out of this tissue samples bronchopneumonia of probably other etiology was present.

Histological findings in herd samples without macroscopic bronchopneumonia: Histological investigations were carried out on lungs from 138 herds without macroscopic lesions. No histologically detectable lesions were present in 130 (94.3%) samples. We diagnosed EP in 2 (1.4%) and found lesions suspicious of EP in 6 (4.3%) samples.

Histological findings in herd samples with macroscopic linear scars: A total of 51 herd samples was affected by linear scars but no pneumonic lesions were evident. Tissue samples from 31 herds was examined of which 15 were typical of EP or allowed not to rule out EP.

Histological findings in herd samples with macroscopic focal lesions: Histological investigations were carried out in 104 herds (23 with macroscopically diagnosed pleuropneumonia, 61 with focal pleural fibrosis and 20 with abscesses). Tissue samples of 29 herds (27.9%) showed lesions indicative of APP (pleuropneumonia or focal necrosis with oat cells), predominantly observed in herd samples with macroscopically diag-

nosed pleuropneumonia. Lesions histologically not allowing APP to be ruled out were observed in 49 herd samples (47.1%) with pleural scars as the main finding (details see Tab. 3 to 5).

Table 3: Histological findings in herd samples with macroscopically diagnosed pleuropneumonia (n = 23)

histological finding	number of herds	%
acute pleuropneumonia with oat cells (typical of APP)	1	4.3
demarcated local necrosis with oat cells (typical of APP)	11	48.0
demarcated local necrosis without oat cells (APP not to be ruled out)	3	13.0
pleural scar (APP not to be ruled out)	5	21.7
other findings (not APP)	3	13.0

Table 4: Histological findings in herd samples with macroscopically diagnosed focal pleural fibrosis (n = 61)

histological finding	number of herds	%
acute pleuropneumonia with oat cells (typical of APP)	1	1.6
demarcated local necrosis with oat cells (typical of APP)	8	13.1
subacute pleuropneumonia without oat cells (APP not to be ruled out)	1	1.6
demarcated local necrosis without oat cells (APP not to be ruled out)	8	13.1
pleural scar (APP not to be ruled out)	24	39.4
other findings (not APP)	19	31.2

Table 5: Histological findings in herd samples with macroscopically diagnosed abscesses (n = 20)

histological finding	number of herds	%
demarcated local necrosis with oat cells (typical of APP)	8	40.0
demarcated local necrosis without oat cells (APP not to be ruled out)	6	30.0
pleural scar (APP not to be ruled out)	2	10.0
other findings (not APP)	4	20.0

Discussion

Surveying lung lesions of swine at slaughter is a valuable tool in assessing the frequency of respiratory disease in a pig population (Straw et al., 1986; Pointon et al., 1992) but the results must be interpreted with caution for they are only valid for a narrow segment of the pig population.

Although our sample size was defined using statistical criteria the sampling was not wholly applicable to the Swiss fattening pig population since it included a dispro-

portionate number of herds of over 50 animals. However, 80% of the fattening pig population is kept in herds with more than 50 animals. Hence, we regard our results to be accurate for this numerically predominant population of pigs.

A further problem in the comparison of prevalences reported in other surveys is the lack of standardized surveying techniques for sampling and recording lung lesions (Morrison et al., 1986). In contrast to our investigation where even very mild gross lesions were classified and recorded, others define the mildest lesions recorded as «moderate pneumonia» (affecting a minimum of 5 cm of the tip of a front lobe) and disregard any less significant changes (Flesjå and Ulvesæter, 1979). Yet other surveys restrict their findings to the prevalence of only one or two types of lung lesions. This implicates a lack of information which would allow a general comparison of the prevalence of lung affections.

Bronchopneumonia in the cranio-ventral lung lobes (21.1%) was the main macroscopic finding in individual animals. This lesion is described as typical of EP (Bertschinger et al., 1972; Whittlestone, 1972; Ross, 1992). But the prevalence of EP among individuals may be even higher. We observed linear scars, a lesion regarded as recovering stage of EP (Bertschinger et al., 1972; Feenstra et al., 1994) in 8.8% of the animals. Apart from Madec and Kobisch (1982), who observed 1.1% linear scars in slaughter pigs, there is – to our knowledge – no other information about the prevalence of this gross lesion.

