

## 'Refugia' and 'in refugium'

'*Refugia*' refers to the proportion of a population of parasites (or stages of parasites) that have either never come into contact with an anthelmintic active ingredient or have somehow missed the genetic mutation that might make them resistant. These worms are known to be '*in refugium*' and remain vulnerable to anthelmintics.

In other words, these worms have pretty much the same genetic configuration as the population of worms our horses had before we humans ever introduced chemical anthelmintic treatments.

It might sound counter-intuitive, but we must look after this population of worms in our horses and in the environment, and endeavour to *increase* the proportion of these worms if possible. In this way, populations of *resistant* worms will remain diluted with non-resistant worms, ie, *refugia*.

It's really a simple numbers game: the higher the percentage of *cyathostomins* 'in refugium', the lower the percentage of resistant *cyathostomins* – it must add up to 100%.

The higher the proportion of worms *in refugium*, the more slowly resistance develops!

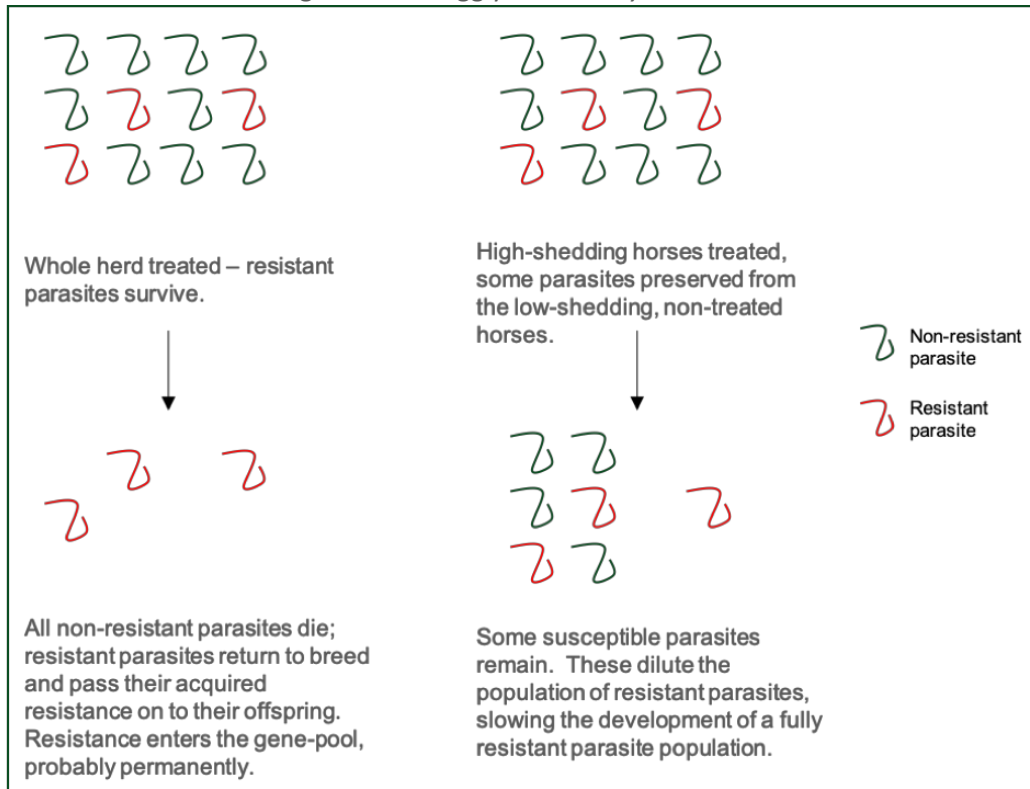
## Where do we find worms 'in refugium'?

Populations of parasitic horse worms 'in refugium' include:

- stages of parasites in the horse not affected by the treatment (eg encysted strongyles when non-larvicidal treatments such as moxidectin are used)
- all free-living, non-resistant, parasite stages in the manure or on the pasture
- all non-resistant parasites in animals that have never been treated with anthelmintics (eg wild horse herds).

This can be a confusing concept, but the graphic on the next page will help to explain it visually.

Imagine these wiggly lines are *cyathostomins*



The key message from this diagram is that the overall **percentage** of resistant parasites reduces considerably when we look after the non-resistant worms.

**WITHOUT FEC TESTING:**

In the example on the left hand side of this diagram, the population of resistant worms (in red) becomes 100% over time, meaning that all of the non-resistant worms will have been eradicated. This is where we are currently heading with continued improper use of anthelmintics.

**WITH FEC TESTING:**

When we only treat some of the horses in the herd based on the evidence from FECs (the high-shedding horses), the **percentage** of resistant worms (in red) is much less. In the example on the right hand side of this diagram, the population of resistant worms has reduced to just 42% while the population of non-resistant worms has increased to 58%, adding up to 100% of worms in total.