Histopathology of Mares Aborting Due to Equine Amnionitis and Foetal Loss

RIRDC Publication No. 10/206
Histopathology of Mares Aborting Due to Equine Amnionitis and Foetal Loss

by K H Todhunter and A J Cawdell-Smith

October 2010
RIRDC Publication No. 10/206
RIRDC Project No. PRJ-002592
Foreword

Millions of dollars are invested every year in the horse breeding industry for the successful delivery of a healthy foal. In 2004 a focus of unusual abortions occurred in the Hunter Valley related by specific histological and microbiological findings in the aborted foetuses. Equine Amnionitis and Foetal Loss (EAFL) was termed to describe these abortions and systematic investigations were undertaken to determine a cause. Exposure to processionaly caterpillars, White cedar moth caterpillars and possibly pennyroyal were found to be high risk factors in these abortions. Subsequent experiments have shown that exposure of pregnant mares via oral ingestion to whole processionary caterpillars or processionaly caterpillar exoskeleton causes abortion in horses (Cawdell-Smith and Bryden, 2008).

The histological aspects of foetuses aborted due to EAFL have been extensively investigated through post-mortem in the field and experimentally. However, it has been unknown how ingestion of the caterpillar actually causes the abortion or the effect, if any, on the mare’s gastrointestinal tract.

This project was undertaken to investigate the histopathological changes in pregnant mares of being fed macerated whole processionary caterpillars. Caterpillar setae were found to cause a wide range of reactions in the gastrointestinal tract, the mesenteric lymph nodes and the uterus of these mares. By increasing the understanding of the pathogenesis of EAFL, members of the horse industry and veterinarians will be able to better manage brood mare exposure to caterpillars and treatment if exposure occurs.

This project was funded by industry revenue which is matched by funds provided by the Australian Government. Additional financial support was provided by the Hunter Valley Equine Research Foundation, and the University of Queensland

This report is an addition to RIRDC’s diverse range of over 2000 research publications and it forms part of our Horse R&D program, which aims to assist in developing the Australian horse industry and enhancing its export potential.

Most of RIRDC’s publications are available for viewing, free downloading or purchasing online at www.rirdc.gov.au. Purchases can also be made by phoning 1300 634 313.

Craig Burns
Managing Director
Rural Industries Research and Development Corporation
Acknowledgments

The researches would like to acknowledge the significant assistance of Dr. Angela Begg, Professors Nigel Perkins and Wayne Bryden and Symbion Vetnostics.

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAFL</td>
<td>Equine Amnionitis and Foetal Loss</td>
</tr>
<tr>
<td>MRLS</td>
<td>Mare Reproductive Loss Syndrome</td>
</tr>
</tbody>
</table>
## Contents

Foreword ............................................................................................................................................... iii

Acknowledgments................................................................................................................................. iv

Abbreviations ........................................................................................................................................ iv

Executive Summary ............................................................................................................................ vii

Introduction ........................................................................................................................................... 1

  Lepidopteran Caterpillar Envenomation ......................................................................................... 1

  Summary ........................................................................................................................................... 4

Objectives ............................................................................................................................................... 5

Methodology .......................................................................................................................................... 6

  Selection of Mares ............................................................................................................................ 6

  Experimental Design ......................................................................................................................... 6

Results .................................................................................................................................................... 9

Discussion ............................................................................................................................................. 13

Implications and Recommendations ................................................................................................. 14

Appendix:  Publications and presentations associated with this research ................................. 15
Figures

Figure 1  Processionary caterpillars (*Ochragastar lunifer*) on a tree trunk ........................................ 2
Figure 2  Changes in the amnion and umbilical insertion in chronic EAFL ...................................... 3
Figure 3  Areas of the stomach corresponding to the tissue samples taken and examined .......... 7
Figure 4  Areas of intestine corresponding to tissues taken ............................................................ 8
Figure 5  Setae with barbules in mucosa of left ventral colon at 20x with magnification of barbules at 40x .................................................................................................................... 10
Figure 6  Setae with barbules in left ventral colon (40x) ................................................................. 10
Figure 7  Cross section of setae fragment with fibrous reaction and mononuclear infiltrate within the left ventral colon (40x) .................................................................................. 11
Figure 8  Setae shaft embedded in uterine gland .......................................................................... 12
Executive Summary

What the report is about

This report concerns the changes exhibited at a microscopic level in the pregnant mare after ingesting processionary caterpillars.

Who is the report targeted at?

