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INFRARED-THERMOGRAPHY IN ZOO ANIMALS: NEW EXPERIENCES WITH THIS METHOD, ITS USE IN PREGNANCY AND INFLAMMATION DIAGNOSIS AND SURVEY OF ENVIRONMENTAL INFLUENCES AND THERMOREGULATION IN ZOO ANIMALS

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Summary

Infrared-Thermography in zoo animals is a new technique in zoo medicine. It enables the diagnosis of surface temperatures at a distance without interfering with the animal in any way. Even pregnancy diagnosis can be performed with this method. A lot more general data on thermoregulation must however be gained before this method will be universally applicable. In the diagnosis of inflammations and the observation of thermoregulatory inadequacy infrared-thermography is already a valuable tool. This technique has a great potential for development and usage in zoo and wild animal medicine.

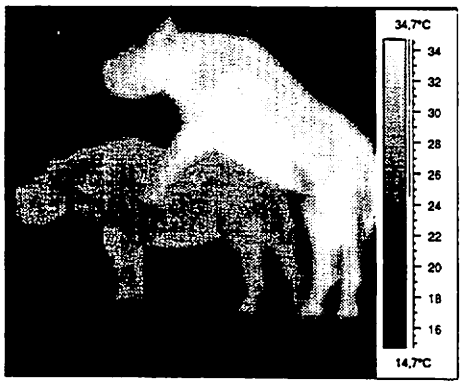
Zusammenfassung

Infrarot-Thermography ist eine neue Technik in der Zootiermedizin. Sie erlaubt die Messung von Oberflächenhauttemperaturen auf größere Distanz, ohne das Tier manipulieren zu müssen. Sogar Trächtigkeiten können mit dieser Methode diagnostiziert werden. Es müssen aber noch viele generelle Daten zur Thermoregulation gesammelt werden, bevor diese Methode universell anwendbar sein wird. In der Diagnose von Entzündungen und der Beobachtung inadequater Thermoregulation ist die Methode schon jetzt sehr wertvoll. Diese Technik hat ein großes Potential zur Weiterentwicklung und Anwendung in der Zootiermedizin.

Résumé

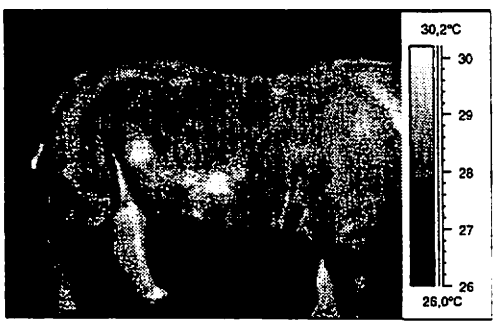
La thermographie infrarouge représente une nouvelle possibilité technique pour la médecine des animaux de zoos. Elle permet de mesurer les températures de la peau en surface à une distance considérable sans que l'on doive manipuler l'animal. Même les gestations peuvent être diagnostiquées de cette manière. Il faut néanmoins encore rassembler beaucoup de données générales concernant la thermorégulation avant que cette méthode ne soit applicable de manière universelle. Aujourd'hui, cette méthode se révèle déjà très utile dans le diagnostic d'inflammations et permet par exemple l'observation d'une thermorégulation imparfaite. Cette technique représente un grand potentiel de développement et d'application pour la médecine des animaux de zoos.

Key words
Infrared-Thermography, rhinos, pregnancy diagnosis, inflammations, thermoregulation, zoo animals



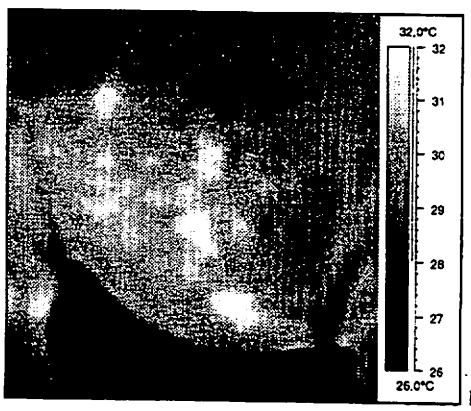
Picture 1a

Picture 1 and Diagrams 1a and b: Black Rhinos mating and non-pregnant rhinos in Diagrams. The Temperature difference between the bull and the cow is 6.4°C on the left side.

