

# Dogs in motion

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Chihuahua in pacing. The movements of 327 dogs from 32 different breeds were recorded with a high speed X-ray video system. Credit: photo: Fischer, from:

How does a dog run? Until now even experts found it nearly impossible to answer this simple sounding question. "We simply didn't know", says Professor Dr. Martin S. Fischer from the Friedrich Schiller University Jena (Germany). Surely: A dog moves on four legs, in pacing, trotting or galloping. But so far even the Jena scientist could only guess at the exact motion sequence within the locomotor system.

The reason being: "So far scientific studies were limited mostly to the movement of sick animals or to single aspects of locomotion", says Fischer, Professor of Systematic Zoology and [Evolutionary Biology](#). To change this, Professor Fischer and his team started a comprehensive study about the locomotion of healthy [dogs](#) in 2006 and have now presented the results.

With enormous technical effort the scientists measured, documented and compared the motion sequences of 327 dogs from 32 different breeds.

The dogs were filmed by two high speed cameras in different gaits from the front and from the side. "In addition we analysed the movements three-dimensionally", Dr. Karin Lilje explains. For this, the zoologist glued reflecting markers on the skin of the animals and filmed their movements with infrared cameras. These sent out short flashes and registered their reflections. Up to 1.000 images per second went into these analyses. "As the reflections were being recorded from several cameras we could assess the position of the markers in the room from the data", Dr. Lilje continues. Additionally, the movements of the dogs were recorded with a high speed X-ray video system. The University Institute for Systematic Zoology and Evolutionary Biology, which the Phyletisches Museum is also part of, owns one of the most modern and efficient systems of this type. "By combining these three methods data about the movement of dogs are available now in a precision so far unknown", says Fischer.

Numerous displays and preparations of skeletons in today's schoolbooks and museums show how patchy and in some aspects fundamentally incorrect the knowledge about the locomotor system was until now: The displays position the hip and shoulder joint of the animals on the same level. "However this implies that these two joints correlate with each other and that they are the centre of rotation in the movement – which is wrong as we could now prove with the help of our analyses", Professor Fischer points out. According to this in the course of the evolution limbs with three – formerly two – segments each developed from the legs. "And so the shoulder blade is added to the forelegs as a segment close to the body while the middle foot of the hind leg is being rebuilt", explains evolutionary biologist Fischer. Therefore it is not thigh and upper arm and lower leg and forearm that are correlated but the shoulder blade and the thigh, the upper arm and lower leg and forearm and middle foot. The centre of rotation of the front legs is the shoulder blade which is only connected to the skeleton through the musculature. The actual shoulder joint stays nearly immobile in the dogs' process of movement.

"These findings will alter the academic teaching", Professor Fischer is convinced. For this zoologists present comprehensive material with their scientific results: With the help of high definition X-ray and position data the scientists animated the course of motion into video sequences. Thus not only the dogs' skeletons can be viewed from all sides, the corresponding patterns of musculature and activity can also be studied in detail according to the gait and the phase of the movement. "In contrast to previous animations our video sequences are based on exact measurements. With this we are setting new standards", Fischer believes.

The Jena study provides another astonishing insight into the locomotion of dogs regarding the proportions of the front legs of the dog breeds examined. These were nearly identical in all dog breeds – although, according to Fischer "it is clear that the upper arm of a Schnauzer is shorter than that of a Great Dane". Regarding the total length of a foreleg its length is always exactly 27 percent. Whereas the relative length of the shoulder blade varies between 24 and 34 percent. "The shoulder blade of short legged dogs is relatively long and that of greyhounds is relatively short. But the length of the upper arm always stays the same."

Moreover the zoologists owe the discovery that the shoulder blade and forearm and the thigh and the middle foot are moving in matched motion – as if linked – to the X-ray view. "If the forearm is in a vertical position, then the shoulder blade will be in the same position", the Jena scientist explains. In its motion sequence this principle of a 'pantograph leg' is highly dependent on the length of the segment in between. "And that is the [upper arm](#) that is exactly the same length in every dog." From this can be concluded that all dogs run very similarly, no matter if they weigh two or eighty kilograms.

The Jena zoologists compiled their extensive collection of data and images in a richly illustrated publication. The newly published volume

"Dogs in Motion", does not exclusively address scientists. "We explicitly want to reach all dog owners and people who love dogs in general", Professor Fischer stresses. In close co-operation with two illustrators more than 100 pictures were created for the book as well as its own visual language. Added to the book is a DVD with extensive footage containing high speed videos of selected thoroughbred dogs, X-ray films and many animations.

Provided by Friedrich-Schiller-Universitaet Jena

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