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# Pathological classification of naturally occurring pneumonia in cattle (*Bos indicus*) and buffaloes (*Bubalus bubalis*) in Mathura district of Uttar Pradesh

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ABSTRACT

Respiratory disease complex (RDC), commonly referred to as pneumonia, is a major cause of mortality in large ruminants. The present study was conducted to investigate the occurrence and pathological classification of pneumonia in fallen cattle and buffaloes. A total of 174 fallen bovines (86 cattle and 88 buffaloes) were examined at the Integrated Livestock Farm Complex and Teaching Veterinary Clinical Complex, DUVASU, Mathura out of which 120 cases with respiratory history or pulmonary lesions were subjected to histopathological examination. Mortality was predominantly higher in young animals and females, with seasonal variation. Histopathological evaluation revealed bronchopneumonia as the most common lesion (43.33%, 52/120), comprising of suppurative (33.33%) and fibrinous (10.00%) forms, followed by interstitial pneumonia (34.16%, 41/120). Verminous pneumonia (9.17%), granulomatous pneumonia (0.84%) and miscellaneous pulmonary conditions including emphysema, atelectasis, pulmonary oedema, congestion and haemorrhage (12.50%) were also recorded. The findings indicated that bronchopneumonia and interstitial pneumonia constituted the major pathological forms of RDC in bovines and underlined the importance of effective management and disease control strategies to reduce respiratory-related mortality.

**Keywords**: Bovines, Bronchopneumonia, Histopathology, Interstitial pneumonia

Livestock rearing plays a vital role in the rural economy of India by providing income, employment and nutritional security to farming and landless households. The livestock sector contributes substantially to the national economy and has emerged as a stable pillar of agricultural growth, accounting for nearly one-third of the agricultural Gross Value. India is the largest milk-producing country in the world, with cattle and buffaloes forming the backbone of dairy production, particularly in states such as Uttar Pradesh. Health disorders affecting these species, especially respiratory diseases, significantly compromise productivity and lead to major economic losses due to reduced performance, increased treatment costs and mortality (DAHD 2025).

Respiratory disease complex (RDC), commonly referred to as pneumonia, is a multifactorial syndrome characterized by inflammatory and degenerative changes in upper and lower respiratory tract, regional lymph nodes and pulmonary parenchyma. In bovines, pneumonia is one of the leading causes of morbidity and mortality, particularly in young animals, and is regarded as one of the most economically important diseases affecting ruminant production systems (Abutarbush *et al.* 2012). The disease manifests in diverse pathological forms depending on the nature of inflammatory exudate, tissue response and anatomical distribution of lesions. Environmental stressors, management practices and host-related factors further influence the severity and pattern of pulmonary lesions (Nickell and White 2010).

Despite the high prevalence and economic significance of respiratory diseases in bovines, systematic pathological investigations focusing on the classification of naturally occurring pneumonia under field conditions are limited in India. Most available reports emphasize clinical or etiological aspects, while comprehensive gross and histopathological characterization of pneumonic lesions in cattle and buffaloes remains inadequate. Region-specific data on the relative occurrence of different pathological types of pneumonia are particularly scarce from major livestock-rearing areas such as Uttar Pradesh.

Therefore, the present study was undertaken to investigate the pathology of naturally occurring respiratory diseases in cattle and buffaloes through detailed gross and histopathological examination, with the objective of diagnosing and classifying different forms of pneumonia and associated pulmonary lesions in bovines from the Mathura region of Uttar Pradesh.

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## MATERIALS AND METHODS

The present investigation was carried out in Department of Veterinary Pathology, Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan (DUVASU), Mathura, Uttar Pradesh, during September 2024 to November 2025. A total of 174 fallen bovines comprising cattle (n = 86) and buffaloes (n = 88), received for routine necropsy at the Instructional Livestock Farm Complex (ILFC) and Teaching Veterinary Clinical Complex (TVCC), DUVASU, were included in the study (Table 1). All animals had a documented ante-mortem history of respiratory distress and/or revealed gross pulmonary lesions suggestive of pneumonia during post-mortem examination.

