Gastrointestinal nematode larvae in pasture

Matt Playford, Dawbuts Pty Ltd
Steve Walkden-Brown, UNE
It's all about the lifecycle!

- **HOST STAGE**
  - Infective larvae become adults that live for many months within the sheep's gut to reproduce and lay eggs.
  - Minimum time from L3 to egg laying is 18 days.
  - The sheep's immunity can expel worms or suppress egg laying.

- **PASTURE STAGE**
  - Third stage 'infective larvae' (L3) move in moisture (rain/dew) and wriggle randomly, some onto the pasture to be eaten by sheep.
  - Quite resistant to cold and heat, but susceptible over 40°C.
  - Most L3 die within 3 (summer) to 6 (winter) months; some live over 1 year.
  - L3 do not feed; they die when energy reserves are used up (faster at higher temperature and humidity).

- **DUNG STAGE**
  - Eggs develop through L1 and L2 stages to L3 'infective larvae'.
  - Time from egg to L3 is 4–10 days (slower when cooler, faster when warmer).
  - Generally, development to infective larvae is markedly reduced below 10°C, above 35°C or when dry.
  - L1 and L2 feed on bacteria in the dung.

Highly resistant but must eventually find host or die. Variable timing.

Constant environment apart from host immunity. Fixed timing.

WormBoss.com.au/
What determines the number of larvae on pasture?
How are larval counts measured?
What is a high larval count?

Variation of pasture larval counts at different sampling sites

Pasture larval count (per kg dried weight)

Sample sites

Cattle Weaner Pdk
Cattle Pdk 2
Horse Spelled Pdk
Horse 2 YO Pdk
Goats Main
Where in pasture are larvae found?

Figure 1e: Vertical distribution of infective larvae on grass.
Do larvae move around?

Source: Santos et al 2012 VetPar

Fig. 2. Average numbers of *Haemonchus contortus* third-stage larvae (L3) recovered from herbage samples, by grass strata (0-10 cm, 10-20 cm, and >20 cm) during each of the three 13-day observation periods: January/February (A); April/May (B); and July/August (C). The mean number of L3 in fecal samples deposited on pasture in those three observation periods was 18,610, 12,160, and 11,102, respectively. Bars represent standard error of the mean.
Survival of *Haemonchus contortus* infective L3 in the New England

ParaBoss Technical Workshop, 2016
Anhydrobiosis (dehydrating and rehydrating) in ruminant L3

- Decreases metabolic activity
- Prolongs survival under natural field conditions
- Promotes survival at freezing temperatures

Figure 3. Survival of L₃ larvae through sequential desiccation and rehydration events. (A) Haemonchus contortus. (B) Trichostrongylus colubriformis. (C) Heligmosomoides polygyrus. (D) Nippostrongylus brasiliensis.

Lettini et al., (2006)
What happens in different pastures?

Moss & Vlassoff (1993)
NZVAR 36:371-375

<table>
<thead>
<tr>
<th>Herbage</th>
<th>Larvae Total n/m² (2)</th>
<th>Larvae Recovered % (3)</th>
<th>Nematode Species (%) (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ryegrass &amp; clover</td>
<td>4722</td>
<td>1.00</td>
<td>A: 46.2, B: 47.5, C: 1.6, D: 4.7</td>
</tr>
<tr>
<td>Prairie grass &amp; clover</td>
<td>6700</td>
<td>1.42</td>
<td>A: 46.6, B: 44.7, C: 2.1, D: 6.6</td>
</tr>
<tr>
<td>Chicory &amp; clover</td>
<td>450</td>
<td>0.07</td>
<td>A: 61.0, B: 21.8, C: 3.3, D: 13.9</td>
</tr>
<tr>
<td>Lucerne</td>
<td>1620</td>
<td>0.44</td>
<td>A: 44.1, B: 38.8, C: 6.7, D: 10.4</td>
</tr>
</tbody>
</table>