The primary target group of this report is equine stud veterinarians, veterinary pathologists, and ultimately any person involved in the breeding of horses. The relevance of these findings in helping advance our understanding of the pathogenesis of Equine Amnionitis and Foetal Loss (EAFL) may also help manage the conditions caused by EAFL before exposure or abortion occurs.

Background

Over the last 10 years there have been episodes of abortion in pregnant mares both in Australia and overseas that have been proven to be caused by the ingestion of caterpillars of the order Lepidoptera. The processionary caterpillar (*Ochrogaster lunifer*) has been demonstrated to cause EAFL, a syndrome which occurred in 2004, with increased abortions on various breeding establishments in the Hunter Valley of Australia causing over 30% of the abortions investigated in that season. It is postulated that ingestion by horses is unwitting either through overwhelming numbers of caterpillars (ie a “plague”) or through scarcity of feed, lack of rain, and distribution of shed exoskeletons and nests over native pastures. However, the pathogenesis of caterpillar-induced abortions is still unknown.

Aims/objectives

The aim of this project was to determine the histological changes that may occur in the pregnant mare after gavage with processionary caterpillars (*Ochrogaster lunifer*) in an attempt to further understand how this exposure causes abortion in horses.

Methods used

Four mares were euthanized and submitted to post-mortem examination during an experimental trial of gavage with macerated whole processionary caterpillars (*Ochrogaster lunifer*) including one untreated control. Samples were taken for histopathology from specific areas of the gastrointestinal tract, reproductive tract, organs, and lymphatic tissue. These samples were placed in 10% buffered formalin and allowed to fix. Small sections from each sample were selected and processed in a routine fashion to make stained slides. Systematic examination under light microscopy was performed to note the presence of caterpillar setae within any tissues and the subsequent reaction if present.

Results/key findings

Ingestion of the caterpillars created a range of lesions within the treated mares. Setae were found throughout the gastrointestinal tract, concentrated within the caecum and large and small colon. Setal fragments were found in the mesenteric lymph nodes and uterus of one mare, and creating a neutrophilic reaction in the serosa of the uterus in another mare. Within the large intestine, setal fragments were present within the lumen and intima of arteries, veins, and lymphatics of the submucosa as well as sporadic findings within the muscularis and serosal layers of the intestine. Inflammatory reactions around setal fragments ranged from unapparent to neutrophilic (microabscess), eosinophilic, lymphocytic, plasmacytic, and/or granulomatous with multinucleated giant cells. Physical presence within the villi of the large colon of one mare caused an acute right dorsal colitis. Setae were not found in the tissues of the untreated control mare.
Implications for relevant stakeholders

The results show that caterpillar setae can cause a wide range of reactions within the equine gastrointestinal tract. This ranges from unapparent reaction to acute necrotising inflammation to chronic granulomas. The presence of setal fragments within the lymphatic channels in the mesenteric lymph node of one mare supports the theory of setae as foreign body emboli within the lymphatics. Migration of setal fragments is demonstrated by their presence in all layers of the large intestines including the serosa causing a hyperplastic serositis as well as within the uterine serosa and glands. This reinforces the need to limit the exposure of horses to processionary caterpillars with an emphasis on pregnant mares due to the possibility of migrating setal fragments causing gastrointestinal disease or other sporadic diseases including gastroenteritis, peritonitis, abortion, and possibly chronic placentitis.

Recommendations

Working with entomologists, landcare agents, agronomists and other agriculturally related fields to develop recommendations to manage the caterpillar presence in areas where horses are grazed is important. The widespread presence of these caterpillars across Australia makes it especially important for management practices to be workable without detrimentally affecting the environment, native plant and animal species, or economics of horse stud management.
Introduction

Over the last 10 years there have been episodes of abortion in pregnant mares both in Australia and overseas (Perkins et al, 2007) that have been proven to be caused by the ingestion of caterpillars of the order Lepidoptera (Cawdell-Smith and Bryden, 2009) (Webb et al, 2004). The Eastern Tent Caterpillar (*Malacosoma americanum*) was shown to cause Mare Reproductive Loss Syndrome (MRLS) in Kentucky and involved millions of dollars of lost foetuses over the 2001-2002 breeding season (Cohen et al, 2003). The processional caterpillar (*Ochrogaster lunifer*) has been demonstrated to cause Equine Amnionitis and Foetal Loss (EAFL), a syndrome which occurred in 2004 with increased abortions on various breeding establishments in the Hunter Valley of Australia causing over 30% of the abortions investigated in that season (Todhunter et al, 2009). It is postulated that ingestion by horses is unwitting either through overwhelming numbers of caterpillars ie a “plague” or through scarcity of feed, lack of rain, and distribution of shed exoskeletons and nests over native pastures. However, the pathogenesis of caterpillar-induced abortions is still unknown.

