



Health and Disease of the Equine Frog

By Candace Platz DVM and Heike Bean

Properties of a Healthy Frog

A healthy frog is essential to the optimal physiological and mechanical function of the horse's foot. Unhealthy frogs can significantly reduce a horse's athletic performance by causing pain, impaired function, inflammation and by becoming a source of chronic infection. Yet the structure, function and appearance of a truly healthy frog is poorly understood by many hoof care professionals.

Veterinarians, farriers and barefoot trimmers are often taught using texts depicting "normal" frogs which are in fact atrophied, contracted or diseased. Therefore what is taught as "normal" is not necessarily healthy. Understandably, with this image in mind, hoof care professionals too often fail to consider the unhealthy frog as an underlying cause of foot pain and lameness. The black malodorous discharge of classic thrush is often the only frog disease taught to veterinary students and farriers. But if we are to do justice to our roles as equine health care providers, it is essential to learn to recognize, treat and prevent the full spectrum of frog disease that affects domestic horses.

The healthy frog is made of very dense, firm and resilient tissue, strong enough to resist indentation by a sharp object. Its appearance is generally smooth, free of flaps, holes, fissures or undermining layers. It is divided by a central sulcus that is dry and solid. The central sulcus should be wide and shallow enough to be easily visualized, cleaned and probed throughout its entire length and depth without discomfort. There should be no slits, pockets or fissures on the side walls of the grooves or sulcus. Caudally it should widen and blend smoothly and strongly to form a solid connection with the heel bulbs.

Similarly, the depths of the collateral grooves where the frog horn joins the horn of the sole should be dry and firm. The collateral grooves should be available for cleaning, probing and inspecting throughout their entire length including the deepest parts. They should be free of snags, rough spots or sensitivity. The junction of frog and sole horn should be tight without any soft, discolored or punky areas. The frog should not "mushroom" laterally over the grooves, which obscures visualization and provides a haven for microbes. The frog should be tall enough to make ground contact throughout most if not all of its length, most importantly toward the back of the foot. It should not be so tall that it is forced to the side or split on weight bearing.

The frog should not be compressible by digital pressure, not even toward the rear of the central sulcus and near the heel bulbs. When palpated, the caudal frog should feel at least as solid as the soles of running shoes, in contrast to the heel bulbs which are much softer

The color and texture of the horn should be consistent throughout the structure, except for pigmented areas of light colored hooves. With this exception,



dark areas are usually associated with underlying infection and loss of structural integrity.

Examples of Healthy Frogs

Fig. 1 The dark area on this beautifully healthy horn is clearly pigmentation of a mark extending from the skin of the heel bulb into the horn of the frog and not evidence of disease.



Fig. 2 In contrast, the darkened areas in the frog of this light colored hoof are associated with compromised tissue due to infection in the central sulcus and collateral grooves.



Fig. 3 Below is an exemplary clean robust pristine frog. The central sulcus and collateral grooves are wide, clean and completely free of any sign of infection. What looks like a layer is actually a mark left by trimming.



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E

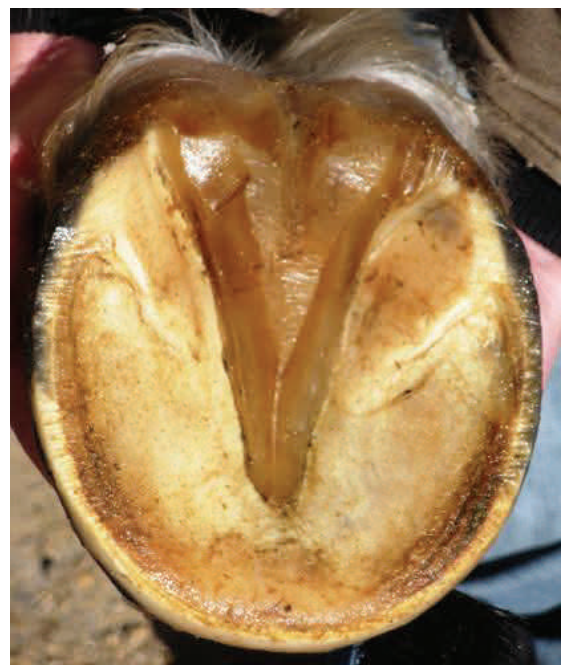
Fig. 4 This frog is from a wet terrain front hoof. Note the clearly defined sulci, the robust size and width, and the clean uniform appearance of the horn. The strength in this frog allows for broad, plump and strong heel bulbs, with an ideal distance between the lateral cartilages.



