How Moisture Affects the Hoof

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Many readers are already well aware of problems that sometimes arise with hooves when moisture is present. A couple important questions are: why does this occur, and, what to do when wet hooves become problematic? In order to answer these questions it is important to take a closer look at the hoof capsule.

The hoof capsule is made up of a dead material called keratin. Keratin is found in the outer layer of skin, hair, nails, horns and hooves. It is the product of a process called keratinization. This process starts with the production of live cells in the deepest layer of the epidermis (outer layers of the skin) called the stratum basale. This layer consists of one row of single cells that are continually being produced through mitosis (cell duplication.) This layer is firmly anchored to a basement membrane. The new cells are produced in an interesting process involving a special type of cell called a stem cell. These cells are generally the only cell type in the epidermis that can go through cell division. When a stem cell divides it produces two cells: a new stem cell and a cell that will change as it migrates through the layers of the epidermis. The bulk of these cells that undergo changes are called keratinocytes. The keratinocytes are the cells that migrate through the layers of the epidermis. The keartinocytes end up dying at the top layer of the epidermis to form a protective keratin 'crust' or stratum corneum. This 'crust' has different architecture depending on its use. In the horse's case, the stratum corneum is the layer what most horse owners and hoof care practitioners handle routinely.

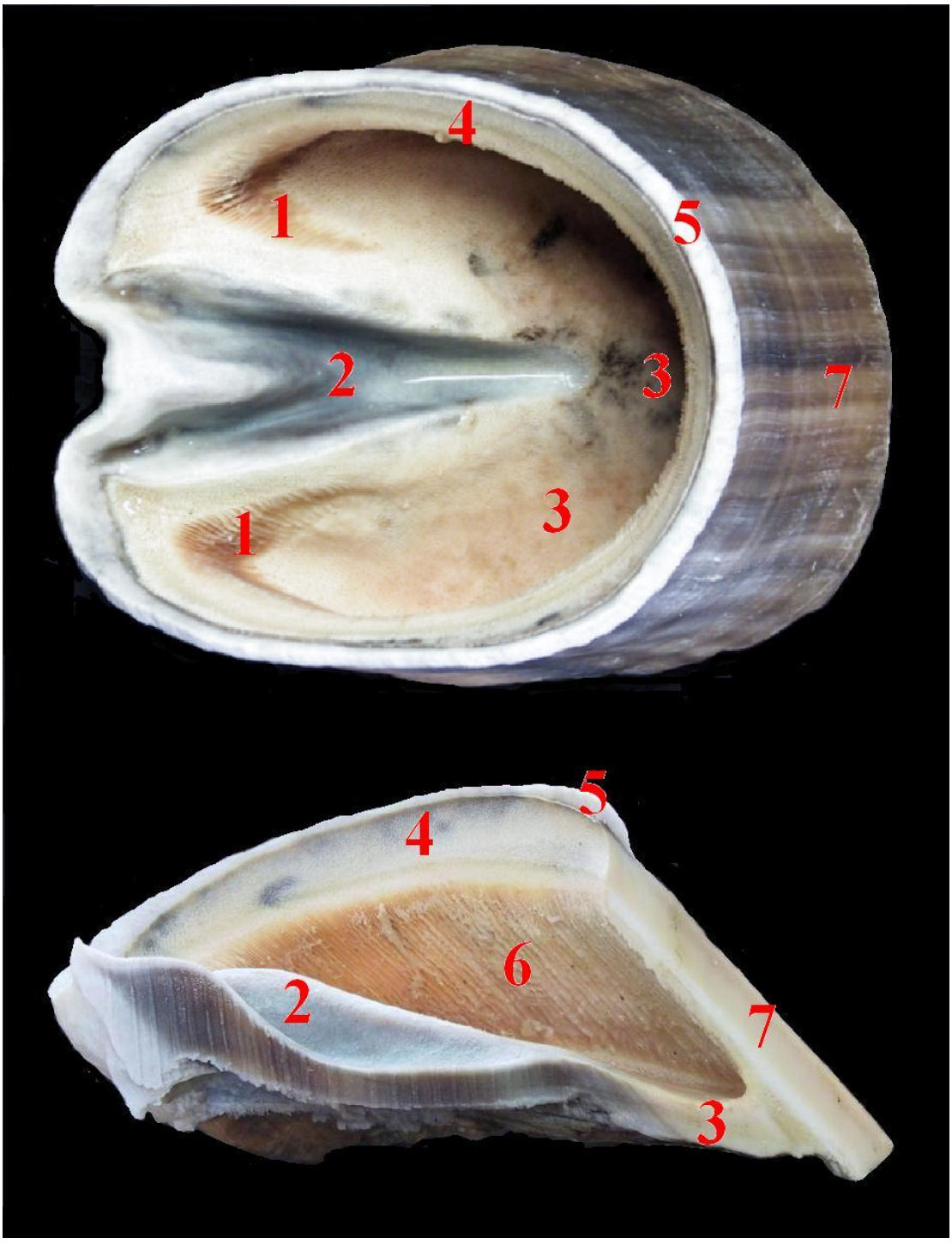

Figure 1: The internal structure of the keratinized hoof capsule. The bottom figure shows a sagittal view of the keratinized hoof capsule. Labeled are: 1) **bar papillae**, 2) **frog**, 3) **sole**, 4) **coronary band**, 5) **periople ring**, 6**) lamellae**, and 7) **wall**.

There are different regions of the hoof capsule (figure 1), each of which has a different architecture. The most intricate design is found in the hoof wall (figure 2).