*Ethical approval*: The study was conducted on fallen animals presented for necropsy at the Instructional Livestock Farm Complex and Teaching Veterinary Clinical Complex, DUVASU, Mathura. No live animal experimentation was involved; therefore, separate ethical approval was not required. Standard institutional biosafety and ethical guidelines were followed.

A complete and systematic necropsy was performed as per standard procedures, with detailed examination of the upper and lower respiratory tract including trachea, bronchi, bronchioles, lung lobes and associated lymph nodes. Representative tissue samples from affected lung lobes and related lymph nodes were collected. Out of 174 necropsied animals, 120 cases exhibiting gross respiratory lesions were subjected to detailed histopathological examination.

Tissue samples were fixed in 10% neutral buffered formalin, processed routinely by paraffin embedding, sectioned at 4–5 µm thickness and stained with hematoxylin and eosin. Special stains such as Masson's trichrome were employed wherever required. Microscopic examination was carried out to evaluate pulmonary architecture, nature and distribution of inflammatory infiltrates, type of exudate and associated tissue response.

Based on gross and histopathological features, pneumonia was classified according to the nature of inflammatory exudate and morphological characteristics into bronchopneumonia, interstitial pneumonia, verminous pneumonia, granulomatous pneumonia and miscellaneous pulmonary conditions. Classification was primarily based on lesion distribution, involvement of airways and alveoli, cellular composition of the exudate and associated structural alterations in the lung parenchyma.

Table 1. Details of sample collected

| Place | Species | No of samples | Sample Type |
|---|---|---|---|
| ILFC, DUVASU, Mathura | Cattle | 56 | Lungs |
| | Buffalo | 22 | Lungs |
| TVCC DUVASU, Mathura | Cattle | 30 | Lungs |
| | Buffalo | 66 | Lungs |
| Total | | 174 | |

The study involved post-mortem examination of fallen animals presented for routine necropsy. No experimental animals were used, and no live animal handling or invasive procedures were performed for the purpose of this study. The investigation was conducted in accordance with the guidelines of the Institutional Animal Ethics Committee and relevant regulations of Pandit Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan (DUVASU), Mathura.

## RESULTS AND DISCUSSION

A total of 174 lung samples from fallen large ruminants were examined in the present study, of which 120 animals showed gross and/or histopathological lesions consistent with pneumonia and were included for detailed evaluation.

Age-wise analysis revealed that mortality was highest in calves aged 0–3 months in both cattle (51.16%) and buffaloes (50.00%), followed by animals in the 3–12 months age group, while animals above 12 months showed the lowest mortality (Table 2). The higher mortality in calves may be attributed to an immature immune system and increased susceptibility to infections, as also reported by Sindhoora (2019) and Roopa (2020). However, variations in age-wise mortality have been documented by Kumar (2022), indicating the influence of management and environmental factors.

Sex-wise mortality was higher in females than males in both cattle (72.09% vs. 27.90%) and buffaloes (85.22% vs. 14.77%). In cattle, this observation differed from earlier reports, whereas in buffaloes, it was in agreement with Kumar (2022) and Roopa (2020). The increased mortality among females might be due to physiological stress associated with pregnancy and lactation, higher metabolic demands and increased susceptibility to diseases during the productive phase (Table 3).

Season-wise distribution showed that the mortality in cattle was highest during winter (38.37%), followed by summer, post-monsoon and monsoon seasons, which may be related to cold stress, poor ventilation and increased incidence of respiratory infections. In buffaloes, mortality was highest during summer (44.31%), followed by post-monsoon, winter and monsoon seasons, possibly due to

Table 2. Age wise mortality pattern in fallen animals

| Species | Cattle | | | Buffalo | | |
|---|---|---|---|---|---|---|
| Age (months) | 0-3 | 3-12 | >12 | 0-3 | 3-12 | >12 |
| Mortality ratio | 44/86 | 28/86 | 14/86 | 44/88 | 43/88 | 1/88 |
| % Mortality | 51.16 | 32.55 | 16.27 | 50 | 48.86 | 1.13 |