Fig. 5 This picture of the same hoof illustrates a strong solid disease-free connection between the frog and the heel bulbs. Also evident are the height and strength of the heels that is created by a fully-functioning frog



Fig. 6 Here is another example of a healthy wet terrain forelimb frog. Notice the consistent light color throughout the entire structure





U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E

Fig. 7 This is an excellent example of a strong healthy hind foot frog living in damp conditions. There are no "secrets" in these collateral grooves or central sulcus.

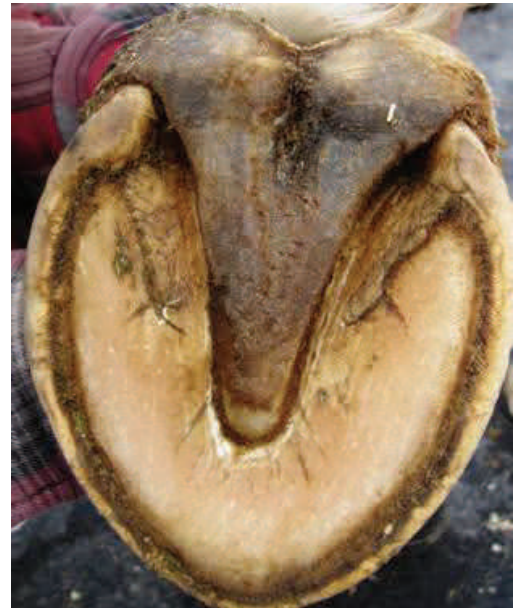


Fig. 8 a and 8 b Below are pictures of the left fore and left hind respectively of a sixteen year old horse, shod for most of his life, who has been barefoot for less than a year. A strong disease-free frog such as this in a de-shod horse contributes to correct, pain-free hoof function, soundness and improved quality of gait. The heels will continue to expand in the front hooves if the frog is maintained in this condition of pristine health. Too often horses "flunk out" of de-shoeing programs because unhealthy frogs are not recognized as the culprit in causing persistent soreness. Notice the clean, solid dry depths to the central sulci and collateral grooves, as well as the robust structure with uniform color and texture throughout.





Fig. 9a and 9b The horse belonging to this strong healthy frog lives in a dry area. Although the collateral grooves were not thoroughly cleaned for this picture, and theoretically could harbor infection, the robust appearance of frog and heel bulbs make this unlikely. The second view of the same foot illustrates a solid connection between caudal frog and the strong heels that can develop in the absence of disease.



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A
T
I
M
E

WHAT DOES A HEALTHY FROG DO?

Mirroring the shape of the underlying digital cushion, the frog determines the width of the foot across the heels by creating a wedge between the flexible heels of the hoof capsule. A healthy frog maximizes the ideal mechanical and energy absorbing capacity of the digital cushion by serving as its functional extension, transmitting concussive and weight bearing forces from the ground to the digital cushion while protecting it from trauma.

The digital cushions of domestic horses, particularly those stabled during the first two years of life, typically have less fibrous connective tissue than those of wild horses, and so do not have the same supportive strength. The relative flabbiness of domestic digital cushions makes the frog's role in maintaining correct hoof mechanics even more important in this population. Bearing in mind that the heel of the horse's hoof is so flexible it can be manipulated with bare hands, it is easy to see that the width of the back half of the foot as well as its resistance to horizontal distortion and torque depends on the size, quality and pain-free function of the frog.

Frogs are also apparently important to sole concavity, since flat feet do not regain concavity without the support of healthy frogs. No matter how good the trim, without adequate frog support concavity cannot be reestablished.



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E

Fig. 10 Cheryl Henderson illustrates how the wedge shape of the frog is ideally designed to perform these functions.

The frog provides mechanical support to the joints of the distal limb. Because the frog and digital cushion are important factors in limiting the descent of the coffin joint upon impact and during weight bearing, inadequate support from these structures can allow the coffin joint to over-extend. When this occurs, the result can be inappropriate stresses on multiple structures in the distal limb, including joint capsules, cartilage, tendons and ligaments. Especially vulnerable are small ligaments associated with the navicular bone. It is interesting but hardly surprising, that increasingly sensitive imaging studies using MRI technology are revealing degenerative and inflammatory lesions in this ligament and other structures deep within the hoof capsule, and that these are now being implicated in chronic lameness.

