Treating Sarcoptic Mange using Moxidectin

Dose rate, pharmacokinetics and case studies for Bare-nosed Wombats.

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History of Moxidectin in Wombats

The Wombat Protection Society of Australia (WPSA) was founded in 2006 to provide wombats with immediate protection from harm. The founder and early members had been working on sarcoptic mange treatment for some years prior, using oils, baths, powders and sprays with all kinds of ingredients. The decision to use Cydectin®/moxidectin pour on was based on the safety of dung beetles, the more lipid soluble content and a high safety margin in cattle; "It affects the nervous system of parasites, leading to their death, but is considered non-toxic to mammals"[1]. The pour on version was also the easiest mode of application in free-living wombats.

The founder, Amanda Cox, invented the wombat burrow flap in 2004, adapted from Brian McCarthy's hanging jar filled with sulphur and oil. Amanda sent "kits" out to volunteers to trial. The first designs were plywood and were soon replaced with lighter materials such as ice cream lids. The milk bottle tops were larger and deeper than today and at that time a suitable cap for the dose rate used at that time.

The first Cydectin® doses of 3 mL used on wombats was a worrying time, not knowing if the wombats were going to survive the medication. It was soon clear that the wombats did not recover from sarcoptic mange and discussions started on repeating doses with monthly applications and were soon replaced with weekly doses of 10-20 mL/dose.

These weekly doses required many months of treatment before a full recovery occurred, however, some wombats did not fully eradicate the sarcoptic mange infection despite years of treatment. The free-living wombats "disappeared", moved and changed to "nocturnal" behaviour making it very hard to follow-up and continue the treatment. As early as 2006, larger doses of 40 mL were accidentally given to a wombat due to a misunderstanding, however these larger doses appeared more positive. Even larger doses of 80-100 mL have been trialled out of desperation since 2009.

The Mange Management (MM) group in Victoria was formed by Jenny and Reg Mattingley in 2012 after consultation with WPSA and a permit to use Cydectin® in free-living wombats was obtained by MM in February 2017. It was then recognised that the "low doses" were not effective due to a number of issues, however as the permit was a "step in the right direction", it was a welcomed progression in the fight against sarcoptic mange.

There have always been multiple issues when treating free living wombats due to a combination of factors such as: difficulty of application, finding the wombats for the required repeat doses, loss of Cydectin® due to the wombat shaking off the medication and not knowing how much of the chemical actually reaches the blood plasma to be efficacious.

Why we use Moxidectin

There are many products available to treat sarcoptic mange successfully such as pour-on, spot-on, injectable, oral and washes. WPSA do not recommend any products that require chasing, capture, holding or handling free-living adult wombats by untrained individuals. The product range containing Moxidectin in this manual are all a pour-on and should be applied along the wombat's back on healthy fur/skin. This can be achieved without additional stress to either the wombat or the person by applying the product using a "pole and scoop" or "burrow flap" device (see page 24). All other means of application (including spot on) requires capture. Moxidectin is the only product currently approved by Australian Pesticides and Veterinary Medicines Authority (APVMA).

Mode of Action

Cydectin® (moxidectin) Pour-On is a second-generation macrocyclic lactone endectocide, specifically formulated to allow it to be absorbed through the skin and distributed internally to the areas of the body affected by endo- and/or ectoparasites. Moxidectin binds selectively and with high affinity to glutamate-gated chloride ion channels which are critical to the function of invertebrate nerve and muscle cells. Thus, moxidectin interferes with neurotransmission resulting in paralysis and elimination of the parasite[2]. These specific glutamate-gated chloride ion channels are found in invertebrates (insects, nematodes and crustacea) but not in vertebrates. The selective toxicity of macrocyclic lactones as an anthelmintic may be explained by the action on GluCl channels that are not present in host animals.[9]

Moxidectin is different from other macrocyclic lactones in that it is a poor substrate for P-glycoproteins (P-gps) and therefore less susceptible to elimination from parasite cells through this mechanism[3]. Moxidectin is a product of fermentation of *Streptomyces cyaneogriseus* subsp. *noncyanogenus*, a bacterial organism isolated in 1983 from a sample of sand from Victoria, Australia[3].

Many factors such as the route of administration, animal species, body composition, and drug formulation can influence the pharmacokinetic behaviour of moxidectin, which is important for applying medication appropriately[4].

The usual dose rate for all of the MLs (macrocyclic lactones) in cattle is 0.2 mg/kg for injectable and 0.5 mg/kg for pour-on formulations. The higher dose rate for pour-on formulations reflects the fact that the active ingredient is less well absorbed through the skin than from the injection site or the gastrointestinal tract. However, cattle will lick each other after pour-on application of anthelmintic and a variable portion of the pour-on dose may be orally ingested, and will lead to unexpected levels of drug in the organisms and efficacy[5].

Tolerance and Toxicity Studies

P-glycoprotein (P-gp) is a plasma membrane protein which acts as a localized drug transport mechanism, actively exporting drugs out of the cell. The effects of P-gp on the distribution, metabolism and excretion of drugs in the body is great[6]. Their presence at the intestinal level contributes extensively to the elimination of these drugs in the faeces. In addition, being located in the blood–brain barrier, they limit the net entrance of the drug into the brain which explains the low toxicity of the moxidectin in mammals[5].