Table 3. Sex wise mortality pattern in fallen animals

| Species | Cattle | | Buffalo | |
|---|---|---|---|---|
| | M | F | M | F |
| Mortality ratio | 24/86 | 62/86 | 13/88 | 75/88 |
| % Mortality | 27.9 | 72.09 | 14.77 | 85.22 |

Table 4. Season wise mortality pattern in fallen animals

| Species | Monsoon Total% | Post-monsoon Total% | Winter Total% | Summer Total% |
|---|---|---|---|---|
| Cattle | 11.62 | 19.76 | 38.37 | 30.23 |
| Buffalo | 15.9 | 21.59 | 18.18 | 44.31 |

heat stress, reduced feed intake and compromised immunity (Table 4).

*Classification of pneumonia*: Histopathological examination of 120 pneumonic lung samples revealed bronchopneumonia as the most predominant lesion (43.33%; 52/120), comprising suppurative bronchopneumonia (33.33%; 40/120) and fibrinous bronchopneumonia (10.00%; 12/120). Interstitial pneumonia accounted for 34.16% (41/120) of the cases, followed by verminous pneumonia (9.17%; 11/120) and granulomatous pneumonia (0.84%; 1/120). Miscellaneous pulmonary conditions including emphysema, atelectasis, pulmonary oedema, congestion and haemorrhage constituted 12.50% (15/120) of the cases (Fig.1 -6).

Bronchopneumonia was characterized grossly by cranioventral consolidation of lung lobes and histologically by inflammatory exudate within bronchi, bronchioles and alveoli. The incidence observed in the present study was higher than that reported by Babu *et al.* (2025), Kumar (2022), Sindhoora (2019) and Bisht (2021), but lower than that reported by Ramachandran and Sharma (1969) and Kumar *et al.* (2014), with comparable reports by Kumar *et al.* (2005) and Singh *et al.* (2017). The higher occurrence of bronchopneumonia may be attributed to bacterial and



Fig. 1A

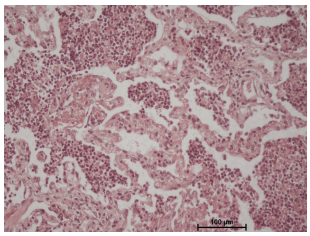


Fig. 1B

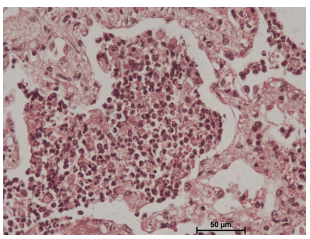


Fig. 1C

Fig. 1. Suppurative bronchopneumonia. (A) Gross lung showing patchy areas of consolidation involving cranial lobes. (B) Lung section showing alveolar spaces filled with inflammatory cells (arrows) and a meshwork of fibrin strands (asterisk). H&E ×200. (C) Alveoli filled predominantly with neutrophilic infiltrate. H&E ×400.

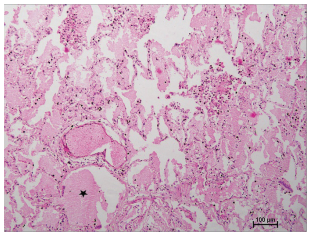


Fig. 2A

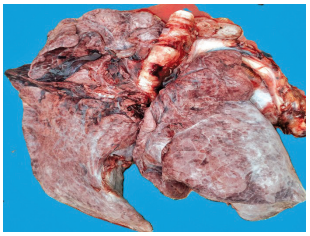


Fig. 2B

Fig. 2. Fibrinous bronchopneumonia. (A) Lung showing enlargement with pale to pinkish-red colour along with areas of congestion and consolidation. (B) Lung section showing alveoli filled with abundant eosinophilic fibrillary material consistent with fibrin deposition (asterisk). H&E ×100.