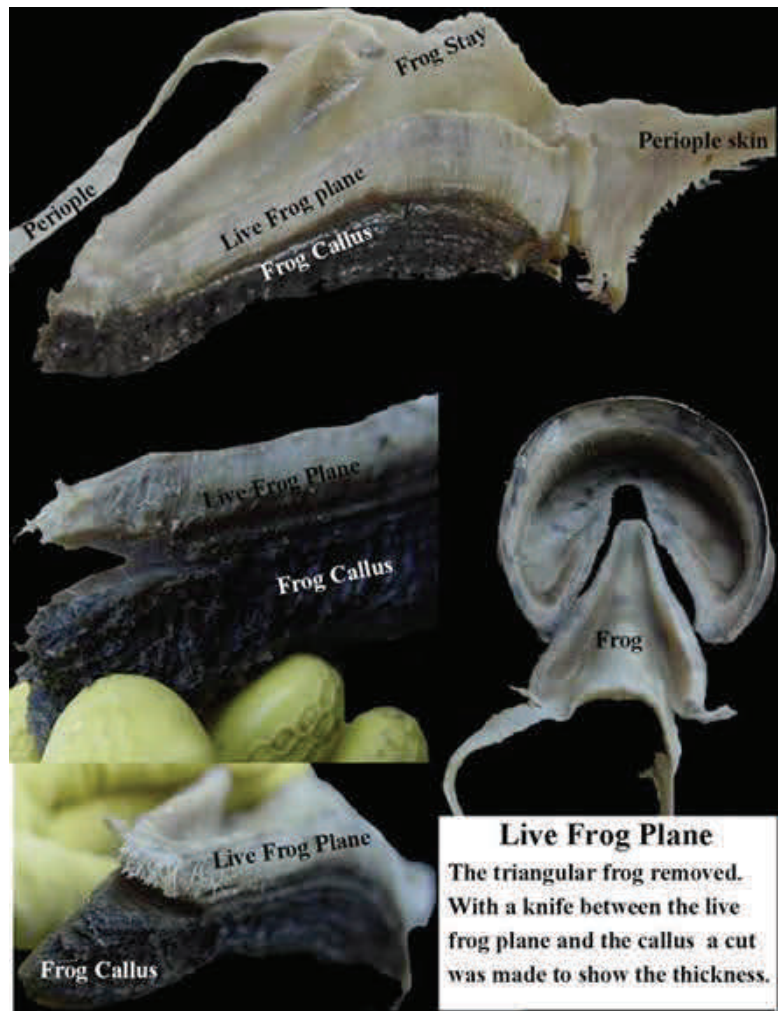
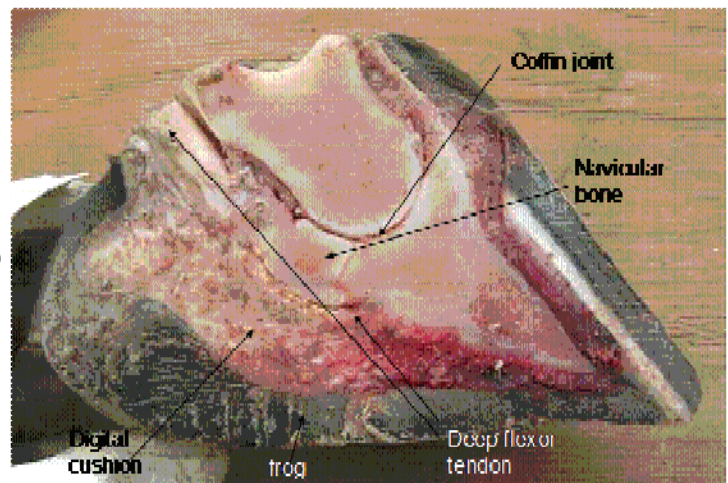


Fig. 11 The cross section below shows the relationship between the frog and the digital cushion above it. Although there is plenty of frog mass to support the digital cushion in this specimen, it is easy to see how the coffin joint could descend too far on weight bearing if the frog is not adequate. The bones of the loaded coffin joint would not articulate properly, the deep digital flexor would be overstretched and there would be excess strain on the navicular bone and its attachments.





WHAT ARE THE CONSEQUENCES OF FROG DISEASE?

Many chronic cases of "caudal heel pain" and "navicular syndrome" are likely manifestations of this proposed vicious cycle:

1) Infected, incompetent frogs create impaired internal and external hoof/foot/leg mechanics due to either frog structural inadequacy, frog soreness or both.

2) Ongoing inappropriate loading or stress on one or more internal structures such as the impar ligament results in inflammatory, then degenerative changes.