LSD P < 0.05
LSR P < 0.05 (1) 2.8

(1) Within column, means with a greater between-treatment ratio are significantly different, P < 0.05. LSR = least significant ratio.
(2) Consists of Strongylate including Nematodirus spp. Values are the exponential of logged means.
(3) Proportion of nematodes recovered relative to eggs deposited.
(4) Nematode species are: A, Trichostrongylus spp.; B, Ostertagia spp.; C, Chabertia; D, Nematodirus spathiger,
Is there a difference between larvae on grass and soil?
Smart Grazing

• Does not require another species or non-susceptible animals

• Based on timing of events of the worm lifecycle

• Mob stock the paddock being spelled with animals that have just been drenched

• Remove them after 20-30 days having made use of the pasture
  – Limited egg deposition
  – No egg deposition if graze for 18 days only (prepatent period)
WEC of lambs and ewes from lambing paddocks prepared by 3 methods

Smart grazing

Table 2. Production from weaner sheep under three management systems at the CSIRO Pastoral Research Laboratory, Armidale (Barger & Southcott, 1978).

<table>
<thead>
<tr>
<th>Management system</th>
<th>Set stocked sheep</th>
<th>12 month rotation with cattle</th>
<th>6 month rotation with cattle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Live weight</td>
<td>1975</td>
<td>35.0</td>
<td>38.5</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>35.0</td>
<td></td>
</tr>
<tr>
<td>Fleece weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fleece weight</td>
<td>1975</td>
<td>3.24</td>
<td>3.45</td>
</tr>
<tr>
<td></td>
<td>1975</td>
<td>3.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1976</td>
<td>2.38</td>
<td>2.61</td>
</tr>
<tr>
<td></td>
<td>1976</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality* (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mortality* (%)</td>
<td>1975</td>
<td>43</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>1976</td>
<td>37</td>
<td>24</td>
</tr>
</tbody>
</table>

All animals (sheep and cattle) were treated with levamisole in January and July. *Sheep were regarded as mortalities if they died or required additional anthelmintic treatment outside of the designated treatment times.
Intensive rotational grazing

• Cell grazing, Technograze etc.
• Highly effective against *Haemonchus*
  – Effective but less so for other species
• Works 3 ways
  – Very short graze periods (3-4 days or less)
    • How does this help?
  – Moderate/Long graze intervals
    • Allows significant L3 mortality
  – When rain happens, only a small proportion of the enterprise gets contaminated with L3
Grazing worm free pastures can increase susceptibility!

• Sheep on an intensive rotational grazing system had very low WEC, but when artificially challenged, showed higher infections than sheep on typical (TYP) or high input grazing systems that had higher WECs

• See next slide
Worm egg counts after artificial mixed infection in SUMMER

<table>
<thead>
<tr>
<th>Grazing treatment</th>
<th>Weeks post bolus challenge with Hc and Tc</th>
<th>3 weeks</th>
<th>4 weeks</th>
<th>5 weeks</th>
<th>Average</th>
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</thead>
<tbody>
<tr>
<td>High input</td>
<td></td>
<td>2700</td>
<td>4900</td>
<td>5900</td>
<td>4500</td>
</tr>
<tr>
<td>“Typical”</td>
<td></td>
<td>2400</td>
<td>3600</td>
<td>5200</td>
<td>3700</td>
</tr>
<tr>
<td>IRG</td>
<td></td>
<td>6100</td>
<td>9900</td>
<td>9700</td>
<td>8600</td>
</tr>
</tbody>
</table>


What are the knowledge gaps?

1. Empirical data on seasonal pasture larval counts across regions
2. Reliable and simple model to produce a tool for predicting larval load on each paddock
3. Clear correlation between pasture larval count and production loss for each management group (economic evaluation)
What are the research priorities?

1. ‘Worm goggles’ for pasture (from space)
   - Detect worm larvae based on frequency
2. Quantitative PCR for pasture larval counts
   - Manually harvest samples and test
   - Number of larvae on pasture
   - Species identification