Tolerance and toxicity studies have demonstrated an adequate margin of safety to allow treatment of cattle of all ages with CYDECTIN® Pour-On. No toxicity was observed in cattle given up to 25 times the recommended dose level[2]. Furthermore, pour-on treatments of Cydectin® appear to be not toxic at rates even as high as 200 mL in bare-nosed wombats[7]. Investigations into the sensitivity of some collie-type dogs to avermectin have identified the presence of genetically based P-gp deficiency which leads to neurotoxicity at doses considered safe in the broader canine population[3]. To evaluate the safety of moxidectin, administration at doses of 10, 20, and 30 times the manufacturer's recommended dose orally in the avermectin-sensitive Collies, they were observed hourly for the first 8 hours and twice daily thereafter for 1 month for signs of toxicosis. Signs of toxicosis were not observed in any dog receiving moxidectin at 10, 20, and 30 times the manufacturer's recommended dose[8]. Moxidectin was considered to be moderately toxic after oral and intraperitoneal administration to rats and mice in acute toxicity testing. The main clinical sign in mice administered a toxic dose of moxidectin was decreased activity. Animals observed with decreased activity had recovered by 4 days after treatment[9]. Dermal application of moxidectin to rabbits had no overt toxicity[9]. The safety of moxidectin has been demonstrated in foals, breeding mares and breeding stallions. A series of three studies was conducted in foals to evaluate safety. One- to two- week-old foals given oral moxidectin showed no clinical signs of toxicity[9].

The genotoxicity of moxidectin has been evaluated in a variety of tests. Negative results were obtained when moxidectin was tested in the Ames test[9]. Two chronic toxicity/carcinogenicity studies have been conducted with moxidectin. Oral moxidectin was used in a 2-year study in mice. Based on these studies, moxidectin is considered to be non-carcinogenic[9].

Due to the lipophilic nature of moxidectin and the lower proportion of body fat carried by wombats, an acute (immediate) poisoning effect is more likely to be seen in a wombat than chronic (long term) poisoning by repeated dosing over a long period. Nevertheless, reasonable care should be taken not to overdose animals.

Therapeutic Levels

Figure 1 below explains the level of insufficient, therapeutic and toxic doses of treatment chemicals over time, indicating that there is a balance required between dosage rates and recovery. Enough of a treatment needs to be given to reach the therapeutic level without reaching toxic levels.

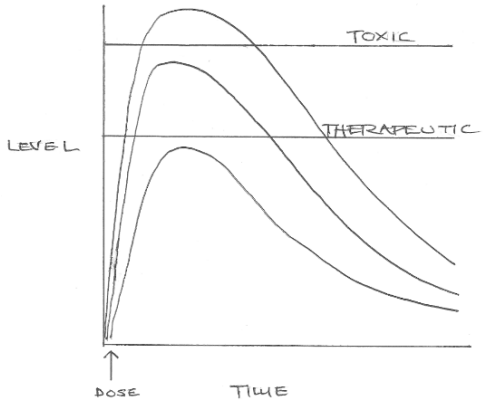

Figure 1: A graphical comparison of levels of chemical treatment over time, indicating toxic, therapeutic and insufficient dosages (Diagram by Dr Howard Ralph).

After extensive use of Cydectin® on free-living adult wombats it is apparent that dose rates of 5 - 20 mL/dose were insufficient, to ensure moxidectin entered the wombat's bloodstream, and was effective at killing the mites and ending the life cycle. This is likely to be due to:

- The difficulty in delivering a therapeutic dose to the target animal's skin. Unlike the fur and skin on deer and cattle (upon which the on-label treatment applies) the skin on a wombat is extremely thick. The fur is also particularly water resistant. Too low dose rates applied to the back of a large wombat will not reach the skin and therefore will not enter the bloodstream.
- The relatively high level of muscle and low level of fat on wombats (as compared to cattle or deer) appears to make it more difficult to deliver a therapeutic dose to the animal's bloodstream.
- The absorption of the chemical from the treatment site (on the wombat's back) appears to require an increased dose, due to additional soil/dust/dirt particles on the skin.
- Unlike deer and cattle, infected free-living wombats with sarcoptic mange generally present with an extremely high level of parasite infection. By contrast, cattle, and deer generally present with a small level of infection (few ticks or other parasites). The high level of infection of mites on free-living

wombats requires a higher dose to kill the mite population and cease their life cycle.

- Hyperkeratosis prevent distribution and absorption of the Cydectin®.
- Individual differences of half-life of moxidectin in the plasma of wombats.
- A low immune system increases the risk of infestation.

Photo highlights a poor absorption after application of Cydectin®, droplets are still visible and the pour on stays on "top of the fur".

Mite Population and Resistance

The production of parakeratosis is correlated with the density of mites burrowing in the epidermis and the thickness of parakeratotic crust is also correlated with the intensity of infection[10].

