EFTBA Veterinary Newsletter 26

"His nostrils drink the air, and forth again, As from a furnace, vapours doth he send."

William Shakespeare (Venus and Adonis)

Physiological Limits

Breathing

Part I

February 2018

. *Performance has physiological limits and the aerobic capacity is one of the reasons*

. This phenomenon has been a subject of great meaning for centuries

. But what does finally account for these limits?

Welcome to EFTBA's veterinary newsletter

Dear Member / Breeder,

Welcome to the spring issue of our veterinary newsletter.

It is hard to imagine our breeding season is upon us so soon. The foals are being born at present bringing with them the dreams and hopes of their breeders, and worries and challenges to their handlers and custodians, who have the responsibility for maintaining their health and wellbeing. As these foals grow and mature to be the race horses of their generation, they face many trials and tribulations prior to appearing on the race track.

One of the most important requirements will be that they are sound of wind. From sales to training the wind factor has remained perhaps the most opinionated and controversial area of breeding and racing as we know it today. Dr Meier has spent a lot of time researching and formulating the text for this article and I am very grateful to him for this informative and easy to understand article. It is not an easy subject and he has simplified it so you don't need a doctorate or Veterinary licence to comprehend it.

On other EFTBA matters, the Brexit story is raging on. Your executive is constantly reviewing and monitoring this very important issue.

However until we get some certainty about the rules or deals to be done there is very little we can say or do, as the goal posts keep changing. EFTBA is currently compiling statistics with the help of other organizations which will give us comprehensive information to help lobby the 749 MEPs. I would urge all members to engage with their MEP's highlighting the value our industry plays to the rural economy and overall economic contribution. It is important we garnish support so as to ensure the minimum disruption to the movement of the European thoroughbred post BREXIT.

We look forward to seeing you all in May for our next meeting, being held for the first time in Germany. I know that the German TBA is putting together a very comprehensive weekend which includes tours and hosting us on the Bank Holiday of 21/5/18, the day of their Two Thousand Guineas at Cologne Racecourse. As usual our AGM will be very informative and at this stage you should consider items you would like included on the agenda.

I wish you all every success in your endeavours to breed champions.

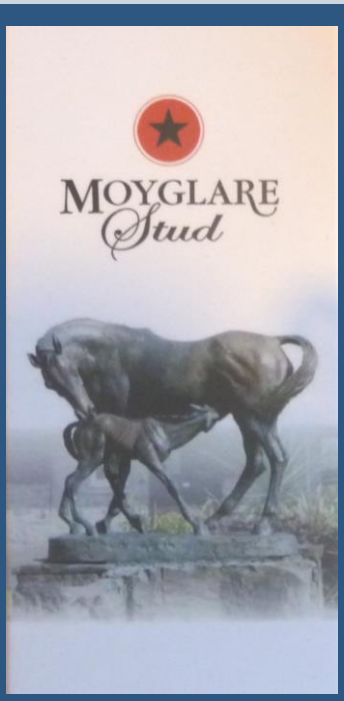
Best regards

Joe Hernon

Joe Hernon

Chairman, EFTBA

"Many thanks to Mrs. Eva-Maria Bucher-Haefner, Moyglare Stud Farm, for her valued sponsorship of this newsletter."



Editorial

Our newsletters of last year dealt mainly with subjects of performance, e.g. breeding and profiling for it. We studied figures, statistics and theories and did become aware that performance has 'physiological limits'.

However, any theory is only as valid as its substantiation, wherefore we want to attend to reasons for this phenomenon now. - Or with other words, what is the meaning of these theories in the daily practice of us breeders and vets?

In this context, we might remember the expression **'sound in wind and limb'** - the empiric appreciation for our endeavours to produce vigorous horses.

Let's have a look than at aspects of the physiology and pathology of respiration with this newsletter.