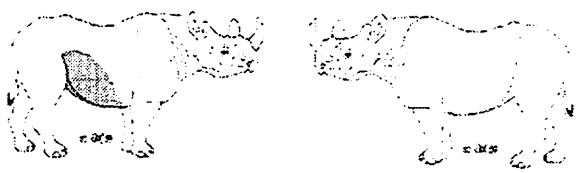


Picture 2a

Picture 2 and Diagrams 2a and b: Black Rhino 7 months pregnant (visible on the right side). The lighter grey heat-area shows the contact-zone between the filled uterus and the skin of the mother. The temperature difference between the mother and the fetal region is approx. 2-4°C, with a relative uniformly warm mother.



Picture 3a

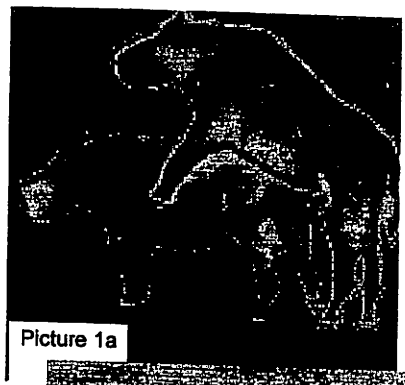


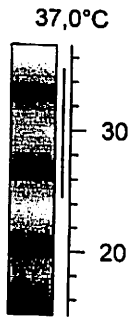
Picture 3 and Diagrams 3a and b: Black Rhino 10 months pregnant (visible on the right side). Heat area on stomach increased compared with area at 7 months. The temperature difference between the mother and the fetal region is approx. 5°C.

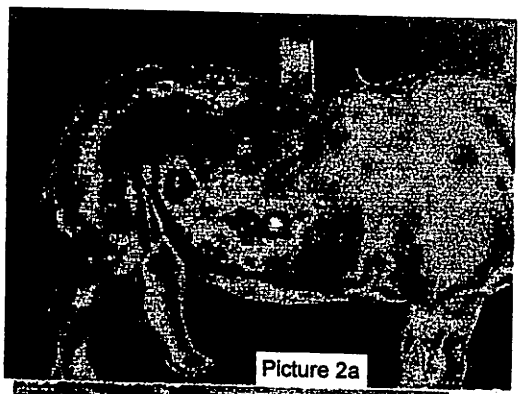
Pregnancy Diagnosis in Black Rhinos

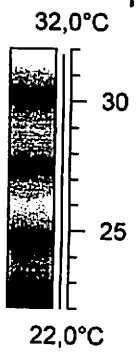
Diceros bicornis

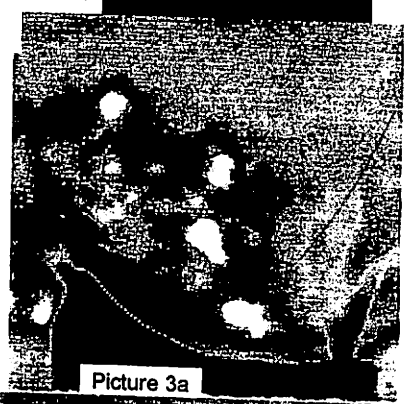
The color pictures correspond to the black and white pictures in the article (also with their numbers)

