

Edited by
Dominiek Maes, Marina Sibila & Maria Pieters

Mycoplasmas in swine

Contents

| | |
|--|----|
| CONTRIBUTORS | 13 |
| Prologue | 19 |
| Abbreviations | 22 |
| CHAPTER 1 | 23 |
| Overview of the general characteristics and classification of porcine <i>Mycoplasma</i> species | 25 |
| 1.1 Introduction | 26 |
| 1.1.1 Characteristics of <i>Mollicutes</i> and mycoplasmas | 26 |
| 1.1.2 Phylogenetic relationships of mycoplasmas | 26 |
| 1.1.3 Pathogenicity in mycoplasmas | 30 |
| 1.2 The mycoplasmas of the pig | 32 |
| 1.3 Phylogenetic relationship between porcine mycoplasmas | 33 |
| 1.4 <i>Mycoplasma hyopneumoniae</i> | 34 |
| 1.4.1 Cultivation of <i>Mycoplasma hyopneumoniae</i> | 34 |
| 1.4.2 The discovery of <i>Mycoplasma hyopneumoniae</i> | 36 |
| 1.4.3 What is the evidence that <i>Mycoplasma hyopneumoniae</i> is responsible for EP? | 37 |
| 1.5 <i>Mycoplasma flocculare</i> | 39 |
| 1.6 <i>Mycoplasma hyopharyngis</i> | 41 |
| 1.7 <i>Mycoplasma hyosynoviae</i> | 42 |
| 1.8 <i>Mycoplasma hyorhinis</i> | 43 |
| 1.8.1 What is the evidence that <i>Mycoplasma hyorhinis</i> can also act as the causative agent of EP? | 43 |
| 1.9 <i>Mycoplasma suis</i> | 46 |
| CHAPTER 2 | 47 |
| Diversity of <i>Mycoplasma hyopneumoniae</i> strains | 47 |
| 2.1 Introduction | 48 |
| 2.2 Genomic diversity | 49 |
| 2.2.1 <i>Mycoplasma hyopneumoniae</i> WGS comparisons | 49 |
| 2.2.2 Genetic diversity in <i>Mycoplasma hyopneumoniae</i> field isolates | 56 |
| 2.3 Virulence variation | 62 |
| 2.4 Antigenic variation | 63 |
| 2.4.1 Size variation through VNTRs | 64 |
| 2.4.2 Size variation through proteolytic processing | 65 |
| 2.5 Diversity in <i>Mycoplasma hyopneumoniae</i> proteomes | 69 |
| 2.6 Concluding remarks | 71 |
| CHAPTER 3 | 73 |
| <i>Mycoplasma hyopneumoniae</i> pathogenicity: the known and the unknown | 73 |
| 3.1 Introduction | 74 |
| 3.2 Sequence of pathogenesis | 75 |
| 3.3 Adhesion | 76 |
| 3.4 Candidate virulence factors | 80 |
| 3.5 Immune modulation and <i>Mycoplasma</i> host interaction | 84 |
| 3.6 Pathogenicity model | 86 |
| CHAPTER 4 | 87 |
| Epidemiology of <i>Mycoplasma hyopneumoniae</i> infections | 87 |
| 4.1 Introduction | 88 |
| 4.2 Prevalence | 88 |
| 4.3 Infection dynamics | 89 |
| 4.4 Transmission | 91 |
| 4.5 Risk factors for <i>Mycoplasma hyopneumoniae</i> infection | 94 |
| 4.6 Molecular epidemiology | 96 |