If a square centimetre of a wombat's skin containing 10 mites and "x" amount of Moxidectin applied per kg of body weight of the wombat is the accurate amount to kill the 10 mites only. If there are 20 mites and the same amount of Moxidectin were applied, 10 mites would survive and therefore the therapeutic level has not been reached to affect these other mites. Molecules of moxidectin get used up by paralysing the mites within the square centimetre.

In veterinary medicine, the standards of anthelmintic efficiency usually demand that ⩾95% of the parasitic nematodes be removed with a single drug treatment and efficacy below this, and certainly below 90%, are accepted as evidence of anthelmintic resistance provided that the anthelmintic has been administered at the

appropriate dose rate and other conditions, such as suitable formulation, are satisfied[11].

It appears likely that low dose rates of Cydectin® that are below a therapeutic level are contributing to resistance building up in the *Sarcoptes scabiei* mite population. Death et al. (2011) have noted that ineffective treatments could extend the period of infectivity of diseased individuals within populations and encourage development of resistant parasites[12].
Old et al. (2017) have noted the possibility of resistance to treatment chemicals and that the *Sarcoptes scabiei* mite has been reported to become increasingly drug-resistant in countries where acaricides had previously been used to cure the disease[13].

Immunity and Transmission

There are currently only a limited number of published studies specifically investigating the wombat immune system[14,15]. However, wombats are likely to be more susceptible to sarcoptic mange because of a reduced resistance to infection, environmental stress eg. droughts, harsh winters, high host density, and environmental conditions favouring growth and transmission of the mite[16,17].
A study by Sengupta, C, confirmed that a site in NSW had high prevalence of wombats with sarcoptic mange and also had high incidence of strongyle infection[15].
Balestrieri et al., (2006) have previously reported a positive correlation between the incidence of sarcoptic mange and parasitic helminth infection in foxes[15,18].
A stressful environment such as land clearing, drought, winter, lack of food etc can lead to chronic stress and an increased burden of parasites. Chronic stress reduces immunocompetence and increases the chances of *Sarcoptes scabiei* infestation[15].

In humans, research has found that a healthy immune system appears to interrupt the reproductive cycle of the scabies mite. For example, most people with scabies will only have 5 to 15 mites on their body at any one time. However, if you have a weakened immune system, the number of scabies mites can increase significantly[19].
The immune response of free-living wombats with severe mange is typical of an immune system that has become de-sensitised to infection with *S. scabiei*. It appears that once parakeratotic scale has built up sufficiently to prevent mites being removed by scratching, the immune response is less effective at limiting the number of mites. The number of mites then increases dramatically and provides the immune system with a vast amount of antigen that probably results in desensitisation[20].

Reinfection of a successfully treated wombat in the wild could occur, it has been shown that dogs medically cured of a sarcoptic mange infection are less susceptible to infection when rechallenged[21]. Resistance (reduced mite burden) to re-infestation with scabies following an initial infestation has been demonstrated for both humans and other animals[22].

A stressful environment such as drought, land clearing, lack of food or injury can force wombats into a closer proximity with each other and lead to a higher risk of transmission of Sarcoptes mites. Direct contact with an infected host is generally considered to be the primary means by which an individual becomes infected. The wombat's sleeping chambers, resting areas and preferred scratching object can also be a source of infection. A study by L. G Arlian (2017), demonstrated that the Sarcoptes mites seek the source of stimuli originating from the host when they are off the host but in close proximity to it[22]. The ability to perceive and respond to a host diminishes with increasing distance from the source. 100% of the mites in the study moved towards the source at a distance of 4.2 cm. The host stimulus that induced the response could have been body odour and heat emanating from the host and/or CO_2 in exhaled breath[22.]

Half-Life of Moxidectin

The half-life of moxidectin is illustrated in Figure 2. Half life is the time it takes for the concentration of a drug or chemical in the plasma to be reduced by 50%. The moxidectin half-life in four "healthy" southern hairy-nosed wombats has been reported to range between 2 to 9.5 days with a mean elimination of 5 days[12]. The varying half-life of moxidectin in the four wombats tested suggest high levels of individual difference in eliminating the treatment, and therefore the time between re-dosing, and the number of repeat doses required alter the efficaciousness of treatment for different individuals. The peak plasma concentration occurred at a mean of 13.6 hr[12]. Figure 3 illustrates how it is critical to re-treat wombats to ensure consistent plasma levels, that are therapeutically efficacious, are maintained for a sufficient time period to break the life cycle of the mite and thus eliminating it.