Disease prevalence on the herd level is rarely reported (Brandreth and Smith, 1985; Mercy and Brennan, 1988; Elbers et al., 1992; Wunderli and Leuzinger, 1992). Surprisingly, the prevalence of disease on the herd level (86.5%) differed radically from that of the individual animals (43.7%). Wunderli and Leuzinger (1992) analysed the prevalence of disease both in individuals and on the herd level. They found that 89.9% of the herds and only 47.2% of the individuals were affected by lung lesions. Obviously the findings in individual animals do not reflect the disease frequency on the herd level.

In our material the most frequent specific lesion at the herd level was diffuse pleuritis (74.9%). Various bacteria have been considered as causative agents (Mousing et al., 1990; Nicolet, 1992; Pijoan, 1992; Pointon et al., 1992). Bronchopneumonia (63.5% at the herd level) is described as a typical sequel of EP (Bertschinger et al., 1972; Whittlestone, 1972; Ross, 1992). Of the (histologically examined) herd samples with bronchopneumonia we diagnosed 93.6% as EP. Of the herd samples without gross bronchopneumonia 94.3% were free from histologically detectable lesions, but the remainder had microscopic indications of EP or EP could not be ruled out. This indicates that bronchopneumonic lesions may heal and are no longer macroscopically detectable at slaughter. Some herd samples with linear scars (but without macroscopically detectable bronchopneumonia) were examined histologically. Such lesions are regarded as a recovering stage of EP (Bertschinger et al., 1972; Feenstra et al., 1994). Changes typical or indicative of EP were

present in half of our cases which supports the opinion that at least a considerable portion of linear scars are due to EP. In conclusion, recording bronchopneumonia at slaughter seems to be an appropriate tool to estimate the prevalence of EP and surveying linear scars give additional information on the actual prevalence of EP.

Focal lung lesions were observed in 32.3% of the herd samples, focal pleural fibrosis being the most prevalent macroscopic finding. However, the histological verification of the gross focal lesions (categorized macroscopically as pleuropneumonia, focal pleural fibrosis and abscess), revealed the diagnoses to be inconsistent - usually a combination of features was present. The precise differentiation of macroscopic focal lesions is difficult, mainly due to the limited time for examination (slaughter line). Histological examinations revealed changes typical of APP in 27.9% of the herd samples with (macroscopic) focal lesions. Histological changes either typical, questionable or without indication of APP were observed in every type of (macroscopic) focal lesion. There was no clear correlation between any one gross lesion type and histological indications of APP.

We found an increased level of lung lesions in larger herds which is consistent with the results reported by Bäckström and Bremer (1976), Straw et al. (1986) and Christensen and Cullinane (1990). This might reflect possible negative environmental factors in large herds that may favour respiratory diseases such as available space, ventilation and risk of infection.

In conclusion this survey shows that respiratory diseases are very common in pigs at slaughter in Switzerland even though about 40% are of SPF origin. The high prevalence of bronchopneumonia (63.5%) and diffuse pleuritis (74.9%) at the herd level is noteworthy. It may be assumed that examining younger pigs would yield higher rates of lung lesions since many may have healed by the age the animals are slaughtered (Noyes et al., 1990). Additionally, it must be borne in mind that our survey was based on a herd sample of 14 animals. We missed herds with a lower disease rate since they were included only if lung lesions were present at a prevalence of 20% or more. Our figures on the prevalence of lung lesions at the herd level are assumed to be a minimal value and the rate of disease in fattening pigs in Switzerland is likely to be higher.