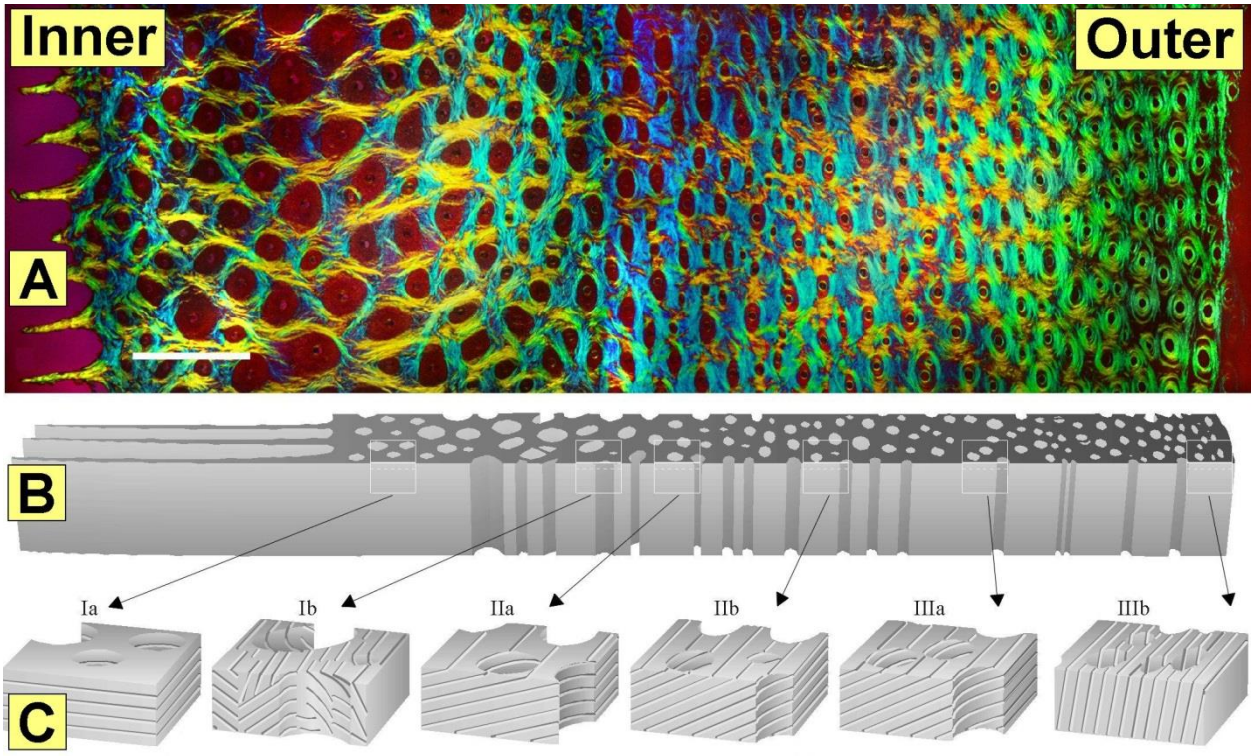

Figure 2: A cross sectional view of the hoof wall is shown in (A). The round structures are the tubules which begin at the coronary band. One can see how their shape changes throughout different regions of the wall. The inner tubules have a different shape and mechanical properties than the outer tubules. The intermediate structure that contains the tubules are represented in (B) and (C). The various orientation that the keratin takes on within the wall are shown in (C). This reminds one on how man-made plywood looks. The complete structure of the hoof wall can be viewed as a composite material such as plywood re-enforced with a mesh.

The hoof walls help deal with the tremendous energy generated from impacts. They also provide structural strength against cracks. A crack forming along the grain of one plane of the keratinous material, will be resisted by a neighboring plane whose fibers have different orientation (figure 2C). The tubules lend some flexibility to the hoof capsule. The tubules can stretch, compress and bow to some extent. The tubules closer to the dermis are more moist and flexible than the outer tubules. The inner tubules -- being close to the sensitive laminae – need to match somewhat the mechanical properties of the dermis, meaning the tubules need to be able to flex. The outer tubules are designed to absorb the main brunt of each landing concussion and to protect against the elements -- this is area needs to be very strong and more rigid. The difference in mechanical strength of the tubules is largely due to the number of hydrogen bonds within the