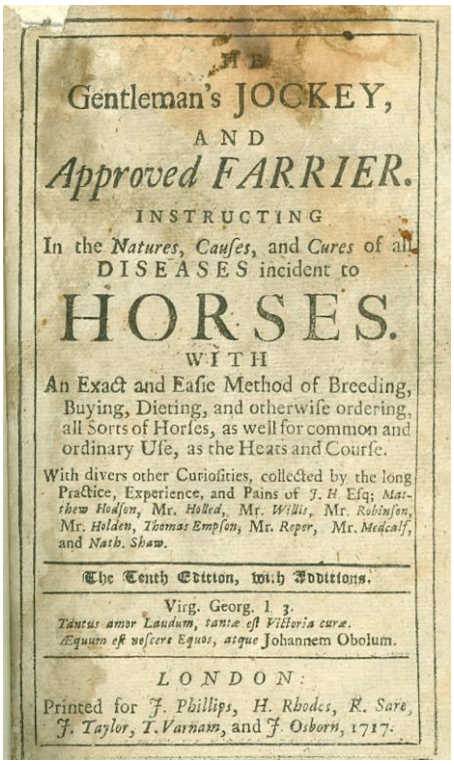
Dr Hanspeter Meier

EFTBA veterinary advisor & Newsletter editor

Introduction

According to Rick Arthur (1990), **respiratory disease is as important and common as musculoskeletal disease in the racetrack practice, and the loss of racing potential from respiratory disease in the equine athlete may never be fully appreciated**.

Such an appreciation of an expert like Arthur certainly justifies the intention to look closer at this subject. And already the first step to the bookcase, to look for a second opinion, delivers further hints to the importance of a sound respiratory tract. In the chapter "*General Observations for the buying of Horses*", Hodson and coworkers (1717) already mentioned: "*If handling of his Cheeks or Chaps you find the bones lean and thin, the space between them, the thropple or windpipe big as you can gripe, and the void place without knots or kernels; and generally the Jaws so open, that the Neck seemeth to couch within them, they are all excellent signs of great wind, courage and soundness of head and body.*" Obviously, already in the early times of racing and breeding in Great Britain, the subjects of "*great wind and soundness*" did play a large importance in "*touching the particular Role of Election, contained in the Discovery of natural deformities, accidental, outward or inward, hidden mischiefs, which are so many, yea, infinite, that it is a world of work to explain them*" (Hodson et al., 1717).



The
Gentleman's JOCKEY,
AND
Approved FARRIER.
INSTRUCTING
In the *Natures*, *Cauſes*, and *Cures* of all
DISEASES incident to
HORSES.
WITH
An Exact and Eaſie Method of Breeding, Buying, Dieting, and otherwiſe ordering, all Sorts of Horſes, as well for common and ordinary Uſe, as the Heats and Courſe.
With divers other Curioſities, collected by the long Practice, Experience, and Pains of *J. H.* Eſq; *Matthew Hudſon*, Mr. *Holled*, Mr. *Willis*, Mr. *Robinſon*, Mr. *Holden*, *Thomas Empſon*, Mr. *Roper*, Mr. *Medcalf*, and *Nath. Shaw*.
The Tenth Edition, with Additions.
Virg. Georg. l. 3.
Tantus amor Laudum, tantæ eſt Victoria curæ.
Æquum eſt noſcere Equos, atque Johannem Obolum.
LONDON:
Printed for *J. Phillips*, *H. Rhodes*, *R. Sare*, *J. Taylor*, *T. Varnam*, and *J. Osborn*, 1717.

A few years later, William Osmer (1756) also referred to this subject in his "*Dissertation on Horses*" with the note: "*It has been said, that the sons of the Godolphin Arabian had better wind than other Horses, and that this perfection of the wind was in the blood.*"

Lord Godolphin's *Lath*
by *Godolphin Arabian* out of *Lady Roxana*
(James Seymour)

'Soundness of the wind' obviously has been a concern for horsemen for centuries and the opinion may arise that there hasn't been much success with the prevention of respiratory problems. One reason for this may be that problems of the musculoskeletal system are obvious for anybody. Respiratory disease also can be obvious, but most ailments of

this tract are much more subtle and insidious (Arthur, 1990). However, the possibilities for investigating the respiratory tract in our days are significantly better than in earlier times. This development was tremendous and certainly will allow further progress as well. The author just remembers how he was taught to examine a 'Roarer' (recurrent laryngeal neuropathy) – at a time when flexible endoscopes weren't available yet. After studying the pedigree (if on hand) the patient was longed and one had to listen to abnormal inspiratory breathing sounds. A method which was possible some decades ago – without all the environmental noise of our times. If in doubt, one also tried to startle the horse – by ramming one's knee into its thorax and listen to the sound of the provoked gasp (Wrangel, 1928).