3) Pain from these changes causes further alteration in gait mechanics.

4) Altered gait mechanics contribute to structural changes such as contracted heels and frog atrophy, which add to mechanical stress and inflammation within the foot.

5) Because of these alterations in morphology, circulation within the foot is compromised, impairing the horse's ability to heal mechanical and inflammatory damage as well as infection. Infection can persist, becoming chronic and deep seated.

6) Because of his chronically sore feet, the horse may be thought to require shoeing, often therapeutic shoes which may provide some immediate relief but also may further compromise function and healing by limiting frog contact, heel expansion, and the circulation. Without treatment of occult infection, heel pain persists, and the horse becomes increasingly dependent on the external support of shoes. This "proves" to owners and practitioners that the horse cannot be sound without corrective shoes,

Eventually the horse may become a candidate for pain medication, injections, surgery, or nerving. Alternatively, the horse could reach a long term equilibrium between inflammation, degenerative changes, chronic infection and level of dysfunction. The weakened foot may only be able to function with the external support of shoeing. If the horse's discomfort is relatively symmetrical, he may not be considered lame, and his loss of athleticism attributed to aging, bad riding, poor training, improper shoeing/trimming, or the demands of his job, depending on who is giving an opinion (some of these factors could be contributing to the problem, complicating the picture). Many professionals are so accustomed to the appearance of compromised frogs that they consider them normal, and thus overlook frog disease as a possible initiating cause of loss of performance leading to lameness.

Frog disease and its negative consequences can be subtle and insidious in onset and progression. Decreasing fluidity, power, suppleness and suspension in the gait may continue unnoticed until there is overt lameness. Like the frog (pun intended, sort of) who stays in a pot of water until he boils to death if the heat is turned up slowly, the horse owner may not be aware of a gradual decline in the horse's performance. The same owner would be quite alarmed if this deterioration happened overnight, just as the frog would immediately jump out if plopped into a pot of hot water. By the time



the problem is recognized, degenerative changes secondary to the initiating frog disease may be evident, and the frog disease is overlooked.

It has been argued that frog disease and lameness is a "chicken and egg" situation where it is difficult or impossible to say if poor hoof mechanics cause frog disease or vice versa. However, it is the authors' experience that effectively treating frog infections has restored soundness to lame horses whose only options were thought to be pain medication and /or nerving, significantly improved the quality of movement in virtually every horse treated, decreased ouchiness on hard surfaces for horses with sensitive feet, and stopped longstanding bouts of hoof abscessing that had persisted for years. With these results, the debate becomes academic at best. Considering that treating frog infections is relatively noninvasive (compared to joint injections and nerving) and inexpensive (compared to MRI's and lifelong corrective shoeing), frog disease should always be included in the differential diagnosis of performance loss and sub-acute or chronic lameness.

To summarize, frog infection causes impaired frog structure and function, which in turn can compromise other structures in the distal limb as well as systemic health. Because unhealthy frogs are so prevalent, diseased frogs which are not obviously " thrushy" are often considered normal and are not treated. Frog disease may be an important initiating or contributing factor in many degenerative changes in the equine digit. Since we rarely find what we aren't looking for, being able to recognize frog disease is an important skill for hoof care providers.

What Exactly is Frog Disease and What does it look like?

Frog disease occurs when the frog tissue is invaded by bacteria and/or fungus which cause damage to the tissue and loss of structural integrity.

Commonly referred to as "thrush," disease in frog is most obvious when it presents with a black malodorous discharge, as illustrated here in Fig. 12:



But this is only one manifestation of frog disease. Any change in the frog which compromises its proper form and function may be viewed as pathological. Alterations in the normal architecture, color or tissue strength of the frog that is not traumatic in nature should be considered possible evidence of underlying disease.

U
N
O
A
L
A
V
O
L
T
A
—
O
N
E
A
T
A
T
I
M
E



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E

Fig. 13 In this example, fissures, flaps, discoloration and loss of frog structure are evident and obvious. Although common, this is not the appearance of a healthy frog.



Diseased frogs sometimes manifest as puny, narrow and weak structures, without obvious evidence of disease, as in the two examples below. (Fig. 14 and Fig. 15) But a careful examination shows that the central sulcus in the first picture has punky material in its depths, with a hole in the back that probably harbors infection.

Right: Fig. 14



Fig. 15 Close inspection of this frog reveals a slit-like central sulcus that may harbor disease. The collateral grooves are not open enough to be evaluated, and are suspiciously irregular and dark.