keratin molecule. The keratin of the inner tubules contains fewer bonds, whereas the keratin of the outer tubules contains more bonds. The bonds provide mechanical strength to keratin, but these bonds are not impervious to outside factors. Moisture plays a role in weakening these bridges. Keratin loses some of its mechanical stiffness and strength when excess moisture is present.

Due to their complex design, the walls seem to have better structural strength than the keratinous sole, frog, and bar papillae. The design of these other structures is somewhat simpler, and closer to that of simple plywood.

Hooves are capable of adjusting between wet and dry conditions without too much trouble. In moist conditions, hydrogen bonds of the keratin molecule to detach thus making the hoof keratin somewhat weaker. This is the reason why hooves tend to look more ‘splayed out’ during the wet season, figure 3A. This is in general not an issue when the ground is also moist. As the conditions become drier the detached

hydrogen bonds reconnect and the wall regains mechanical strength, allowing hooves to deal with harder surfaces, figure 3B. Hooves are designed to adjust back and forth without major issues as long they are of good quality and moisture is not excessive and persistent.

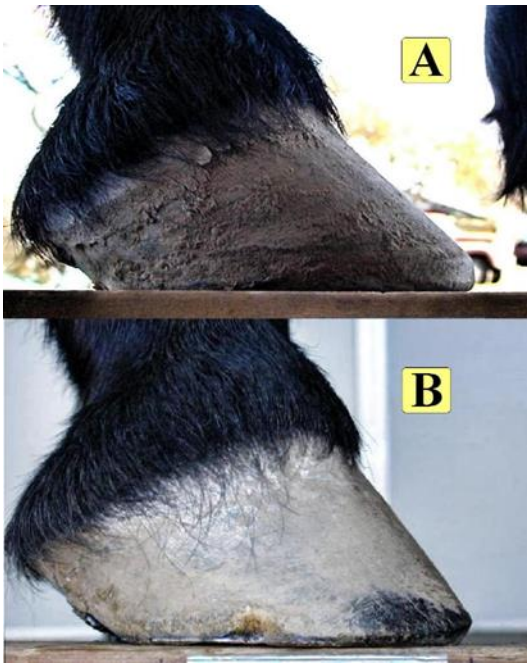

Figure 3: Same hoof, same trimming method, but in image (A) was on a very wet pasture, while image (B) was a year later on a very dry pasture.

However there are situations due to moisture that need to be addressed, especially when it is prolonged. Here are a few tips to avoid some issues caused by moisture.