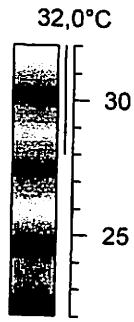


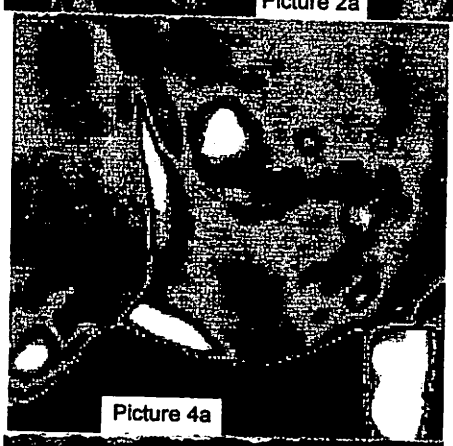


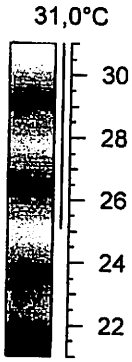


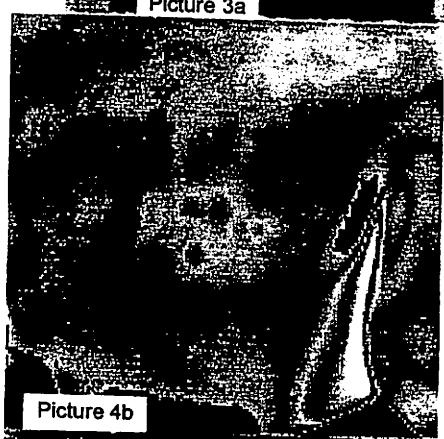


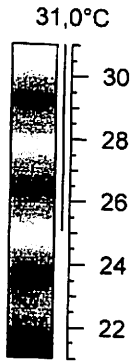


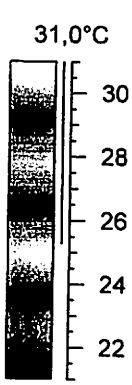


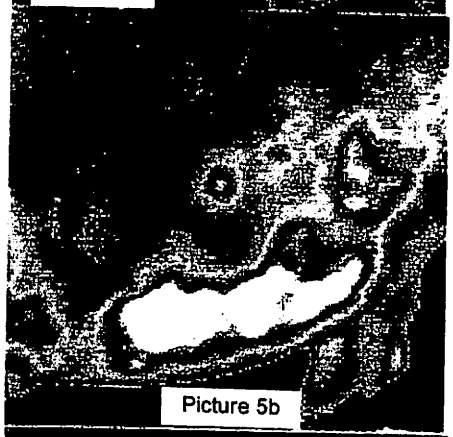


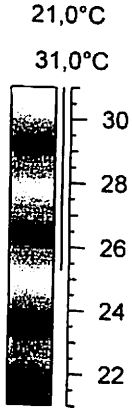


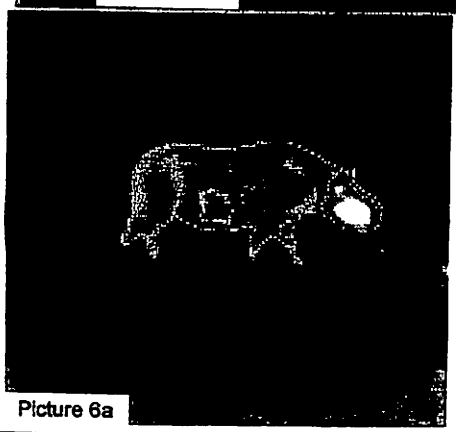


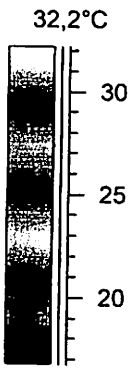


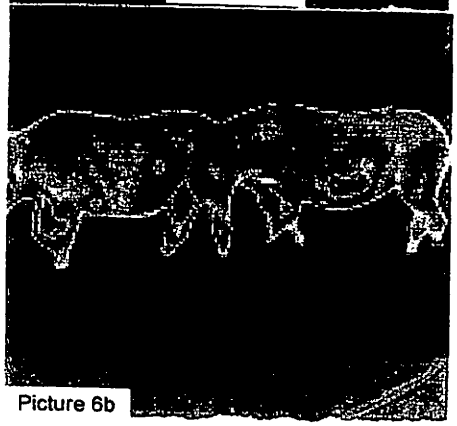


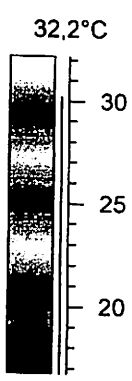


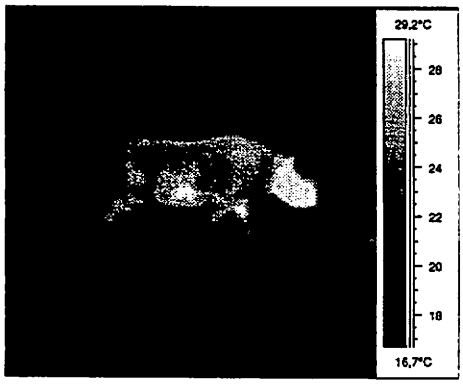












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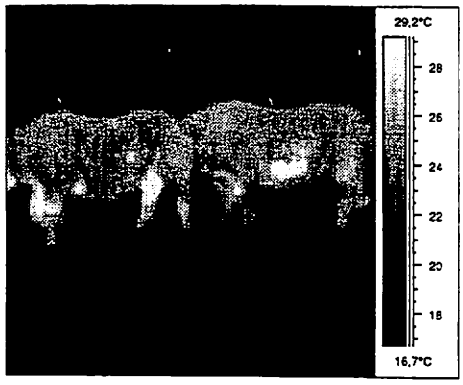