Infection is often accompanied by a peculiar rotten onion smell, but there may be no odor at all. In most cases there is no discharge. The frog horn may have regions of soft punky tissue or be riddled with holes. The entire frog may be yellow and cheesy looking like in the picture below (Fig. 16) or the cheesy areas limited to pockets and layers encountered during trimming, as in the central sulcus of the hoof two pictures above (Fig. 14)

Right: Fig. 16



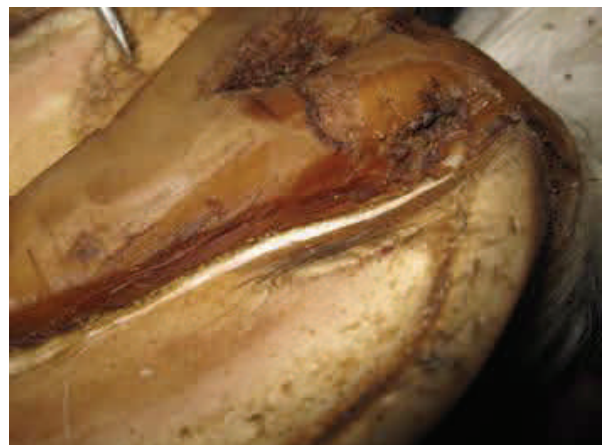
Fig. 17 Very often, diseased horn is dark and discolored as in the image below. Notice the crack extending from the infected central sulcus into the heel bulb and the ragged appearance of the body of the frog, as well as the extensive discoloration.



Dissecting layers coated in a light powdery substance are pathological, as are fissures, flaps, holes, and other defects in the structure. Undermining tracks and layers may or may not be fluid filled, and may or may not lead to cavities within the frog.

Defects may be obvious but often nothing is visible at all unless the frog is carefully trimmed and then scrutinized, using appropriate tools and good light.

Fig. 18 The frog shown below looked overall quite healthy but there was one small area near the heel on the side of the frog that was discolored and irregular.



U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E



Fig. 19 Probing deeper in this area revealed a soft spot.



Fig. 20 Careful trimming released this odorless milky fluid, most likely necrotic debris.



Fig. 21 After the milky material was removed, this cavity was left. This horse was not lame, but if left untreated such lesions provide access to pathogens and ongoing damage. Later we will discuss how to treat this defect.



This example demonstrates the importance of meticulous examination of the entire frog including the ground surface, body, heels, and the depths of the central sulcus and collateral grooves. Any pockets, slits, flaps, holes or other defects should be probed and evaluated. The entire structure of the frog should be of uniform color and resistance to digital pressure, with no soft spots. A healthy frog does not decrease in strength from toe to heel or soften and darken toward the back of the central sulcus as is too often the case. There should be no slit continuing from the central sulcus into the area between the heel bulbs or necrotic tissue in the collateral grooves. There should be no unpleasant odors associated with the clean equine foot.



Fig. 22 The frog shown here is severely pitted and undermined, with dissecting layers of infection causing sloughing of chunks of tissue superficial to the diseased areas. Horses in New England (wet climate) who periodically "shed their frogs" as part of the "normal growth cycle" stopped doing so after their frogs were treated for infection and appropriately maintained, even during the mud season. Frog shedding in chunks or thick layers that significantly changes the shape and mass of the frog may in fact represent sloughing of tissue due to undermining infection.



U
N
O
A
L
L
A
V
O
L
T
A
—
O
N
E
A
T
A
T
I
M
E

Fig. 23 Look how deep a screw driver could penetrate painlessly into the back of this frog. A small slit near the bulb caused by frozen ground allowed access to pathogens which excavated a huge cavern in the frog tissue. Eventually, a large portion of this frog "shed" due to dissecting of the disease process into the body of the frog.



Fig. 24 This frog has multiple deep pockets and fissures. The central sulcus is reduced to an infected slit, and the collateral groove is also diseased. Notice the darkening of tissue toward the more damaged rear of the frog. The toe area has more normal light coloration except in the area of the defect, which is probably infected.





Fig. 25 Despite some effort to clean up the collateral grooves, the trimmer of this foot ignored the necrotic tissue in the central sulcus, and the almost complete destruction of the caudal portion of half the frog due to disease. This horse was not thought to be lame, though he was persistently "ouchy" on hard footing. Colleagues considered this an exemplary trim and did not comment on the frog disease. The horse's lack of forwardness was thought to be due to a poor attitude and his sensitivity attributed to lamellar pain. Once his frog infection was controlled, the horse moved happily forward on soft footing as well as hard going.