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Studio sulla prevalenza delle lesioni polmonari nei suini macellati in Svizzera

Nel periodo compreso tra Maggio e Settembre 1992, presso 6 stabilimenti di macellazione svizzeri, è stato condotto uno studio sulla prevalenza delle lesioni polmonari in un campione casuale di suini regolarmente macellati e rappresentativi della popolazione svizzera di suini all'ingrasso. Per ragioni statistiche è stato stabilito che la dimensione minima del campione fosse di 384 allevamenti. Per ogni allevamento sono stati esaminati 14 animali in sede di macellazione: in questo modo è possibile repertare almeno un animale affetto per allevamento quando la malattia è presente con una prevalenza del 20%. Un dato allevamento veniva considerato colpito da un determinato tipo di lesione quando almeno uno dei soggetti campionati per quell'allevamento risultava affetto. In totale sono stati esaminati 8921 polmoni provenienti da 561 allevamenti. Campioni di tessuto destinati all'esame istologico sono stati prelevati per ogni allevamento. Il 56% dei suini esaminati non presentava lesioni macroscopiche. Con maggior frequenza, a livello individuale, sono state osservate broncopolmonite (21%) e pleurite diffusa (20%); mentre sono risultate a prevalenza inferiore: depressioni cicatriziali arborizzate a carico dei lobi craniali (9%), fibrosi focale della pleura senza lesioni del parenchima polmonare sottostante (2%), pleuropolmonite (1%) ed ascessi (1%). La frequenza delle lesioni a livello di allevamento è risultata completamente differente: solo il 14% degli allevamenti non era colpito da lesioni a carico dei polmoni. Il principale reperto, a livello di allevamento, è risultata la pleurite diffusa (75%), seguita dalla broncopolmonite (64%), lesioni cicatriziali (60%), fibrosi pleurica focale (20%), ascessi (14%) e pleuropolmonite (9%). Nel 94% dei campioni provenienti da allevamenti con diagnosi macroscopica di broncopolmonite, il quadro istologico risultava compatibile con la diagnosi di polmonite enzootica del suino.

Prévalence des lésions pulmonaires chez les porcs charcutiers en Suisse

Une étude réalisée dans 6 grands abattoirs de Suisse, durant la période de mai à septembre 1992, a permis de déterminer la prévalence de lésions pulmonaires chez des porcs d'engraissement au niveau de l'individu et au niveau des exploitations. Pour des raisons statistiques la grandeur de l'échantillon a été fixée à un minimum de 384 exploitations porcines. Quatorze poumons ont été analysés par exploitation. Ce nombre est suffisant pour que dans une exploitation où la prévalence de maladie pulmonaire est de 20%, au moins un poumon malade puisse être mis en évidence avec 95% de certitude. La mise en évidence d'une lésion pulmonaire, même dans un seul poumon, était suffisante pour classer l'exploitation correspondante comme étant atteinte par cette lésion. Des analyses histologiques ont été effectuées dans chaque exploitation. Au total 8921 poumons en provenance de 561 exploitations ont été analysés. Chez 56% des porcs aucune lésion macroscopique n'a été observée. Les lésions les plus fréquentes ont été les bronchopneumonies (21%) et les pleurésies généralisées (21%). Les sillons cicatriciels (9%), les pleurésies localisées (2%), les pleuropneumonies (1%) et les abcès (1%) ont été rarement mis en évidence. Au niveau des exploitations les pourcentages des lésions pulmonaires mises en évidence étaient plus élevés pour les pleurésies généralisées (75%), suivies des bronchopneumonies (64%), des sillons cicatriciels (60%), des pleurésies localisées (20%), des abcès (14%) et des pleuropneumonies (9%). Seulement 14% des exploitations n'ont présenté aucune lésion pulmonaire. Dans 94% des cas, les échantillons diagnostiqués macroscopiquement comme atteints de bronchopneumonie, ont montré à l'examen microscopique des lésions correspondant au diagnostic de la pneumonie enzootique des porcs.

Acknowledgments

This study was financially supported by the Swiss Federal Veterinary Office.

For assisting in the collection of data in the abattoirs we thank Dr. M. Amgarten (Micarna AG in Bazenhaid), Dr. P. Francfort (Abattoir Lausanne), Dr. F. Inderbitzin (Abat-

toir Bern), Dr. M. König (Micarna AG in Courtepin), Dr. P.W. Lauper (Abattoir Zürich) and Dr. R. Weiss (Abattoir Basel). Particular thanks also to Ms. R. Weilenmann and her colleagues in the Department for Veterinary Pathology, University of Zürich, for preparing the excellent histological sections.

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Manuskripteingang: 2. April 1997