| | |
|--|-----|
| CHAPTER 5 | 97 |
| <i>Mycoplasma hyopneumoniae</i> clinical signs and gross lung lesions, including monitoring | 97 |
| 5.1 Introduction | 98 |
| 5.2 Clinical signs | 99 |
| 5.2.1 Negative farms (farms with all animals seronegative against <i>Mycoplasma hyopneumoniae</i>) | 100 |
| 5.2.2 Epizootically affected farms | 100 |
| 5.2.3 Enzootically affected farms | 101 |
| 5.3 Gross lung lesions | 102 |
| 5.4 Clinical-pathological monitoring | 105 |
| CHAPTER 6 | 109 |
| Immune responses against porcine <i>Mycoplasma</i> infections | 109 |
| 6.1 Introduction | 110 |
| 6.2 Innate immune responses | 111 |
| 6.2.1 Overview of innate immune responses | 111 |
| 6.2.2 Inflammatory responses after infection of pigs with <i>Mycoplasma hyopneumoniae</i> | 112 |
| 6.2.3 Sensing of <i>Mycoplasma</i> by the innate immune system | 113 |
| 6.2.4 Contribution of myeloid cells | 114 |
| 6.2.5 Complement and other opsonins | 116 |
| 6.2.6 Antimicrobial peptides | 116 |
| 6.3 Antibody response against <i>Mycoplasma hyopneumoniae</i> | 117 |
| 6.3.1 General considerations of antibody responses against <i>Mycoplasma</i> | 117 |
| 6.3.2 Kinetics of antibody responses after <i>Mycoplasma hyopneumoniae</i> infection | 117 |
| 6.3.3 Role of antibodies in protection against <i>Mycoplasma</i> | 119 |
| 6.3.4 Maternally-derived antibodies | 120 |
| 6.3.5 Mucosal antibody responses | 120 |
| 6.4 T-cell mediated immune responses against <i>Mycoplasma</i> | 121 |
| 6.4.1 General considerations of T-cell responses against <i>Mycoplasma</i> | 121 |
| 6.4.2 Role of T cells in protective immunity against <i>Mycoplasma</i> infections | 123 |
| 6.4.3 Role of different types of T-cell responses | 123 |
| 6.5 Conclusions | 125 |
| CHAPTER 7 | 127 |
| Interactions of <i>Mycoplasma hyopneumoniae</i> with other pathogens and economic impact | 127 |
| 7.1 Introduction | 128 |
| 7.2 Impact of <i>Mycoplasma hyopneumoniae</i> interactions with other pathogens on production and economic performance | 129 |
| 7.3 Interactions of <i>Mycoplasma hyopneumoniae</i> with bacteria involved in lung diseases | 130 |
| 7.3.1 Interaction with <i>Actinobacillus pleuropneumoniae</i> | 130 |
| 7.3.2 Interaction with <i>Bordetella bronchiseptica</i> | 132 |
| 7.3.3 Interaction with <i>Pasteurella multocida</i> | 132 |
| 7.3.4 Interaction with other <i>Mycoplasma</i> species | 134 |
| 7.3.5 Interaction with other bacterial species | 135 |
| 7.4 Interactions of <i>Mycoplasma hyopneumoniae</i> with viruses involved in lung diseases | 137 |
| 7.4.1 Interaction with PRRSV | 137 |
| 7.4.2 Interaction with PCV-2 | 139 |
| 7.4.3 Interaction with swine influenza A viruses | 140 |
| 7.4.4 Interaction with other viruses | 142 |
| 7.5 Interactions of <i>Mycoplasma hyopneumoniae</i> with parasitic infections and mycotoxins | 144 |
| 7.6 Conclusions | 144 |
| CHAPTER 8 | 147 |
| Diagnosis of <i>Mycoplasma hyopneumoniae</i> infection and associated diseases | 147 |
| 8.1 Introduction | 148 |
| 8.2 Clinical-pathological diagnosis | 148 |
| 8.2.1 Differential diagnosis | 150 |

| | | |
|---|---|-----|
| 8.3 | Detection of the pathogen | 151 |
| 8.3.1 | Isolation and culturing | 151 |
| 8.3.2 | Detection and localization of <i>Mycoplasma hyopneumoniae</i> in tissues | 152 |
| 8.3.3 | Detection of the pathogen by PCR | 154 |
| 8.4 | Detection of antibodies against <i>Mycoplasma hyopneumoniae</i> infection | 157 |
| 8.5 | Selecting an adequate sample size | 160 |
| 8.6 | Conclusions | 160 |
| CHAPTER 9 | | 163 |
| General control measures against <i>Mycoplasma hyopneumoniae</i> infections | | 163 |
| 9.1 | Introduction | 164 |
| 9.2 | Production systems | 166 |
| 9.2.1 | Herd size | 166 |
| 9.2.2 | Piglet source | 167 |
| 9.2.3 | Pig flow and batching | 167 |
| 9.2.4 | Parity one vs. multiparous sows | 168 |
| 9.3 | Gilt acclimation | 169 |
| 9.4 | Management | 172 |
| 9.4.1 | Pre-weaning management | 172 |
| 9.4.2 | All-in/all-out | 173 |
| 9.4.3 | Stocking density | 174 |
| 9.4.4 | Stocking rates | 175 |
| 9.4.5 | Group size | 176 |
| 9.4.6 | Other diseases management | 176 |
| 9.5 | Climate and housing conditions | 177 |
| 9.5.1 | Seasonality | 177 |
| 9.5.2 | Thermal sensation (temperature, air speed and humidity) | 177 |
| 9.5.3 | Air contaminants | 178 |
| 9.5.4 | Improving air quality | 180 |
| CHAPTER 10 | | 181 |
| Antimicrobial treatment of <i>Mycoplasma hyopneumoniae</i> infections | | 181 |
| 10.1 | Introduction | 182 |
| 10.2 | Antimicrobial treatments | 183 |
| 10.2.1 | Antimicrobials | 183 |
| 10.2.2 | Administration routes of antimicrobials for treatment of respiratory diseases in pigs | 187 |
| 10.2.3 | Efficacy of several antimicrobials against <i>Mycoplasma hyopneumoniae</i> infections under experimental and field conditions | 189 |
| 10.3 | <i>In vitro</i> determination of antimicrobial activity against <i>Mycoplasma hyopneumoniae</i> | 197 |
| 10.3.1 | Minimal inhibitory concentration (MIC) determination | 197 |
| 10.3.2 | Minimal bactericidal concentration (MBC) determination | 199 |
| 10.4 | <i>In vitro</i> activities of antibiotics against <i>Mycoplasma hyopneumoniae</i> | 200 |
| 10.5 | <i>Mycoplasma hyopneumoniae</i> resistance to antimicrobials | 202 |
| 10.5.1 | Resistance to macrolides | 203 |
| 10.5.2 | Resistance to fluoroquinolones | 204 |
| 10.5.3 | Resistance to other antimicrobials | 205 |
| 10.6 | Conclusions | 205 |
| CHAPTER 11 | | 207 |
| Vaccines and vaccination against <i>Mycoplasma hyopneumoniae</i> | | 207 |
| 11.1 | Introduction | 208 |
| 11.2 | Commercial vaccines against <i>Mycoplasma hyopneumoniae</i> | 209 |
| 11.3 | Mechanisms of protection | 212 |
| 11.4 | Effects of vaccination | 214 |
| 11.5 | Vaccination strategies | 215 |
| 11.5.1 | Piglet vaccination | 216 |
| 11.5.2 | Breeding gilt vaccination | 217 |
| 11.5.3 | Sow vaccination | 218 |
| 11.5.4 | Administration routes | 218 |