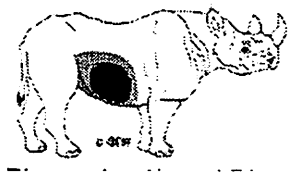
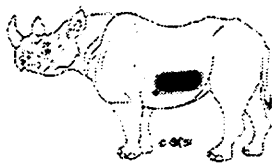
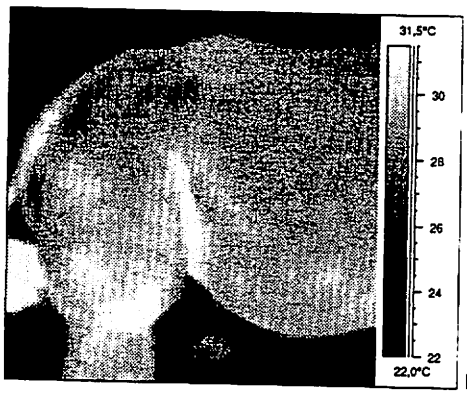


Picture 6b

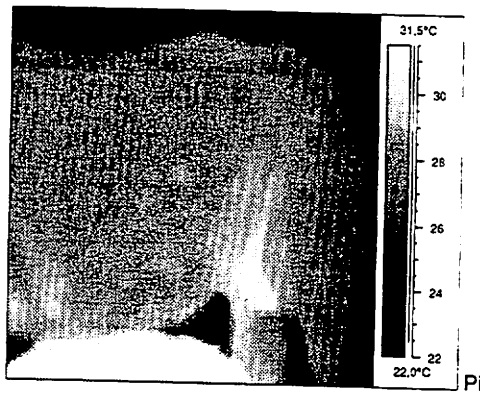




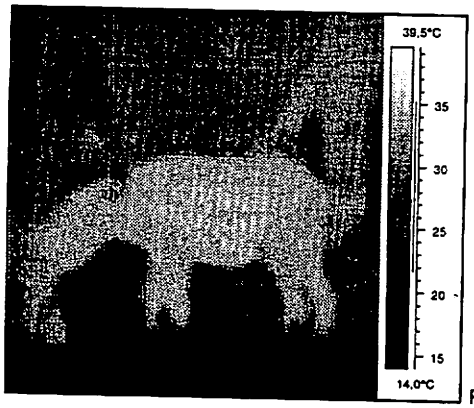
Picture 6a, 6b and Diagrams 6a and b: Black rhino 13 - 14 months pregnant. Distance: 20 m. Even at a distance of 20m the heat area is visible. The front animal in the right Picture is not pregnant. These thermal images were taken in the outside enclosure. The temperature difference between the mother and the fetal region is approx. 5°C on the right side and 6°C on the left side.