After this excursion into history, which really made the author thoughtful in realizing that his personal experiences already can be considered historic, we better turn to research on physiology of the equine respiratory tract by experts of our days. And on second thoughts, this action also proves that significant progress has been made and great satisfaction should be a more adequate approach to the facts.

Specifications for Speed in the Racehorse

Very detailed and comprehensive information on the physiology of breathing and its connection with racing performance was published by the British veterinarian Cook in 1993. With this book (with the same title as above), he made an effort to write a scientific publication in plain English on soundness of wind in the racehorse and its connection with speed. Beside this, he also highlighted the benefit connected with the opportunity to improve the welfare of the horse and the health of breeds. In his opinion, insufficient attention had been paid to the prevention of respiratory disease yet. In this respect he also addressed us breeders and said: *"When many diseases are inherited, the only way they can be prevented is by assigning more importance to the genetic soundness of the sire and dam.* ***This is something that only breeders can do****. Inherited diseases and defects are becoming more common and so the need for better communication between veterinarian and horse owning public becomes increasingly more necessary"* (Cook, 1993).

For explaining physiological aspects of respiration and performance, he compares the horse with a car. Speed requires energy in both specimens. In the horse, energy is produced in the muscles, just as in a car, where energy comes from burning gasoline. In a horse, energy comes from burning muscle sugar (glycogen). Just as gasoline needs oxygen in order to burn, so also does muscle sugar. If muscles are starved of oxygen, they cannot work properly.

Both the heart and the process of breathing depend on muscles: muscles in the diaphragm, chest wall, neck, nostrils and, most important of all, one particular muscle in the voice box (Fig. 1). Unhappily, this very muscle (m. cricoarytaenoideus dorsalis) is the one muscle in the whole body which is most commonly diseased (Cook, 1993).

In Cook's opinion, two measurable characteristics in the racehorse correlate with performance and both are connected with the respiratory system. They consist of the width of the horse's jaw and the health of its voice box (larynx). He is convinced that the two characteristics determine how efficiently a horse breathes, because they determine the size of the airway. But because size is relative, further items to be taken into account are the height and the

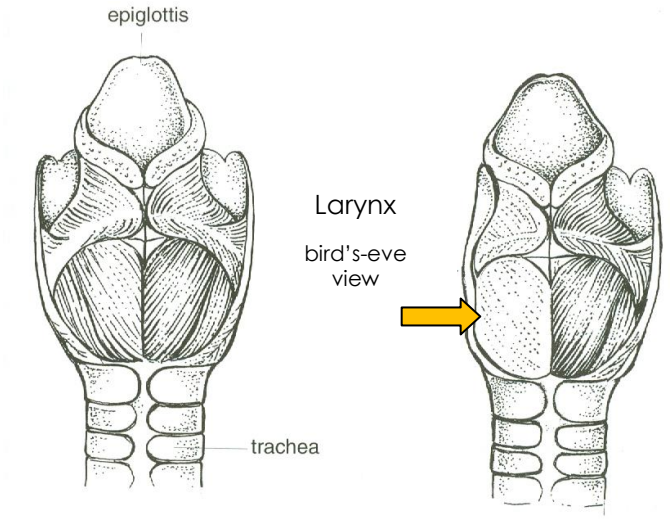


Fig. 1 Bird's-eye view of the larynx of a horse: the normal larynx (left) and atrophy of the left m. cricoarytaenoideus dorsalis (arrow) of the voice box (right) (Gray, 1994).

weight of the horse. Speed and stamina are limited, he believes, more by the conformation of the horse's airway than by e.g. the length or straightness of its legs, the angle of its pasterns, or the slope of its shoulder (Cook, 1993).

In regard to the width of the jaw, Wrangel (1928) also mentions that *"it hardly can't be too big"*. The only difference between these two authors is the method of measuring the width: Cook (1993) speaks of at least 4.5 fingers (8.1cm); Wrangel is here more pragmatic and wrote that *"there should be enough room for a wine-bottle"*.

Cook (1993) did find that only about 5% of Thoroughbreds have wide and healthy airways and postulates that it is this group of horses, which represent the best prospects of becoming stakes winners. He therefore wonders whether breeding for a wide and healthy airway may be the most effective way to improve performance.