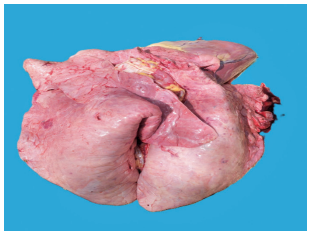


Fig. 3A

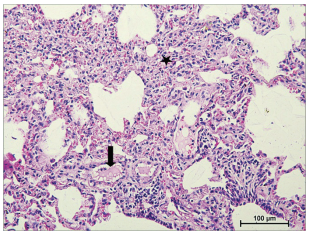


Fig. 3B

Fig. 3. Interstitial pneumonia. (A) Gross appearance of non-collapsible lungs with rubbery consistency. (B) Lung section showing thickened interlobular septa due to inflammatory cell infiltration (asterisk) with mild interstitial oedema (arrows). H&E ×200.

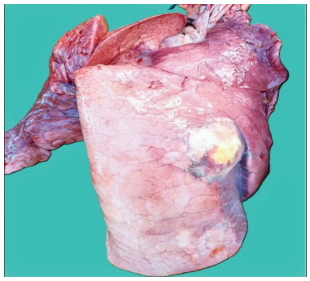


Fig. 4A

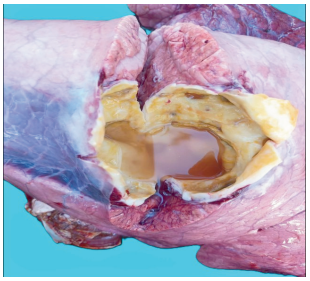


Fig. 4B

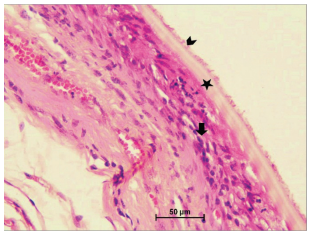


Fig. 4C

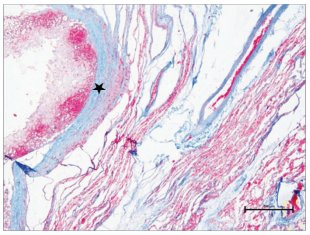


Fig. 4D

Fig. 4. Verminous pneumonia (pulmonary hydatidosis). (A) Lung showing enlargement and pale pink colour with a prominent, well-circumscribed spherical cystic swelling on the right diaphragmatic lobe. (B) Cut section revealing a large, well-defined cystic cavity containing clear to slightly turbid straw-coloured fluid. (C) Lung section showing distinct acellular laminated layer (asterisk) with marked host inflammatory response (arrow) surrounding a less distinct germinal layer (arrowhead). H&E ×200. (D) Cyst showing host fibrous capsule (asterisk) adjacent to the parasitic acellular laminated layer. Masson's trichrome ×200.

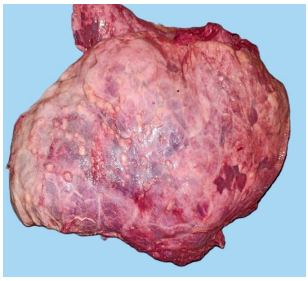


Fig. 5A

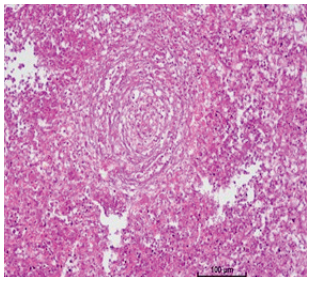


Fig. 5B

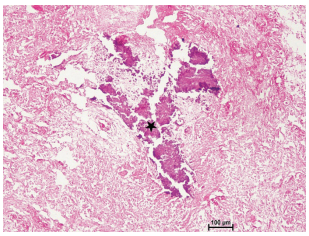


Fig. 5C

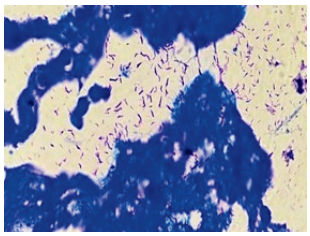


Fig. 5D

Fig. 5. Granulomatous pneumonia. (A) Lung showing enlargement with firm consistency and multiple pale to yellowish nodular lesions interspersed with congested areas. (B) Lung section showing a well-organized non-caseating granuloma. H&E ×200. (C) Granulomatous lesion with centrally located dark calcified area (asterisk) surrounded by a fibrocellular capsule. H&E ×100. (D) Lung impression smear showing slender acid-fast bacilli. Ziehl–Neelsen stain ×1000.