Lepidopteran Caterpillar Envenomation

Caterpillar envenomation involving the Lepidopteran caterpillars has long been documented in humans and animals with a range of syndromes involving both acute reactions (urticaria, anaphylaxis) and chronic inflammation due to migrating setae (urticating hairs) (Diaz, 2005). Most of these reactions are from dermal or ocular exposure and reports of effects of oral ingestion are rare (mainly small children) with the observation of gross changes prior to setae removal (Lee et al, 1999). The Eastern Tent Caterpillar (*Malacosoma americanum*) family *Lasiocampidae* had not previously been documented to be toxic in humans or animals although there is anecdotal evidence of gastrointestinal disturbance (diarrhoea, intestinal distension) when dried and fed to rats as a protein source (Fink et al, 1989). The Lepidopteran family Notodontidae, subfamily Thaumetopoeidae contains processional caterpillars including *Ochrogaster* sp. (Figure 1), that have been well documented to cause erucism (dermal urticaria), ophthalmodendritis, and lepidopterism (systemic illness with various manifestations) (Diaz, 2005). The venom from the hairs and spines of the European pine processional caterpillar (*Thaumatopoea pityocampa*) called thaumetopoein has been demonstrated to cause dose dependent mast cell degranulation in the skin of guinea pigs (Lamy et al, 1983) and systemic histamine release (Werno et al, 1993). Caterpillar setae migration has been documented in the chronic syndrome of ophthalmodendritis, an ocular manifestation of urticating hair exposure in the eye (Cadera et al, 1984).
Pathology of MRLS

Most of the pathological changes associated with MRLS were attributed to bacterial infection within the amnion (amnionitis), umbilical cord (funisitis), and lungs of the foetus (foetal pneumonia) (Williams et al, 2002). Changes in the umbilical cord including oedema, presence of surface bacteria with moderate neutrophil infiltration, and haemorrhages within the stroma and surface of the amnionic portion were the most common finding other than recovery of bacteria from the aborted foetuses. Occasional similar changes were found in the amnion with mild neutrophil infiltration of the allantoic and coelomic areas of the chorioallantois. Foetal pneumonia consisted of bacteria within the alveoli, low numbers of neutrophils and macrophages, and aspirated squames within the lungs (Williams et al, 2002).

Over the two years of major MRLS abortion, non-haemolytic Streptococcus (including Streptococcus bovis) or Actinobacillus spp. or both were recovered from 65% of cases. The Actinobacillus spp were later found to be similar to commensal organisms found in the digestive tract of horses (Donahue et al, 2006). Significant bacteria were not able to be recovered from 20.5% of the MRLS cases (Donahue et al, 2003). MRLS-associated syndromes included fibrinous pericarditis (34 cases) and unilateral uveitis (35 cases) (Seahorn et al, 2003) (Latimer, 2003). Sows were challenged with the eastern tent caterpillars in an attempt to develop an experimental model of MRLS (McDowell et al 2004). Microgranulomas around setal fragments were found in the intestinal submucosa.

There are two theories as to the pathogenesis of abortion caused by caterpillar exposure. The first involves a possible toxin made by or carried by the eastern tent caterpillar that has a detrimental effect on the placenta and/or foetus. The second hypothesis is that a bacterial septicaemia of normal flora occurs after mechanical breaching of the intestinal barrier by the caterpillar setae. The bacteria are able to cross the placenta and cause death to the foetus (Sebastian et al, 2008).
Pathology of EAFL

Equine amnionitis and foetal loss caused variable gross pathological changes in the foetal tissues and membranes depending on the age of the foetus (Todhunter et al, 2009). Foetuses of younger gestational age (acute cases) were fresh with only generalised vascular engorgement, slight haemorrhage on the pleura and amnion, and occasional mild interstitial oedema of the lungs. Some foetuses were autolysed consistent with death in utero prior to expulsion. Older foetuses and stillborn foals showed more chronic changes. Oedema, vascular engorgement and haemorrhages on the allantoic surface of the chorioallantois around the umbilical vasculature were often present. Amniotic pathology ranged from vascular engorgement, oedema, and haemorrhages often around the convergence of amniotic vessels, to nodular thickenings, discoulouration, areas of pallor and focal diphtheritic membranes (Figure 2). Umbilical cord changes included oedema, vascular engorgement and haemorrhage sometimes with focal diphtheritic membranes. Foetal changes in the more chronic cases ranged from generalised vascular engorgement and interstitial oedema of the lungs with pleural haemorrhages to only meconium staining of external surfaces, and hypermature development (Todhunter et al, 2009).