Fig. 26 The central sulcus on this hoof is too deep and narrow, providing an ideal site for infection to persist. The decay in the caudal collateral grooves communicates through the quarters with the white lines, which are also diseased. The flared tissue over the collateral grooves toward the back of the foot is too flabby to provide significant support. By leaving this tissue to "protect" the foot, the trimmer has in fact provided protection and nourishment for the disease process. Removing these flaps to treat the infection revealed how atrophied and inadequate the frog truly was. This contracted hoof de-contracted with treatment for frog disease. As the frog healed, so did the hoof.



Fig. 27 Careful probing of the central sulcus below showed that the infection extended high and deep into the sensitive tissue between heel bulbs. The caudal half of this discolored frog was severely undermined by infection, and there was a dissecting layer of infection extending all the way to the toe.

U
N
O
A
L
L
A

V
O
L
T
A
—
O
N
E

A
T
A

T
I
M
E

U
N
O
A
L
L
A
V
O
L
T
A
—
O
N
E
A
T
A
T
I
M
E



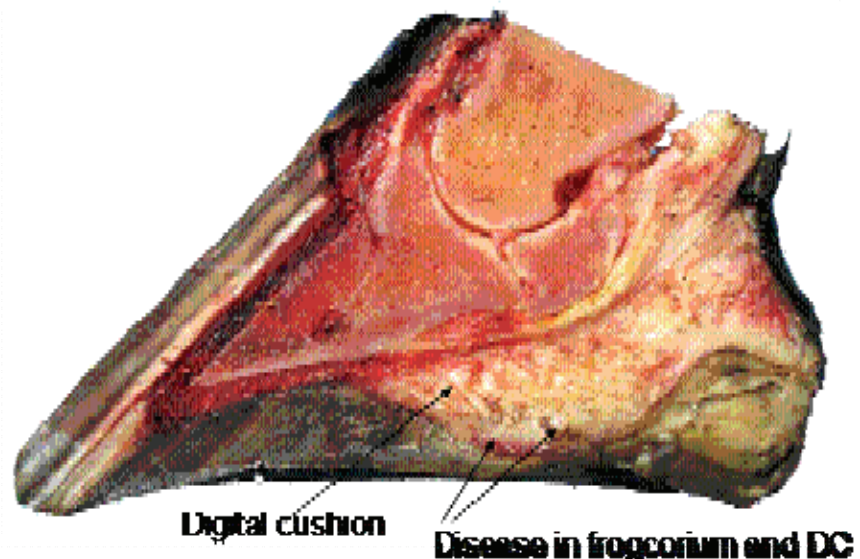
Fig. 28 Many cases of frog disease are less obvious. This frog looked healthy and solid when first examined, but the collateral grooves were overlain by horn so that prior to trimming it was not possible to evaluate them. However, the telltale sour onion smell suggested infection. With the excess horn removed as shown here, diseased tissue was visible at the depths of the collateral grooves, which were tender. The darker tissue toward the heel and the collapsed heel bulbs were evidence of disease in the back of the foot, probably spreading from the slit-like central sulcus. With treatment, the tenderness resolved, the odor disappeared and the heel bulbs strengthened.



Fig. 29 Occasionally the opposite is true. Frogs can be superficially tattered and dirty, but a careful trim reveals a robust healthy structure, such as in this example below. Notice the clean collateral grooves and strong connection between caudal frog and heel bulbs. The central sulcus will ideally become shallower with time, but some horses have deep clefts without any problems as long as they are kept clean and free of infection. The "floor" of the central sulcus should be firm, dry and free of fissures or holes, as in this example. The sulcus should not be sensitive to probing.



Fig. 30 The illustration below underscores the significance of infections in the frog horn. It is obvious from this cross-section that disease in the frog horn can and does readily invade the frog corium and digital cushion. Since the frog corium is the source of frog horn, disease in this tissue compromises the ability to grow horn and repair the damaged frog.





Why Do Horses Get Frog Disease?