"Freedom and length in breathing are qualities as essential to a racehorse as conformation of his legs" (1791)

The title of this chapter, which deals with the breathing-galloping relationship in Cook's book, is a statement of the Frenchman Charles Benôit Vial de St. Bel, whose plan for 'An Institute to Cultivate and Teach Veterinary Medicine' developed into Britain's first veterinary school in London in 1791 (Pattison, 1984).

In an essay on the geometric proportions of *Eclipse*, published in the same year, colleague de St. Bel wrote: "*Freedom and length in breathing are qualities as essential to a racehorse as conformation of his legs. The breathing will become shorter* (decreased depth of respiration) *and more accelerated* (increased respiratory rate)*; the animal will lose his wind; his legs will grow weak under him and even suffocation may ensue if he is imprudently urged beyond the limits of the vital powers nature has given him*" (Cook, 1993).

With this assertion, St. Bel already gave a hint to the topic that at canter breathing is in time with the legs of a horse. Cook (1993) experienced this phenomenon himself while riding and came to the conclusion that there are only two factors which determine speed: the stride rate and the stride length (speed = stride rate x stride length).

As stride rate is locked in with respiratory rate and stride length with depth of respiration, he suggested that the above equation can be rewritten:
SPEED = RESPIRATORY RATE x DEPTH OF RESPIRATION
(Depth of respiration is the same as the volume of air inhaled at each breath).

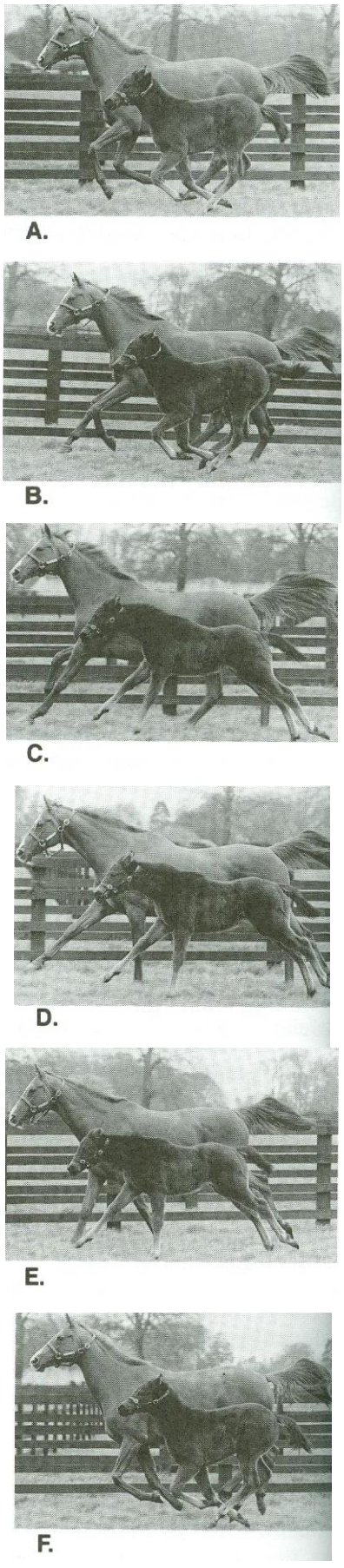


Fig. 2 The Thoroughbred mare *Pebbles* and her foal by *Reference Pont* demonstrate the synchrony of gait which can occur, even between two horses of differing size. These photographs demonstrate that length of stride is not determined by length of leg. Both horses, cantering in step with each other are also, by definition, breathing in sequence. Inhalation is occurring during photographs A to C and exhalation during D to F (Cook, 1993).
(Photos courtesy of Michael Osborne)

The manner in which gait and respiration are linked in any one stride at the gallop is illustrated in Figure 2. Inhalation occurs as the hind legs take the weight of the horse and rider, whereas exhalation occurs as the forelegs take the weight. Exhalation may also continue into the first portion of the airborne phase of the gallop, when all four legs are off the ground. The complete respiratory cycle is repeated between two and two and a half times every second (150 a minute), for as long as the horse continues to gallop (Cook, 1993).