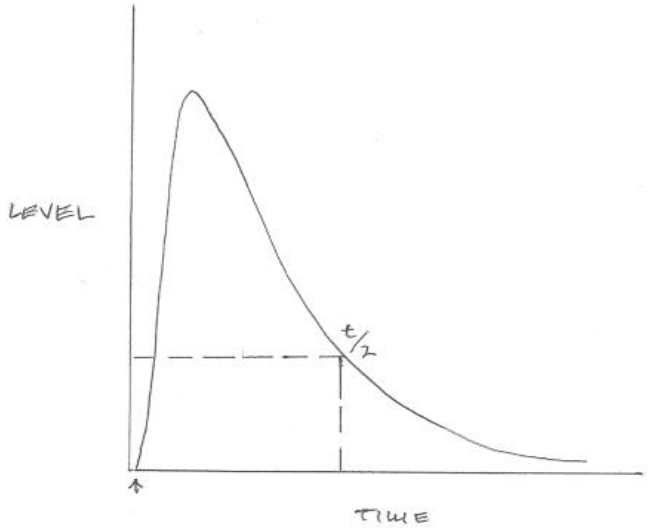

Figure 2: Graphical illustration of level of moxidectin half-life over time (Diagram by Dr Howard Ralph).

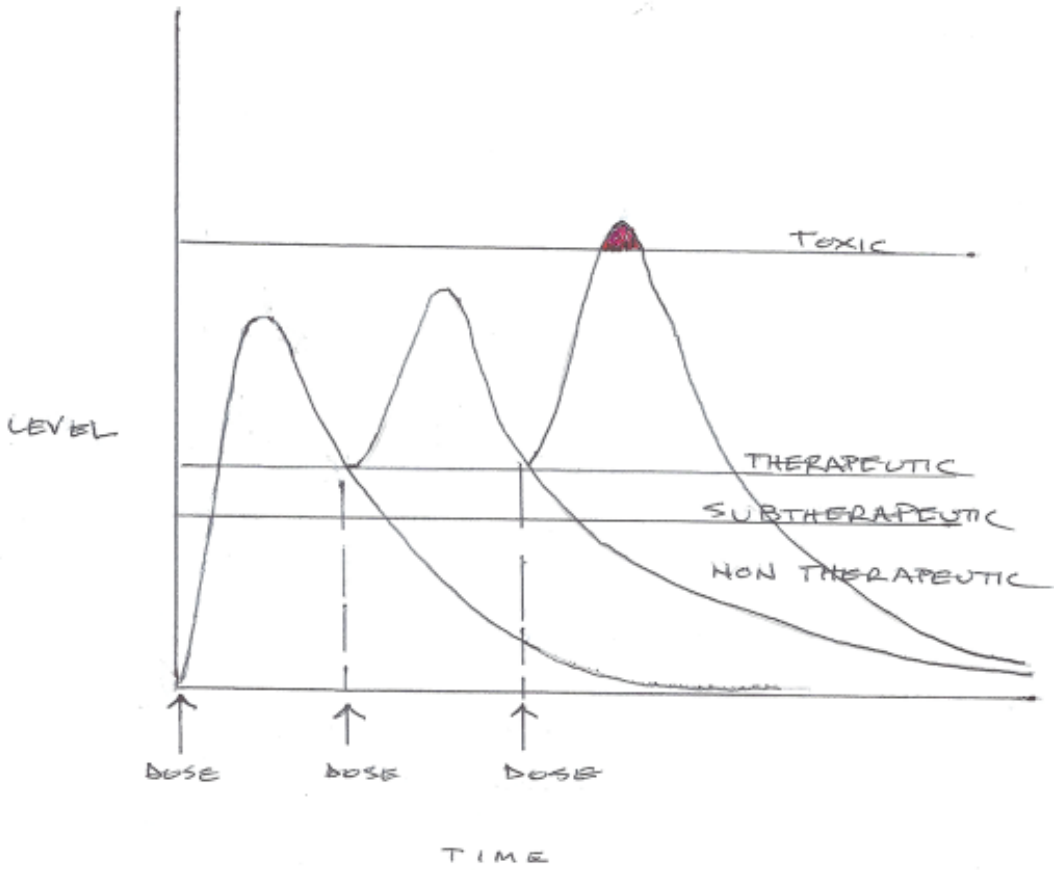

Figure 3: Graphical explanation of why moxidectin application needs repeat doses to maintain the therapeutic level (without reaching toxic levels) until all mites have been killed (Diagram by Dr Howard Ralph).

Life Cycle of *Sarcoptes scabiei*

The sarcoptic mite takes approximately two-three weeks to complete its life cycle (Figure 4) on the host animal however all life stages of the mite can be found in the environment of the animal and some mites can survive off the host for up to three weeks in cool humid conditions[23]. The mite undergoes four stages in its life cycle: egg, larva, nymph, and adult[23]. The eggs hatch in 3 to 4 days into larvae with only 3 pairs of legs and lives about 3 to 4 days[23]. The larvae moult again resulting in nymphs with 4 pairs of legs and are slightly larger[23]. These nymphs moult into sac-like, round eyeless adults[23].