Pathogens are ubiquitous in the horse's environment. Those that prefer anaerobic living conditions probably cause most frog infections, but the great variety in how the disease presents, progresses and responds to treatment suggests that a number of different organisms as well as mixed infections may invade the foot. Because of their tiny size, pathogens do not need a visible defect to gain access, but colonization is facilitated by flaps, layers, slits and cavities which provide a moist anaerobic environment. Persisting deep in the tissue, disease can be difficult to detect, both in the early stages and after superficial areas appear healed. Signs may not be apparent until the infection is well established or re-established,

The living conditions of domestic horses encourage and sustain frog disease. Unstabled confined horses tend to cluster around water sources, feed areas and shelter, resulting in prolonged exposure of their hooves to urine and manure. Ammonia in these wastes damages hoof and frog horn, facilitating invasion by harmful organisms. Stabled horses may also suffer prolonged exposure to ammonia from bedding soiled with manure and urine. Moisture in lush pastures, damp bedding or mud softens horn, making it more friable and thus vulnerable to invasion by pathogens.

Rubber mats, especially when used without bedding, seem to promote re-infection. In many cases, the ground beneath the mats provides an ideal location for fungal growth, as is known by every groom who had to strip and disinfect a dirt stall. Fortunately these areas can be disinfected. If not scrupulously clean, bedding can also promote disease not only by retaining moisture and ammonia, but also becoming a reservoir of organic material to support microbial growth. Classic thrush is often associated with standing in dirty stalls.

Dry conditions do not guarantee frog health. The function and physiology of the horse's hoof evolved in response to the demands of constant travel over long distances and rough terrain. Under most natural (not pasture or induced exercise) conditions, frog horn grows approximately as fast as it is worn away, so trimming is unnecessary and excess horn is not available to provide a haven for infection. Since most domestic horses do not have the opportunity to adequately self-trim, human intervention including trimming is necessary to accommodate the discrepancy between the lifestyle the frog was designed for and its modern circumstances.

Optimal horn growth and development are dependent on circulation of blood and lymph, which in turn is dependent on movement, i.e. repeatedly loading and unloading of the foot. Even in large pastures, domestic horses rarely approach the distances traveled by wild horses. Stabled horses with periodic or daily turnout do not even come close, especially those who have no companion with whom to play. Because the most domestic horses do not get enough exercise for optimum foot health, their frog horn is not as tough and resistant to invasion as that of unconfined horses in true natural conditions.

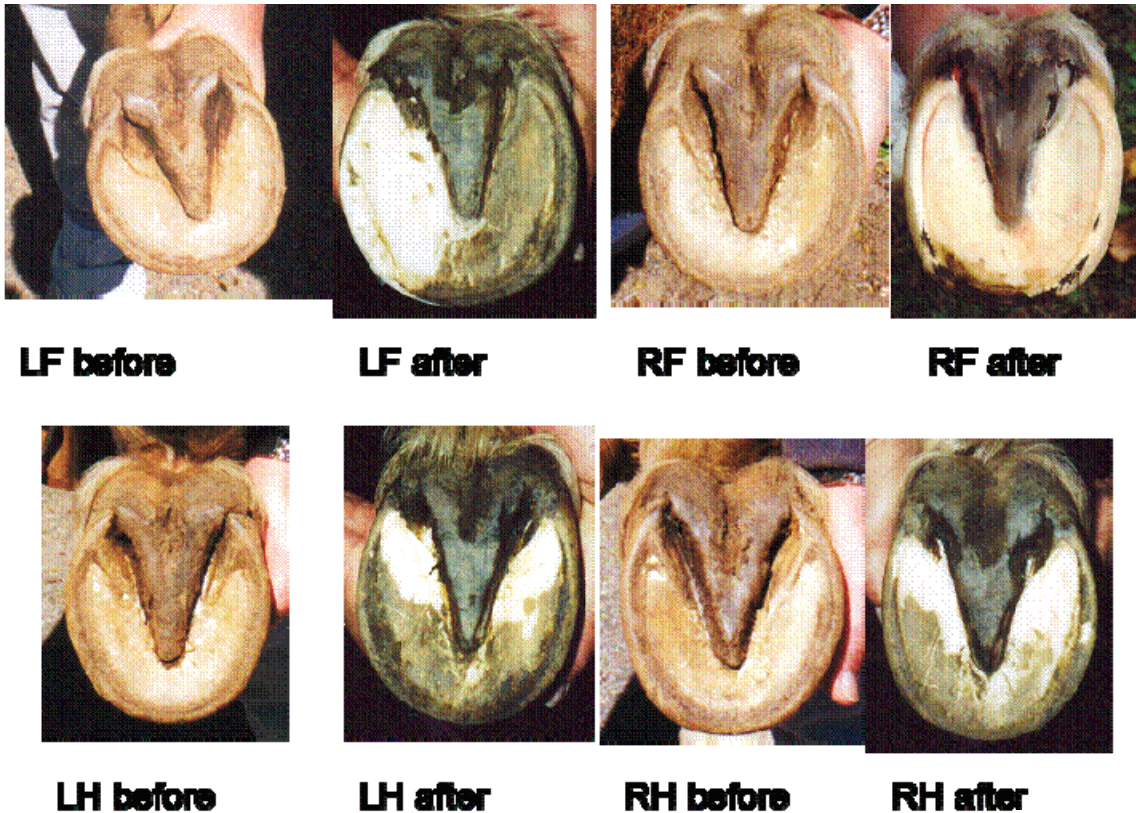
Systemic health is intimately related to the health of the equine foot, so any factor which affects overall health including nutrition, stress, and chronic or acute disease has an effect on frog health as well. Metabolically-challenged