Implement Pasture Management

Ideally, give your horse a place to spend some time of the day in dry conditions, such as a large covered pen with footing that is kept dry, or at least drains well. Better would be to stall your horse at night.

Do not Over-Hydrate Hooves

Regular washing of horses affect the hooves since water weakens the hoof keratin. Try to sponge horses avoiding watering hooves. If you live in a dry area, this constant bathing can be hard on hooves as they constantly adapt back and forth between wet and dry.

Prepare for Seasonal Changes

Depending on the hooves, it is important that the sole, frog and bars be lightly trimmed under wet conditions. Have the excess wall length and distortion removed but make sure that your hoof care practitioner is 'zen' with the hoof. For those of you who travel with their horses be very careful when moving from wetter area to more arid area. Hooves do not necessarily re-adjust instantly to a fast change in moisture. It often takes a least a month for a hoof to adjust to such changes. Often wet hooves are a bit flakier than dry one. Make sure that your hoof care practitioner knows that the hoof needs to adapt to its new environment and does not remove too much material until the hoof has adjusted to its new environment.

Beware of Early Signs of Hoof Sensitivity/Tenderness

Hoof tenderness can be caused by different factors. Some horses do not naturally produce enough sole, even under the best management. In order to be comfortable while under saddle, a horse should have at least half an inch or more of quality sole. I would advise that you take quality lateral (side view) radiographs of your horse annually as part of a preventative hoof care program. Radiographs will help with assessing

the sole depth of your horse (figure 4). This will help your horse's hooves but also give your hoof care practitioner a better read on how to address such issues.

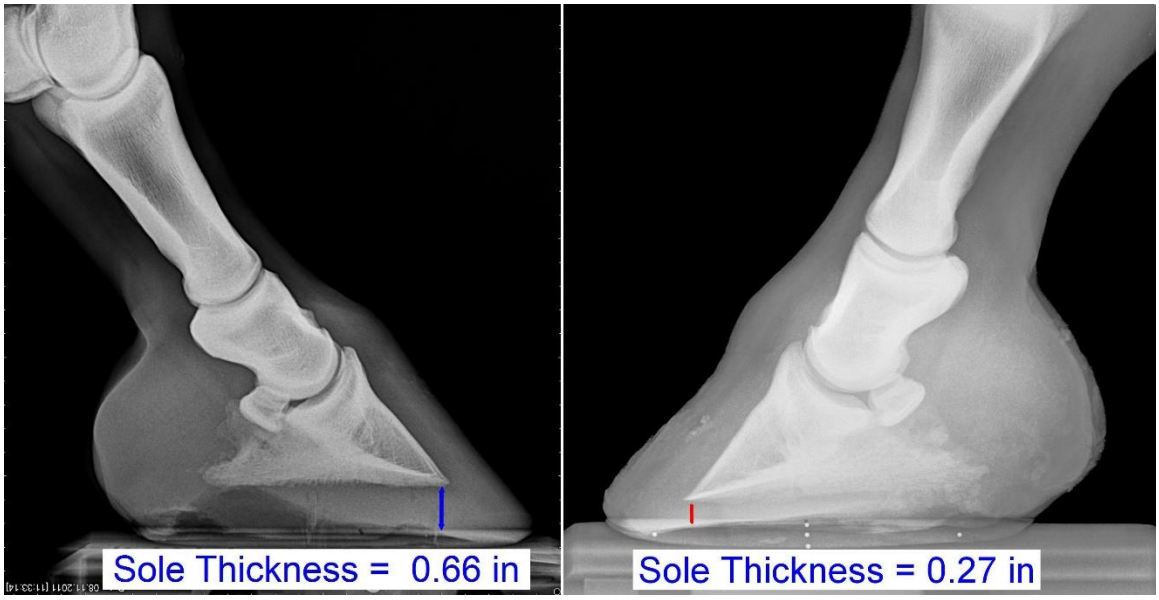

Figure 4: A lateral radiograph can help you assess the thickness of the sole. The radiograph on the left shows a hoof with good sole depth. The radiograph on the right shows a hoof with marginal sole depth.