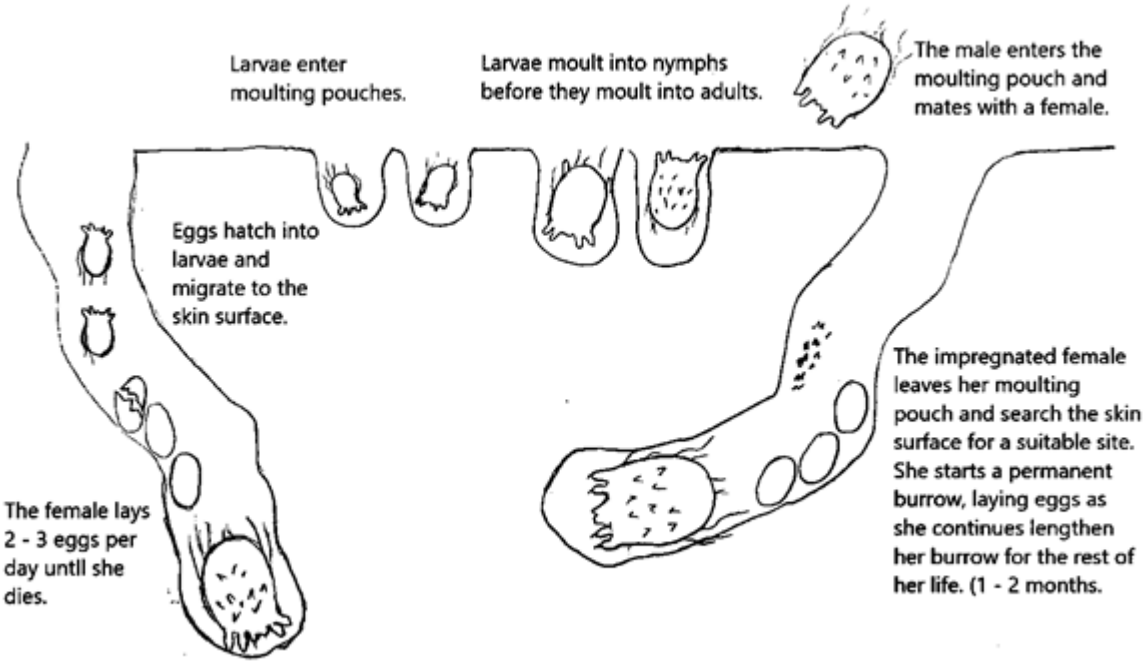

Figure 4: The life cycle of the *Sarcoptes scabiei* mite (Adapted from Molin 2009[24])

Free-living Wombats

Whilst the re-treatment of wombats who are 'in-care' using pour-on, spot-on or subcutaneously administered Cydectin, is relatively straight forward it is much more problematic to treat and re-treat free-living wombats. Compare with COVID-19, by targeting the individuals, find and treat the clusters and consider who is in contact with who via direct contact or burrow sharing. Hence, due to the difficulty in finding, treating, and re-treating free-living wombats it is critical to use a dose regime that both kills the mite and ends its lifecycle as quickly as possible.

- Animals can "disappear": Alter the time of day/night when grazing, move to a nearby grazing area and change burrows.
- Burrows can be shared with healthy wombats.

- Burrow flaps can be destroyed, or wind may spill the treatment onto the ground.
- It can be difficult to position the burrow flap to ensure the wombat receives a dose along its back line.

Case study number 1, highlights some of the problems when treating free-living wombats when using inappropriate dose rates. After a few doses, the wombat's mite load reduces, the wombat returns to "normal" behaviour and follow up treatment becomes extremely difficult. The wombat "disappears", mange infestation increases and depending on further doses, leading to a vicious cycle that can continue for years decreasing the wombat's chances of recovery. Case studies 2, 3 and 4 demonstrates the benefit of more appropriate doses with a short treatment duration.

We have 1,464 documented case studies, using 5 – 20 mL weekly doses by carers and members of the public attempting to treat wombats with mange. Of these 1,464 wombats, only two wombats were confirmed as successfully treated following continuous weekly treatments over 5 – 6 months. The other 1,462 wombats either died, disappeared or the person treating gave up.

Appropriate doses of Moxidectin

Some of the benefits of more appropriate doses of Cydectin®/moxidectin include:

- More mites are killed much quicker.
- The treatment duration is greatly reduced.
- The chances of successfully applying the treatment are greatly increased before the wombat "disappears".
- The wombat is "sick" for a shorter duration and will therefore be able to put on weight faster and more quickly return to normal nocturnal feeding.
- The animal's fur will grow back faster and therefore reduce the risk of hypothermia.
- A short treatment cycle greatly increases the number of people who will commit to completing the treatment.
- It is less likely the mites will build up resistance.

Case Studies

Case study 1 – Treatment duration too long when too small doses are used.

Below is a case study of a wombat treated in-field at Jarake Wildlife Sanctuary continuously over 4 years. During the first three and half years the male was given 20-30 mL doses and was never sarcoptic mange free but continued to have various degree of sarcoptic mange. After the three and half years, he was given 80-100 mL doses weekly for 16 continuous weeks. The sixteen weeks were most likely not necessary but the fear of resistant mites and the return of mange infestation

contributed to the prolonged treatment duration. All doses were given by the 'pole and scoop' method. He spent the following six (close to) years sarcoptic mange-free and healthy. Late March 2020 he was found with a large swelling on the side of his face and was taken to wildlife veterinary surgeon Dr Howard Ralph for assessment and treatment. He received a physical examination and tests included full haematology and comprehensive biochemistry. It was confirmed that his liver, kidneys, and other organs were healthy, and his presented teeth issues were unrelated to having had sarcoptic mange or sarcoptic mange treatment.