horses are at increased risk for infection. Cushing's disease, insulin resistance, obesity and other maladies of the modern horse can all compromise foot health. Genetics undoubtedly play a role; full siblings living in a group showed similar susceptibility to hoof problems, while herd mates responded differently to the same management conditions.

Fig. 31 Poor hoof mechanics can contribute to the development of frog disease. In this case, over-trimming the heels and ignoring proper breakover resulted in the following changes in just seven months. Note the increased discoloration, the narrowing and atrophy of the frog body, and the decay evident in central sulci and collateral grooves after only seven months of suboptimal hoof care.

Frog trimming is a controversial topic in hoof care circles. Recommendations



range from radical excision to a complete hands-off policy. Current popular theories include "only take what would come off by itself," "the frog has its own wisdom and is capable of self-maintenance" and "never touch the collateral grooves because they are too sensitive".

The first two theories may be appropriate for populations of healthy free-ranging horses whose social and nutritional circumstances dictate continuous and unlimited movement over abrasive varied terrain. Since this is not the case for most domestic horses, their foot care protocol must be adjusted accordingly. Years of experience using judicious technique to address infection in collateral grooves have shown that trimming, cleaning and treating them has not been damaging. While it may be true that infected collateral grooves can be quite sensitive, eliminating disease in the collateral grooves eliminates this sensitivity. It also improves the health of the white lines by removing a constant source of infection. Several horses who suffered years of chronic, repeated and extensive foot abscesses were



healed by treating occult disease in the collateral grooves after other approaches, including corrective shoeing and trimming by highly qualified practitioners, scrupulous diet and environmental management, rehabilitative exercise and recommendations by a regional referral clinic, all failed to help.

The following two pictures (Fig. 32 and fig. 33) are from the "Let It Be" school of frog care. Most hoof clinicians are very conscientious about hoof balance, while the diseased frog (the "elephant in the living room") may go unnoticed. The second horse (Fig. 33) was referred to hoof care specialists to evaluate the correctness of the trim, since the horse was chronically sore on hard surfaces. The trim was judged to be adequate and the recommendation was to continue to force him to walk him on asphalt to toughen up his feet. The obvious frog disease was not mentioned.

Once these frogs were treated, the white line disease resolved and the horse



trotted happily on paved roads.

By interfering with the natural expansion of the hoof capsule, decreasing frog/ground contact, and altering hoof mechanics, shoeing can contribute to the development of frog disease. If the caudal extent of the collateral grooves is covered by the heel of the shoe, it cannot be adequately cleaned.

U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E



Fig. 34 Here is an example of a shoe that completely covers the caudal collateral groove on one side. If this hoof were not so terribly contracted, even more of the collateral grooves would be unavailable for inspection and cleaning. Compare the frog in this foot to the examples of healthy frogs above. Presumably the wide web shoes are to improve soundness and movement, but why not try healing the infection in the middle of the foot first?



Fig. 35 This is the same foot, with the shoe removed. Many hallmarks of a diseased frog are obvious, including discoloration, contraction, slitting of the central sulcus, atrophy, pitting and necrotic debris in the collateral grooves.



In summary, frog disease is largely a condition of domestication. The demands of living in the human world are often in conflict with equine physiology as it evolved over time. While the philosophy of 'natural horse keeping' is admirable, caretakers must be realistic and honest with themselves about the unavoidable negative impact of modern life on the horse's health. The conscientious owner or equine professional must be responsible for taking steps to do what they can to recognize, treat and prevent the damage that horses inevitably suffer due to human management. Frog care, including management practices which discourage disease, as well as daily maintenance and treatment when infection occurs are relatively easy and inexpensive ways to improve the quality for life for modern horses and those who care about them.

U
N
O

A
L
L
A

V
O
L
T
A
—

O
N
E

A
T

A

T
I
M
E