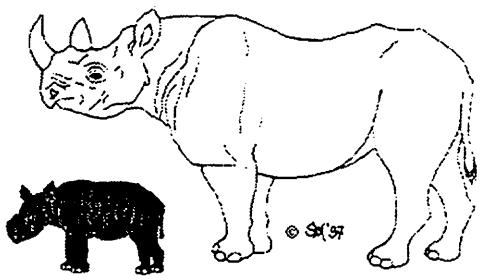
Picture 7a



Picture 7b

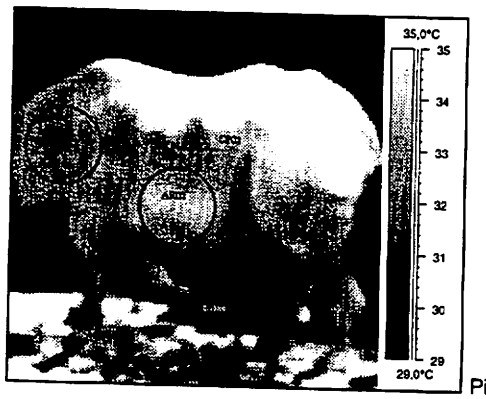


Picture 7c

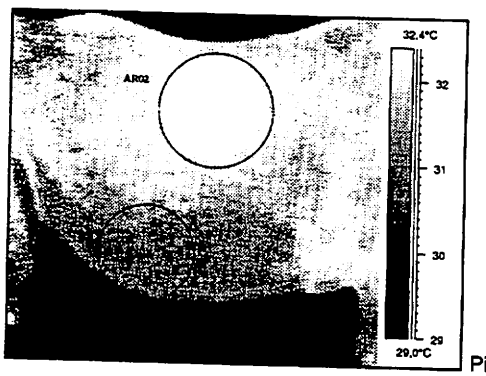


Picture 7a, b, c and Diagrams 7a: Black rhino one day after giving birth to the calf. The intense heat area originating from the calf on the skin of the mother is not visible any more. Only the uterus produces a little heat on the mothers skin. The temperature differences on the skin of the mother between the general surface and the area where the fetus was is now reduced to approx. 2.6°C on the ventral stomach. The mammary gland has a temperature of 4.4°C higher than the mothers body. The temperature difference between the mother and the newborn is 6.1°C on the left side.

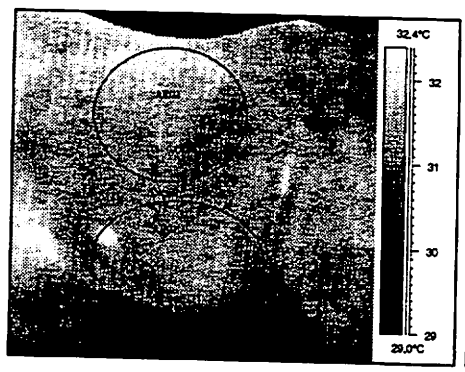
b) pregnancy diagnosis and abrupt changes in ambient temperatures:
The thermal images illustrate that due to abrupt changes in ambient temperatures, pregnancy diagnosis is impossible for approximately two hours. This time frame is also used in building thermography, where the setup requirements state that the building must be under the same ambient temperature conditions for at least two hours before thermal images should be taken. The pictures illustrate the same animal at 10 minute intervals. the first pictures were taken outside under bright sunlight (hence the heat intense area on the back of the animal), the second set of pictures 10 minutes later in the stall, where ambient temperatures were cooler than under the bright sunlight.



Picture 8a



Picture 8b

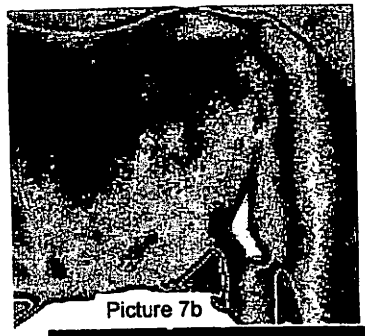


Picture 8c

Picture 8a to c: In these pictures it becomes visible that too short time allowance for thermoregulation after changes in ambient temperatures results in almost complete invisibility of the heat area of the fetus. The mother had previously spend several hours under bright sunlight (8a). The elapsed time between these thermal images was only 10 minutes. In Picture 8a the temperature differences between the mothers neck (AR02) or spot 1 (SP01) and the fetal area (AR01) is approx. 2°C. The back in the sunshine has a temperature of more than 35°C. In Picture 8b the temperature difference between the mothers back (AR02) and the fetal region (AR01) is 1.4°C with the fetal region cooler than the mothers back. In Picture 8c the temperature difference between the mothers back (AR02) and the fetal region (AR01) is 0.7-1.6°C with the mothers back cooler than the fetal region.

This sets requirements for infrared diagnosis:
The animal under investigation must at least be 2 or more hours under the conditions under which it is to be investigated. This means that the animal should be in its stall or paddock in which it is to be investigated for 2 hours. If the ambient temperatures are very different from the prior housing place, than more time for adequate thermoregulation must be allowed. Best results are achieved, when the animal is investigated in the morning after a night of continuous environmental conditions.