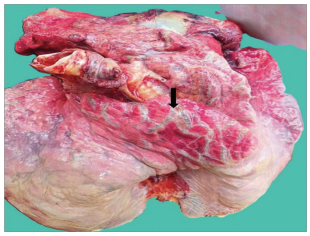


Fig. 6A

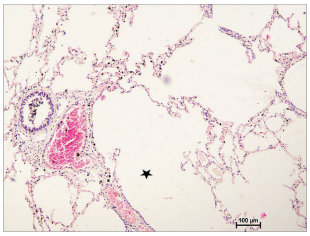


Fig. 6B

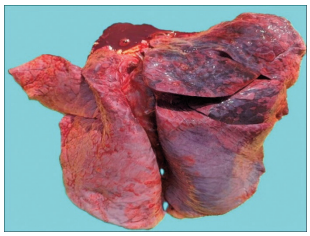


Fig. 6C

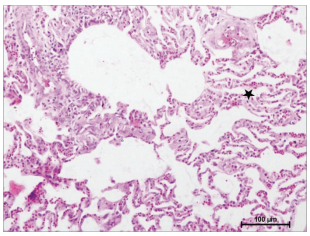


Fig. 6D

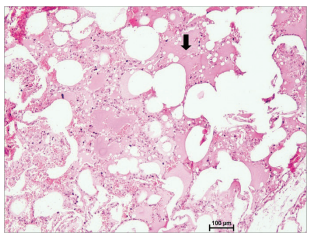


Fig. 6E

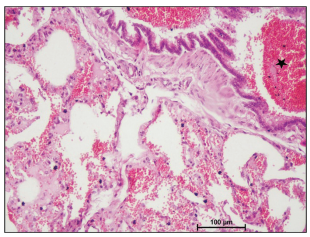


Fig. 6F

Fig. 6. Miscellaneous pulmonary conditions. (A) Gross lung showing interlobular emphysema (arrow). (B) Lung section showing marked emphysema (asterisk) with dilatation and rupture of alveolar spaces and vascular congestion. H and E ×100. (C) Lung showing dark red multifocal areas of atelectasis (arrow) involving cranial and middle lobes. (D) Lung section showing collapsed alveoli with closely apposed walls (asterisk) and reduced air spaces. H and E ×100. (E) Lung section showing alveoli and interlobular septa filled with homogeneous eosinophilic oedematous fluid (arrow). H and E ×100. (F) Lung parenchyma showing haemorrhagic foci with extensive extravasation of erythrocytes into bronchiolar lumina (asterisk). H and E ×200.

mycoplasmal infections affecting the lower respiratory tract.

Suppurative bronchopneumonia was characterized by patchy consolidation of cranial lung lobes with alveolar spaces filled with neutrophilic exudate and necrotic debris. The incidence was markedly higher than that reported by Kumar (2022), Bisht (2021), Roopa (2020), Sindhoora (2019) and others, and was predominantly associated with *Pasteurella multocida*–positive cases. Fibrinous bronchopneumonia was characterized by heavy, firm lungs with fibrin-filled alveoli. The incidence was higher than most earlier reports but lower than that reported by Choudhary *et al.* (2024), possibly reflecting differences in pathogen prevalence and disease severity.

Interstitial pneumonia showed non-collapsible lungs with thickened interlobular septa due to inflammatory cell infiltration and mild interstitial oedema. The incidence observed was comparable with earlier reports by Kumar (2022), Roopa (2020), Sindhoora (2019) and others, suggesting its frequent association with viral and toxic insults to the lung parenchyma. Granulomatous pneumonia was recorded in a single case (0.84%) and was characterized by well-organized non-caseating granulomas with central calcification and demonstration of acid-fast bacilli on Ziehl–Neelsen staining. The lower incidence compared to earlier reports indicates regional variation in disease occurrence.