As breathing and galloping are synchronized, according to Cook (1993), a number of interesting questions arise. Does the manner in which a horse breathes affect the way it gallops? Or, does the way it gallops affect the way it breathes? If the answer is "*yes*" to either of these questions, which it is, then two new questions arise. Does the way a horse breathes affect its stride rate and stride length? Or, does its stride rate and stride length affect the way it breathes? Once again, Cook's (1993) answer is "*yes*" to both questions. At the start of a race, when acceleration is uppermost in the horse's mind, stride rate is likely to determine respiratory rate. At the end of a race, when the horse is short of breath, the business of breathing is topmost in the horse's mind and depth of respiration is likely to determine length of stride. He believes now that breathing efficiency determines the rate and length of stride, and as these are determined by the dynamics of airflow, then **speed itself is a function of airflow** (Cook, 1993).

Physiological limits of airflow

"Nothing in Biology Makes Sense Except in the Light of Evolution"

This quotation of the evolutionary biologist and geneticist Theodosius Dobzhansky (1973) crosses one's mind when one reads the reflections of Cook (1993) about ***"Airflow as a limiting factor in racing performance"***.

Here he speaks of the notion "*heart*", the elusive 'will to win' of a racehorse. This much sought after quality in a racehorse is thought of as the soul of a racehorse. "*Heart*" is spoken of as though it embodied a specific competitive instinct, a special desire to win and a willingness to continue racing in the face of severe exhaustion.

Contrary to this traditional conception, Cook (1993) is of the opinion that "*heart*" may be determined more by the way a horse's body functions (physiology) than be the way a horse's mind thinks (psychology). As a horse that gets more air is better able to ignite and burn its muscle fuel than another, the horse that has "*heart*" may simply be a horse that breathes more easily than another. One horse, by nature a prey animal, may be able to run further and faster than another because of a greater ability to take in oxygen. The horse which loses "*heart*" during a race may be simply experiencing oxygen starvation.

The cause of this shortage of oxygen in the racehorse may well be poor airflow, due to diseases of the airway which are common in the horse. Of all the organs in the body, the brain is probably the most sensitive to a shortage of oxygen. One can imagine few mechanisms more likely to destroy the instinct for survival ("*heart*") than a reduction in the amount of oxygen reaching the brain, which threatens minute-to-minute preservation of life. What better system could there be than an internal and chemically-controlled monitoring system that is automatically self-adjusting? When oxygen is in short supply, the brain registers this immediately and a reduction of effort is signaled to the rest of the body. The horse then stops trying and "*heart*" evaporates (Cook, 1993).

The difference between a superior runner and an average or below average runner is measured in fractions of a second per furlong run. A 12 seconds furlong is equal to 37.5 mph and a 12.1 seconds furlong is equal to 37.19 mph. What means that in a mile race, a 12 seconds horse will finish four lengths in front of a 12.1 seconds horse (For the purposes of calculation, a Thoroughbred is assumed to cover a length in 1/5 of a second). The importance of fractions of a second in races of various distances is listed in table 1.

Seconds Per Furlong	MPH	Distance in Lengths		
		6 Furlongs	8 Furlongs	10 Furlongs
12.0	37.50	-	-	-
12.1	37.19	3	4	5
12.2	36.89	6	8	10
12.3	36.59	9	12	15
12.4	36.29	12	16	20
12.5	36.00	15	20	25

Table 1 Showing the distance in lengths that will separate six horses at 6, 8 and 10 furlongs when their speeds per furlong differ by as little as one tenth of a second (Cook, 1993).

(37.50 mph = approx. 60.0 km/h
36.00 mph = approx. 57.6 km/h)

Since 1/10th of a second per furlong run equates to three lengths at the finish in a 6 furlong race, it is not difficult to understand the importance of a horse's ability to breathe efficiently. **Its upper airway structure is critical to its performance** (Cook, 1993).

It is not uncommon to find Thoroughbreds which, because of a disease of their voice box (e.g. RLN, recurrent laryngeal neuropathy) have their breathing capacity reduced by as much as 50% or more. Intuitively, we can understand how even a small impairment of a horse's ability to breathe will affect its ability and eagerness to race (Cook, 1993). Such problems will by the subject of our next newsletter.

Assault (1940, *Bold Venture – Igual* by *Equipoise*)

Assault, winner of the Triple Crown in the USA in 1943, worked in the final stretches of the Preakness Stakes at the low rate of 131 strides (breaths) per minute, as was *Secretariat* in 1973. *Seattle Slew* worked in the final stretches of the Preakness Stakes at 129 strides (breaths) per minute, 128 in the Belmont, and 130 in the Jockey Club Gold Cup (Cook, 1993).

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