Picture 7a



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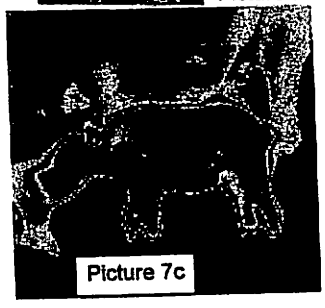
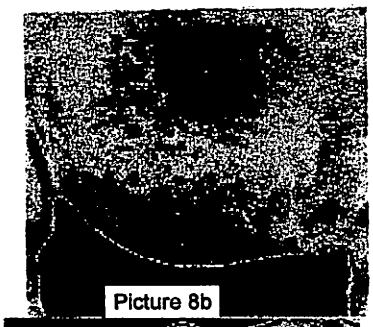


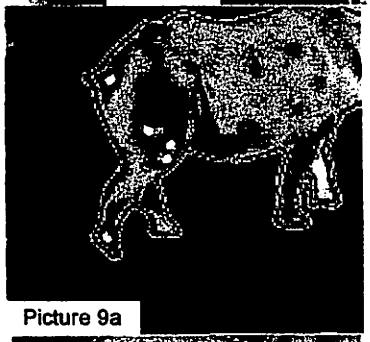
Picture 7c

Picture 8a

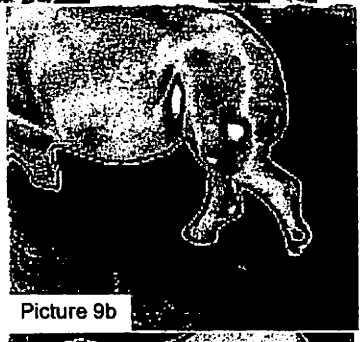


Picture 8b

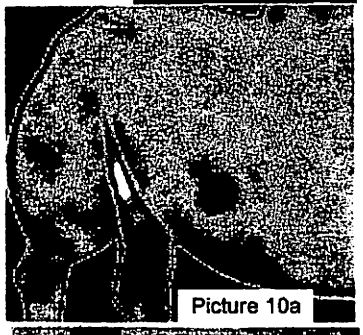
Picture 8c



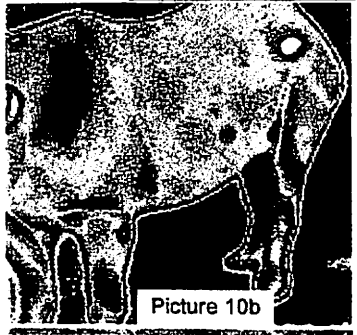
Picture 9a



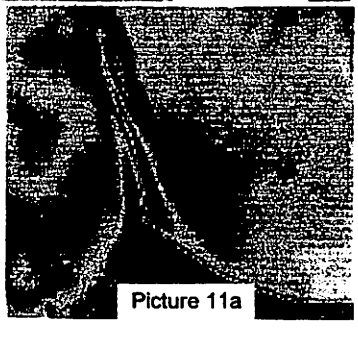
Picture 9b



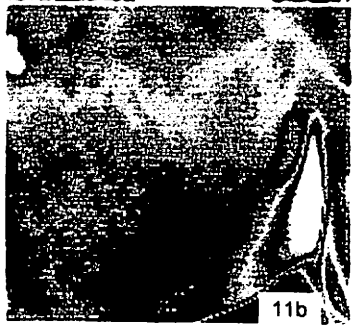
Picture 10a



Picture 10b



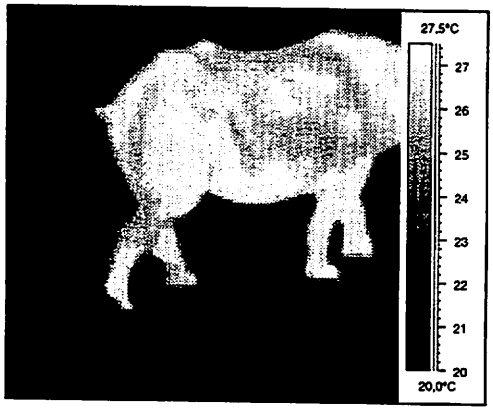
Picture 11a



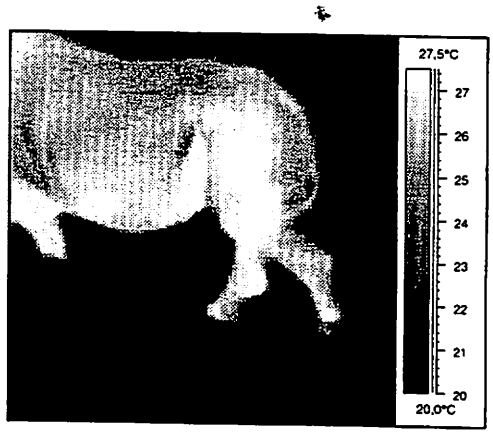
11b

c) pregnancy diagnosis and intensive physical exercise:

The thermal images show two black rhinos after extensive exercising in form of running around in their enclosure. From the exercise many muscle parts warm up. The warming up begins with the hind legs, a little later on the shoulders and lastly on the back. As the animal warms up it becomes difficult to diagnose the pregnancy, because the difference between the heat area of the fetus and the rest of the mothers body becomes smaller, it might even become indistinguishable. Here the differences in both animals are still visible very vaguely. The temperature differences are between 1.6 and 3.4°C.