| | | |
|---|--|-----|
| 11.6 | Factors influencing efficacy of vaccination | 220 |
| 11.6.1 | Stress factors | 220 |
| 11.6.2 | Infections with other pathogens at the moment of <i>Mycoplasma hyopneumoniae</i> vaccination | 220 |
| 11.6.3 | Co-infections with other pathogens involved in PRDC | 221 |
| 11.6.4 | Diversity of <i>Mycoplasma hyopneumoniae</i> strains | 222 |
| 11.6.5 | Maternally derived immunity | 222 |
| 11.7 | Experimental vaccines | 223 |
| CHAPTER 12 | | 229 |
| Eradication of <i>Mycoplasma hyopneumoniae</i> from pig herds | | 229 |
| 12.1 | Introduction | 230 |
| 12.2 | <i>Mycoplasma hyopneumoniae</i> eradication protocols | 231 |
| 12.2.1 | Depopulation/Repopulation | 232 |
| 12.2.2 | Swiss method | 234 |
| 12.2.3 | Herd closure and whole herd medication | 235 |
| 12.2.4 | Whole herd medication without closure | 240 |
| 12.2.5 | Other protocols | 241 |
| 12.3 | The value of <i>Mycoplasma hyopneumoniae</i> eradication | 242 |
| 12.4 | Eradication economics | 243 |
| 12.5 | <i>Mycoplasma hyopneumoniae</i> eradication trends | 245 |
| CHAPTER 13 | | 247 |
| <i>Mycoplasma hyorhinis</i> and <i>Mycoplasma hyosynoviae</i> in pig herds | | 247 |
| 13.1 | <i>Mycoplasma hyorhinis</i> | 248 |
| 13.1.1 | Etiology | 248 |
| 13.1.2 | Epidemiology | 250 |
| 13.1.3 | Pathogenesis | 251 |
| 13.1.4 | Clinical-pathological presentation | 252 |
| 13.1.5 | Diagnosis | 256 |
| 13.1.6 | Therapy | 258 |
| 13.1.7 | Control and prevention | 259 |
| 13.2 | <i>Mycoplasma hyosynoviae</i> | 260 |
| 13.2.1 | Etiology | 260 |
| 13.2.2 | Epidemiology | 261 |
| 13.2.3 | Pathogenesis | 262 |
| 13.2.4 | Clinical signs | 263 |
| 13.2.5 | Diagnosis | 263 |
| 13.2.6 | Therapy and control | 265 |
| CHAPTER 14 | | 267 |
| <i>Mycoplasma suis</i> infections in pigs | | 267 |
| 14.1 | Pathogen history | 268 |
| 14.2 | Pathogen characteristics | 268 |
| 14.3 | Epidemiology: prevalence and transmission | 270 |
| 14.4 | Pathogenesis | 271 |
| 14.4.1 | Adhesion and invasion | 272 |
| 14.4.2 | Nutrient scavenging | 274 |
| 14.4.3 | Eryptosis | 274 |
| 14.4.4 | Immunopathology | 276 |
| 14.4.5 | Endothelial targeting | 277 |
| 14.5 | Incubation period and clinical signs | 278 |
| 14.6 | Socio-economic impact | 280 |
| 14.7 | Diagnostics | 280 |
| 14.8 | Treatment, general control measures and vaccination | 282 |
| References | | 285 |