History of doses:

- 15th October 2010 – first dose of 20-30 mL
- October 2010 – 3 doses
- November 2010 – 3 doses

- 5 months without treatment
- April 2011 – 2 doses
- May 2011 – 1 dose
- June 2011 – 1 dose
- August 2011 – 3 doses
- September 2011 – 4 doses
- October 2011 – 2 doses

- 3 months without treatment
- February 2012 – 5 doses
- March 2012 – 4 doses
- April 2012 – 3 doses
- May 2012 – 2 doses
- June 2012 – 1 dose
- July 2012 – 2 doses
- August 2012 – 2 doses
- September 2012 – 2 doses

Photo taken on the 22nd September 2012 – 2 years from the first dose. Note the still active sarcoptic mange on the back of his leg and side of his cheek below his ear.

- October 2012 – 2 doses
- November 2012 – 0 doses
- December Xmas day – 1 dose
- Jan – March 2013– 4 doses (one dose per month)

At this stage it was a concern that the mites were building up resistance to the Cydectin® and therefore Ivermectin® was used for 10 doses over four months.

- April to July 2013 Ivermectin – 10 doses over four months

Photo taken on the 22nd July 2013 – nearly three years since the first dose. The doses were clearly not sufficient, and sarcoptic mange was still evident.

- During the following 10 months from August 2013 to May 2014, he had 31 doses

He was still not mange free and dose amount was now increased to 80-100 mL/dose.

- **May to September 2014 – 5 Months 16 doses of 80-100mL/dose**

After 4 years of treatment, on the 19th September 2014, he was sarcoptic mange-free.

Above photo taken July 2019, nine years after the start of treatment. He was never again infested by mange mites.

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- The treatment duration is greatly reduced.
- The chances of successfully applying the treatment are greatly increased before the wombat "disappears".
- The wombat is "sick" for a shorter duration and will therefore be able to put on weight faster and more quickly return to normal nocturnal feeding.
- The animal's fur will grow back faster and therefore reduce the risk of hypothermia.
- A short treatment cycle greatly increases the number of people who will commit to completing the treatment.
- It is less likely the mites will build up resistance.

Case study 2 – Intense treatment and faster recovery

This second case study, treated at Jarake Wildlife Sanctuary, describes treatment of an adult male treated in-field with appropriate doses and fast recover. He is a free-living calm wombat that was easy to approach. All doses were given via pole and scoop.

- Day 1 - First dose of **100 mL** (11 May 2018)
- Day 4 - Second dose of **100 mL** (15May 2018)
- Day 7 - Third dose of **100 mL** (18 May 2018)

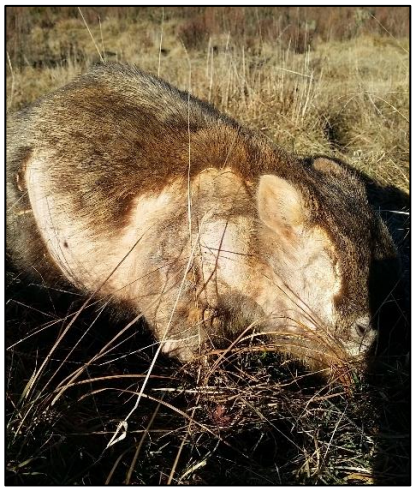
Hence, 300 mL within the first week over three doses.

Day 20 – Fourth Dose of 100 mL (30 May 2018)
Scabs are starting to come away from the sides of the wombat


Day 25 – Fifth dose of 100 mL (4 June 2018)
More scabs have been removed from sides. Scabs are starting to lift off face and legs.


Day 30 – Sixth Dose of 50 mL (9 June 2018) Last Treatment
Sides are nearly free of scabs and scabs are lifting from legs, face, and neck.


Day 38 – NO TREATMENT 17 June 2018
Scabs are continuing to disappear

7 WEEKS AFTER 1ST DOSE
Scabs around face have been removed (this is often the last area to improve)



3 MONTHS AFTER 1ST DOSE
Skin looking clear and signs of new hair growth


4 MONTHS FROM 1ST DOSE
Last of scabs disappeared


5 MONTHS FROM 1ST DOSE
Body weight returning and improved stance.

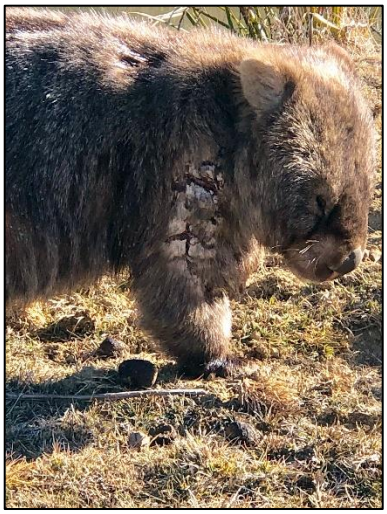

6½ MONTHS FROM 1ST DOSE
New hair coverage over whole body.