Verminous pneumonia was observed in 9.17% of the cases, predominantly affecting the caudo-dorsal lung lobes, with lesions consistent with parasitic migration and lungworm infection, as described by Ballweber (2024) and Pancier and Confer (2010).

Miscellaneous pulmonary lesions included congestion and/or haemorrhage (5.00%), emphysema with atelectasis (4.16%) and pulmonary oedema (3.33%), with incidences largely comparable to previous studies, reflecting terminal circulatory disturbances and secondary pulmonary changes.

The study concluded that, mortality was higher in females and in younger animals (0–3 months) in both cattle and buffaloes, with markedly lower mortality in animals above one year. Seasonal variation was evident, with peak mortality during winter in cattle and summer in buffaloes. Among pulmonary lesions, bronchopneumonia was the most prevalent (43.33%), followed by interstitial pneumonia (34.16%), indicating these as the predominant causes of pneumonic mortality in large ruminants.

REFERENCES

Abutarbush S M, Schunicht O C, Wildman B K, Hannon S J, Jim G K, Ward T I and Booker C W. 2012. Comparison of enrofloxacin and ceftiofur sodium for the treatment of relapse of undifferentiated fever/bovine respiratory disease in feedlot cattle. *The Canadian Veterinary Journal* **53**: 57–62.

Babu S, Kumar SV, Singh CP, Singh V, Kumar P, Singh R and Pawaiya R V S. 2025. Occurrence of pneumonia based on histopathology in domestic ruminants – a seasonal record. *Indian Journal of Veterinary Pathology*. https://doi:10.5958/9jdf6y53.

Ballweber L R. 2024. Lungworm infection (verminous bronchitis/pneumonia) in animals. *Merck Veterinary Manual*. Merck and Co., Inc., Kenilworth, NJ, USA.

Bisht A. 2021. Studies on pathology of respiratory diseases in bovine calves with reference to bacterial and viral infections. PhD thesis submitted to Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Himachal Pradesh, India.

Choudhary M, Choudhary B K, Ghosh R C, Bhoyar S, Chaudhari S and Barbuddhe S B. 2019. Cultivable microbiota and pulmonary lesions in polymicrobial bovine pneumonia. *Microbial Pathogenesis*. https://doi:10.1016/j.micpath.2019.103577.

Department of Animal Husbandry and Dairying (DAHD). 2025. *Annual Report 2024–25*. Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, New Delhi.

Kumar D, Erdman D, Keshavjee S, Peret T, Tellier R, Hadjiliadis D, Johnson G, Ayers M, Siegal D and Humar A. 2005. Clinical impact of community-acquired respiratory viruses on bronchiolitis obliterans after lung transplant. *American Journal of Transplantation* **5**: 2031–2036.

Kumar V. 2022. Study of the pathology of bovine respiratory disease complex with special reference to BPI3V and BRSV. MVSc thesis submitted to Deemed University, Indian Veterinary Research Institute, Izatnagar, India.

Nickell J S and White B J. 2010. Metaphylactic antimicrobial therapy for bovine respiratory disease in stocker and feedlot cattle. *Veterinary Clinics of North America: Food Animal Practice* **26**: 285–301.

Panciera R J and Confer A W. 2010. Pathogenesis and pathology of bovine pneumonia. *Veterinary Clinics of North America: Food Animal Practice* **26**: 191–214.

Roopa N. 2020. Etiopathology of respiratory disease complex in ruminants and molecular characterization of important pathogens. MVSc thesis submitted to Deemed University, Indian Veterinary Research Institute, Izatnagar, India.

Sindhoora K. 2019. Etiopathology of pneumonia in ruminants and molecular characterization of BPI3/BRSV. MVSc thesis submitted to Deemed University, Indian Veterinary Research Institute, Izatnagar, India.