Figure 2 Changes in the amnion and umbilical insertion in chronic EAFL

The most common pathological finding was microscopic pulmonary lesions consisting of acute or chronic foetal pneumonia (56%). Inflammation of the allantoic surface of the chorioallantois and funisitis each affected 52% of the EAFL cases. Amnionitis (48%), aspirated squamous epithelial cells in the small airways of the lungs (44%), and umbilical cord oedema, haemorrhage and congestion (41%) were the next most common findings. No single pathological finding characterized EAFL with only 52% of cases having foetal pneumonia, funisitis, and allantoic inflammation of the chorioallantois (Todhunter et al, 2009).

Histologically, bacteria were found in the tissues of the lung (26%), amnion (41%), chorioallantois (37%), and umbilical cord (41%) in over one-third of the cases. The majority of bacteria isolated from foetal tissues were environmental coryneforms (44%) and gram-negative rods (44%). Alpha haemolytic Streptococcus spp. was found in only 15% of identified cases. Many of the cultured bacteria are commonly found in the environment and soil (Todhunter et al, 2009).
Summary

While MRLS and EAFL share a common aetiology of caterpillar ingestion, the pathophysiology and the mechanism which eventually causes the abortion has not been delineated. Common intestinal or environmental bacteria are allowed access to the foetal membranes but it is unknown if the setae act as a mechanical vector (ie a “hypodermic needle”) allowing bacteria access to the bloodstream from the intestine, or if there is a toxin within the setae that creates an increased vascular permeability via anaphylaxis allowing the bacteria to cross many tissue barriers. Histolopathological examination of the tissues of mares following caterpillar exposure via gavage treatment may provide a clearer idea of how these caterpillars and their setae cause the abortions with variable clinical presentations.
Objectives

The objective of this study is to determine the histopathological effect, if any, on the tissues of the mid-gestational pregnant mare after experimental ingestion of the processionary caterpillar (*Ochrogastar lunifer*).
Methodology

Selection of Mares

Mares selected for post-mortem were participating in a trial using a low dose of macerated whole caterpillar with caterpillar collection and preparation previously described (Cawdell-Smith and Bryden, 2008).

Experimental Design

The trial consisted of three groups of mares at mid-pregnancy (>90 days but <300 days pregnant) with 2 groups undergoing gavage of 50g macerated whole caterpillar once daily for 5 days. Group 1 was composed of mares from a previous caterpillar challenge trial. These mares had aborted, were rebred, and were back in foal. Group 2 was composed of naïve mares never exposed to caterpillars. Group 3 was a control group which would not receive caterpillar but would be housed and managed the same as Group 1 and 2. Two naïve mares from group 2 were humanely euthanized during the 5 day treatment period. The control mare from group 3 was euthanized on day 6 of the trial. The last mare from group 1 was euthanized 12 days after the last treatment after aborting her foal.

Post Mortem Examination and Sample Collection

All post-mortems were carried out in a systematic manner for each mare. Samples required for other studies (fluids and tissues for culture and EHV-1 exclusion) were taken prior to any tissues for histopathology. After euthanasia mares were laid in right lateral recumbency. The left forelimb and hindlimb were removed. Skin, fascia, and musculature were removed to expose the left side of the trunk. The abdominal cavity was opened by incising through the lateral abdominal wall from the vertebral column to the xiphisternum, following the line of the rib cage. The entire left abdominal wall was removed. The left sternocostal attachment of the diaphragm was severed and the left thoracic wall was removed by cutting through the origins of the ribs at the vertebral column and through the sternum with bone cutters. Organ systems were removed to be sampled independently on a stainless steel surface. Labels were attached to each tissue corresponding to the pre-planned areas of the gastrointestinal tract and reproductive tract to be sampled. Approximately 1 cm sections of tissue were taken from numerous areas of the gastrointestinal tract (Figures 3 and 4), organs (liver, spleen, lungs, kidney, heart), lymph nodes (tonsil, mediastinal, mesenteric) and reproductive tract (ovary, uterus, cervix). All tissues were immediately placed into phosphate buffered 10% formaldehyde at a ratio of 1 part tissue to 10 parts of buffered formaldehyde and left to fix for 48 hours or longer before sectioning.
Figure 3  Areas of the stomach corresponding to the tissue samples taken and examined
Thin (3-4mm) sections of tissue were cut from all formalin-fixed samples for embedding. All sections were dehydrated in alcohol and embedded in paraffin. Six µm sections of each tissue were cut using a microtome, mounted on glass slides and stained with Wrights modification of the haematoxylin and eosin (H&E) stain before being examined by light microscopy.