Over two years later and he is still mange free with no further infestation. Notice the line of fur growth still visible. A common mistake made by treaters is the misidentification of a healthy wombat seen some time later believing it's the wombat they have been treating. Returning fur growth and increased body weight takes time especially if treatment is taking many months when inappropriate doses are used. Digital photos can be misleading with different light during different time of the day. Photos taken by remote sensor cameras during night can be difficult to make an accurate identification.

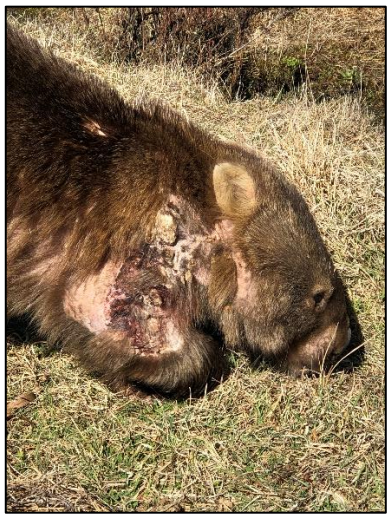
Case study 3 – Thick hyperkeratosis

A male free-living wombat treated at Jarake Wildlife Sanctuary using pole and scoop method. Mange did not appear widespread on his body but infestation was severe with very thick hyperkeratosis on both shoulders. He was depressed, emaciated and easy to approach. In this case the thickness of the affected area indicates the severity of mange. The sixth treatment two weeks after completion of the program was applied as a "safety dose" to prevent re-infestation.

Treatment 1: (Day 1) the 25th August 2019 – 100 mL
Treatment 2: (Day 8) 2nd September 2019 – 100 mL
Treatment 3: (Day 14) 8th September 2019 – 100 mL
Treatment 4: (Day 24) 18th September 2019 – 100 mL
Treatment 5: (Day 31) 25th September 2019 – 100 mL
Treatment 6: (Day 46) 10th October 2019 – 100 mL



Day 1 Thin and depressed



Day 31 Eyes clear, scabs falling off

Day 46 All scabs have lifted. Last day of treatment

Day 80 since start of treatment

Case study 4 – Emaciated and still a fast recovery with intense treatment.

An emaciated adult free living wombat was treated at Jarake Wildlife Sanctuary using pole and scoop method. With intense treatment, the mange infestation cleared quickly followed by an improved body condition at an earlier time compared to using a prolonged treatment duration. The last photo (Fig 5) shows the wombat close to one year later.

The doses via pole and scoop were:

- Day 1 – 100 mL
- Day 8 – 100 mL Emaciated and depressed.
- Day 13 – 100 mL Still very poor body condition.
- Day 18 – 100 mL Scabs are lifting, superficial bleeding, eyes clear and improved body condition.
- Day 31 – 100 mL Last dose

Day 8, Emaciated and depressed, extent of infestation not visible through fur.

Day 13, Very poor body condition.

Day 18, Scabs lifting, eyes clear, improved body condition.

Close to one year later. Line of fur growth is still visible.

Things to Consider

- Are you treating (the) one wombat under the house or shed reported by a member of the public?
- Are you treating a few or a large number of wombats?
- Are they approachable and accustomed to people, or wary and will dart into a burrow before you reach them?
- Have you treated in the area before and will be doing "maintenance"?
- How big is the targeted area and number of burrows? 10 burrows or 100's?
- How often can you monitor, and do you have helpers and or remote sensor cameras?
- What is the environment like? Blackberry covered riverbanks? Farmland? Along roads? Forests? Camp sites or parks?
- Do you need to contemplate dogs, cattle, sheep, horses, or other hazards?

Young Wombats

When do we capture and take into care and when do we leave and treat *in situ*?

Every situation is different, and assessment has to be made accordingly. The wombats should not be chased or stressed in anyway. Can you walk up and just pick him/her up? Are there any additional issues such as territorial aggression wounds, unusual behaviour or does he seem emaciated or injured in any other way? Can the wombat be taken to, assessed, and treated by a veterinarian?

The decision should not be led by our emotions or belief that the wombat needs to be hugged, fed, and loved by us. Many joeys at 10 kg and above will start to spend time grazing on their own and catch up with "mum" in the burrow. They are also familiar with their environment and territorial establishment has started. We are seeing a snapshot of the time and we cannot know if the young wombat has a mother nearby (probably also with sarcoptic mange and needing treatment). If there is no mother, it does not mean he/she cannot survive, even though it is not ideal, urgent treatment and daily monitoring is needed. It is also hard to estimate their weight and age accurately when in the field, they might be older than he/she looks. Joeys with mange of this size often do not do well in care and the additional stress of capture and handling frequently leads to the death of the wombat. Location also needs to be considered, i.e. is he/she safe from cars, dogs, etc. Close observation and monitoring are needed before a decision is made.

NOTE: These guidelines are restricted to wombats of 10 kg and above. Younger orphaned joeys should be taken into care and treated according to veterinary advice.