All organs were examined for the presence of setae and any reaction to those setae if present. Any other abnormalities were noted.
Results

Setae

Setae were not found in the control mare and her tissues showed minimal changes.

Setae in the treated mares were generally fragmented and elicited a range of inflammatory cellular reactions ranging from unapparent to eosinophilic, neutrophilic (microabscesses), lymphocytic-plasmacytic, and/or monocytic including multinucleated giant cells.

Oesophagus

One mare had diffuse acute oesophageal erosion and ulceration with bacterial infiltration into the squamous epithelium. Setae were not evident in these ulcerated areas. Two mares had sporadic setal fragments within the mucosa or submucosa with unapparent or a mononuclear cellular reaction.

Stomach

Variable mild gastritis was present. One mare had extensive acute deep mucosal ulceration of the non-glandular portions of the stomach with small numbers of setal fragments only within the mucosa and submucosa of the glandular stomach. Another mare had low to moderate numbers of setae in both the mucosa and submucosa of most areas of the stomach with a range of inflammatory reactions and the other mare had no obvious setal fragments or inflammation.

Duodenum

The duodenum of all mares had infrequent mucosal and submucosal setal fragments and occasional evidence of mildly increased neutrophil infiltration within the villi. One mare had focal hyperplastic serositis.

Jejunum

All mares had infrequent mucosal and submucosal setal fragments in the jejunum with minimal reaction.

Ileum

Mucosal and submucosal setal fragments were only sporadically found with minimal reaction.

Caecum

All mares had typhlitis of varying severity with moderate to large numbers of setal fragments within the caecum. Fragments were found within artery and lymphatic lumens, artery walls, veins, submucosa, and villi. The reaction was more pronounced around many fragments. One mare had focal hyperplastic serositis.

Ventral Colon

All mares had colitis of varying severity and large numbers of variably sized setal fragments within the ventral colon (Figures 5 and 6). The reaction was varied and fragments were found within multiple layers of the colon including the serosa, evoking a focal hyperplastic serositis in some mares. Within the submucosa, fragments were found through vessels, lymphatics, and nerve bundles often with a granulomatous reaction (Figure 7).
Figure 5  Setae with barbules in mucosa of left ventral colon at 20x with magnification of barbules at 40x

Figure 6  Setae with barbules in left ventral colon (40x)
Dorsal Colon

All mares had colitis of varying severity. Large numbers of setal fragments were found within the dorsal colon of all mares with more present in the right dorsal colon than the left. Setae were found from the mucosa to serosa. One mare had a diffuse acute right dorsal colitis. Setal fragments evoked a range of reactions with dramatic changes in some areas. Areas of hyperplastic serositis were present multifocally.

Small Colon

All mares had colitis of varying severity. The numbers of setal fragments varied for each mare ranging from infrequent to many. The reaction to setal invasion of the tissues was dramatic in some areas and unapparent in others.

Uterus

All mares had an acute subtle to dramatic superficial endometritis. One mare had multifocal hyperplastic acute serositis with a setal fragment acting as a focus in one area. Another mare had a setal shaft embedded within a uterine gland with proteinaceous material within the glandular lumen (Figure 8).
Figure 8  Setae shaft embedded in uterine gland

**Lungs**

General changes within the lungs were mild in all mares and consistent of congestion with mild interstitial infiltration of neutrophils. One mare in one area of lung had multifocal eosinophilic granulomas with increased peribronchiolar infiltration of eosinophils and mild interstitial fibrosis.

**Mediastinal Lymph Node**

There were no obvious changes in the mediastinal lymph nodes of any mares.

**Mesenteric Lymph Node**

Multiple setal fragments were present in the mesenteric lymph nodes of one mare with mild reaction. Setal fragments were not found in the lymph nodes of the other mares.

**Liver**

There were no obvious abnormalities in the liver of any mare.

**Spleen**

There were no obvious abnormalities in the spleen of any mare.

**Kidney**

When collected there were no obvious abnormalities in the renal tissue.
Discussion

EAFL and MRLS share a common aetiology of caterpillar ingestion causing abortion with involvement of bacteria from the gastrointestinal tract and environment (Perkins et al, 2007; Sebastian et al, 2008). The histological findings in this study identify more than one possible mechanism by which caterpillar setae can enable bacteria to translocate from the gastrointestinal tract to the foetal membranes.

The first is mechanical breaching of the gastrointestinal mucosa allowing bacteria to potentially colonize areas within the lamina propria of the mucosa to the level of the submucosa as evidenced by deep mucosal and submucosal microabscesses. Subsequent bacteraemia could result in localisation within foetal membranes. The anaphylactic reaction caused by administration of the caterpillars and possible subsequent histamine induced oesophageal and non-glandular stomach ulceration may cause secondary bacteremia due to bacterial colonization of the squamous epithelium of the oesophagus and non-glandular stomach in the ulcerated areas.

The second is direct migration of setal fragments acting as a bacterial vector carrying bacteria from the gastrointestinal lumen to the serosa of the large colon and continued migration through the serosa of the uterus into the endometrial glands. Setal migration from the large colon caused a focal hyperplastic serositis which was also present on the surface of some sections of small intestine suggesting that migration of setal fragments is not limited to the large colon. Fragment migration happens rapidly as evidenced by the acute changes in the naïve treated mare where a setal fragment was found within the uterus.

The third is a combination of one and two, with the setal fragment carrying intestinal bacteria along as it enters the bloodstream through submucosal vasculature including the lymphatics and subsequent bacteraemia.

All three mechanisms may play a part in the range of clinical presentations seen with EAFL.

The role that any setal toxin plays is difficult to assess histologically. It can only be postulated that the systemic anaphylaxis seen after administration of the caterpillars (Cawdell-Smith and Bryden, 2009) either alone or in conjunction with the mechanical embedding of the setae within the intestine may initiate a bacteraemia which localises in the foetal membranes. The mare appears to be affected only on a local level with mild histological changes that are often focal or mildly diffuse in some areas of gut and reproductive tract without affecting the overall health of the mare.
Implications and Recommendations

The rapidity of setal migration may indicate that the uterus is affected by proximity to the large colon rather than by vascular disturbance. The range and variety of reactions to embedded setae within the gut is unpredictable ranging from mild to severe. These findings highlight how much is not known regarding the mechanism of action, despite the new information acquired in this project about how caterpillar hairs affect the mare after ingestion. It is of continuing importance to minimize the exposure of pregnant mares to areas where there have been caterpillars either in the past or present. How long mares should remain off affected paddocks is unknown. This emphasizes how important it is to work with agronomists, entomologists, and veterinarians in a continued effort to understand the life cycle and population dynamics of processionary caterpillars as well as the factor(s) that allow the caterpillar, when ingested, to induce abortion in mares. Recommendations for managing the feeding practices involving pregnant mares have been previously defined (Cawdell-Smith and Bryden, 2009) and should continued to be followed. These include not utilizing paddocks where caterpillars are known to present, supplementing feed in times of weather extremes and keeping feed off the ground and away from trees, removal of caterpillar nests, or replacement of trees that are the natural habitat and/or food source for caterpillars.
Appendix: Publications and presentations associated with this research


References


The processionary caterpillar (*Ochrogaster lunifer*) has been demonstrated to cause Equine Amnionitis and Foetal Loss (EAFL). This syndrome occurred in 2004 with increased abortions on various breeding establishments in the Hunter Valley of Australia, causing over 30% of the abortions investigated in that season. This report concerns the changes exhibited at a microscopic level in the pregnant mare after ingesting processionary caterpillars.

The primary target group of this report is equine stud veterinarians, veterinary pathologists, and ultimately any person involved in the breeding of horses. The relevance of these findings in helping advance our understanding of the pathogenesis of Equine Amnionitis and Foetal Loss (EAFL) may also help manage the conditions caused by EAFL before exposure or abortion occurs.

RIRDC is a partnership between government and industry to invest in R&D for more productive and sustainable rural industries. We invest in new and emerging rural industries, a suite of established rural industries and national rural issues.

Most of the information we produce can be downloaded for free or purchased from our website <www.rirdc.gov.au>.

RIRDC books can also be purchased by phoning 1300 634 313 for a local call fee.

Cover photo: Setae with barbules in left ventral colon (40x) Back cover photo: Processionary caterpillars (*Ochrogaster lunifer*) on a tree trunk