Dose Rate (as per APVMA application – not the current permit)

Use the Sarcoptic Mange Scoring Table (Table 1) for "In-field" free-living bare-nosed wombats. Most wombats reported with mange are severely infected and easy to approach. The "pole and scoop" device ensure the wombat receives the optimum dose (Figure 5).

Figure 5: A) Photograph of the 'pole and scoop'; B) Photograph showing 'pole and scoop' method being utilised to treat a free-living wombat.

Dose rate **4ml per kg/body weight** using direct application ('pole and scoop' method).

Example:

For an adult wombat weighing 20 kg

4mL x 20 kg = 80 ml dose

Number of Doses (Direct Application):
Mild sarcoptic mange - every 5 - 7 days 1 - 3 doses.
Moderate sarcoptic mange - every 5 - 7 days 4 - 5 doses.
Severe sarcoptic mange - every 5 - 7 days 5 - 6 doses.

Assessment after completion if further doses are required.

Burrow flaps (Figure 6) are best used when the targeted wombat has been observed going down the burrow. A flap can then be installed and the possibility that the targeted wombat receives the dose increases. Flaps can also be set up in the general area where wombats with sarcoptic mange have been confirmed. Infra-red sensor cameras should be used as an additional tool to provide evidence of who and how many animals are visiting the particular burrow.

Figure 6: Examples of burrow flaps used to treat free-ranging wombats in the field.

Dose rate **4ml per kg/body weight up to a maximum single dose of 50 ml** (in recognition that a wombat may swap between burrows that may be being treated simultaneously).

Example 1: Juvenile 10kg wombat = 40 ml dose

Example 2: Adult 20 kg wombat = 50 ml dose

Example 3: Adult 30 kg wombat = 50 ml dose

Table 1 Sarcoptic Mange Scoring Table for "In-field" Free-living Bare-Nosed Wombats - Dose rate 4ml per kg/body weight
Example= **Adult** 20^{+} kg **Joeys** 10^{+} kg

Score	Description	Example
1 Mild	Hair loss starting to show on sides, characterised by tiger stripes. Inside and back of legs may appear pink and crusty. Ears and around eyes may look dry and bare. Wombat still looks rounded.	
2 Moderate	Can still have good covering of hair. Area around eyes and ears may appear dry and crusty. Large portions of hair loss on sides of body, shoulders and neck. Skin appears crusty in these regions. Mange is starting to spread to the limbs. Small lesions may be present.	
3 Severe	Extremely emaciated. Most of body usually covered in scabs. Ears and eyes crusted 'cauliflower' appearance. Face crusted 'mask like'. Not all wombats exhibit these characteristics. Easily approached. Appears to be blind and deaf. Very little hair except down spine and rump 'Mohawk appearance'. Lesions likely to be present. Very sick, noticeably 'hunched up' appearance.	 

Joeys >10kg	Rescued or “in care” joeys should be supervised by a veterinarian.

Wombat attack – territorial aggression	Wombat attack wounds are usually visible on the wombat’s rump and in more severe cases also down the middle of the back. These wombats may also be seen during daylight hours as they are avoiding contact with the dominant wombat which will be active at night. *These wombats need veterinary attention.*

Wombat attack can present to the inexperienced observer as sarcoptic mange. Members of the public will often report sarcoptic mange when they see any skin issue or wounds. Always try to get a photograph to confirm the size of the wombat, degree of mange, territorial aggression wounds or dog attack wounds before recommending any “treatment”.

If concerned contact mange@wombatprotection.org.au or local wildlife group.

Products to be used (the Products): Cydectin Pour-On for Cattle and Red Deer (APVMA 45970) which is supplied in smaller containers, labelled as CYDECTIN POUR-ON (appendix 2).

Moxidectin Pour-On for Cattle (APVMA 69563/61136) which is supplied in smaller containers, labelled as MOXIDECTIN POUR-ON (appendix 3).

Covine MOXY Pour-on for Cattle and Red Deer (APVMA 86691/116384) which is supplied in smaller containers, labelled as COVINE MOXY POUR-ON (appendix 4).

Cattleguard Pour-on for Cattle and Red Deer (APVMA 66931) which is supplied in smaller containers, labelled as CATTLEGUARD POUR-ON (appendix 5).

Moximax Pour-on for Cattle and Red Deer (APVMA 80298 / 100570) which is supplied in smaller containers, labelled as MOXIMAX POUR-ON (appendix 6).

Maximus Pour-on for Cattle and Red Deer (APVMA : 67606/57557) which is supplied in smaller containers, labelled as MAXIMUS POUR-ON (Appendix 7).

These products contain 5g/l moxidectin as the only active ingredient and 150 g/l Hydrocarbon Liquid.

First Aid Directions: If poisoning occurs, contact a doctor or Poisons Information Centre. Phone 13 11 26. Safety Directions: Poisonous if swallowed. Will irritate eyes and skin. Avoid contact with eyes and skin. Wash hands after use. Do not inhale. May irritate the nose and throat.

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