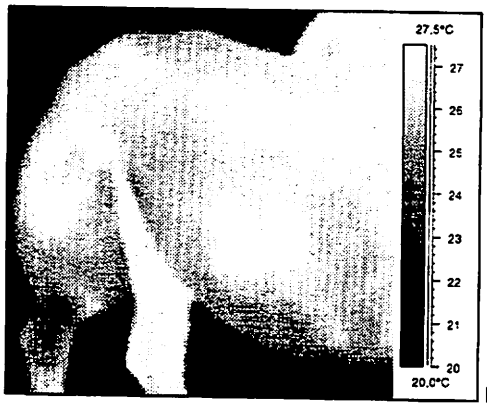


Picture 9a

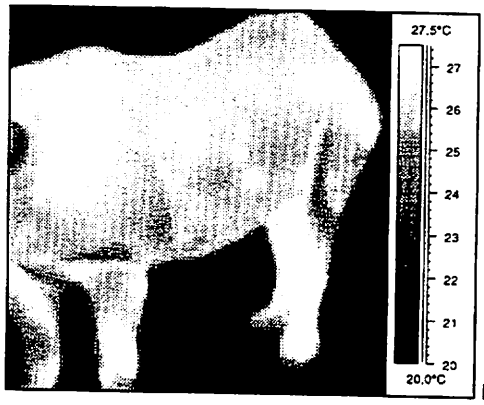


Picture 9b

Picture 9a and b: The pregnancy (13 months) can be observed under difficulties, because the temperature difference between the mother and the fetal region is only 3.4°C on the right side and 2.2°C on the left side.



Picture 10a



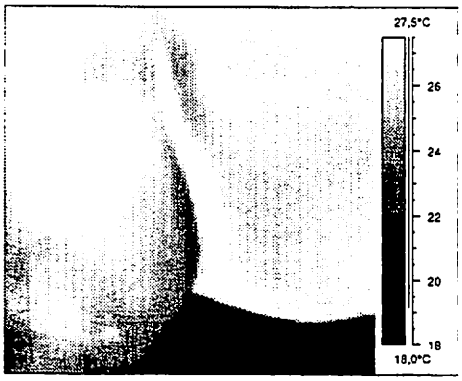
Picture 10b

Picture 10a and b: The pregnancy (2 months) can be observed under difficulties, because the temperature difference between the mother and the fetal region is only between 1.7-2.7°C on the right side and 1.6-2.8°C on the left side.

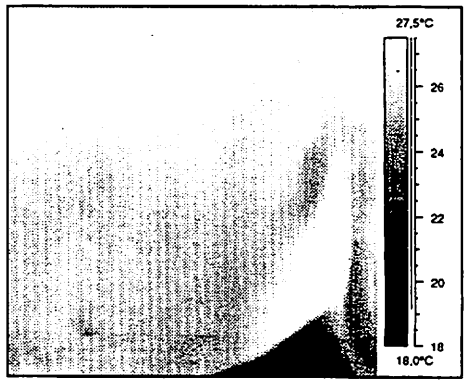
Resolution:

It should be achieved that the animals to be investigated are not exercising too much before the investigation.

d) pregnancy diagnosis and distress in black rhinos:
The thermal images presented here are from a very nervous black rhino. For the investigation of pregnancy the animal was stalled in a new stall, where it had not been for two month. This stall was generally occupied by a rhino with a new born. Since the arrival of this calf 6 weeks ago, this rhino to be investigated, a generally already very nervous individual, became even more irritated. By the time of investigation with the infrared camera, the animal was so warm, that a difference between the females body and a potential fetus were indistinguishable.



Picture 11a



Picture 11b

Picture 11a and b: The pregnancy (2 months) can be observed under difficulties, because the temperature difference between the mother and the fetal region is only 1.3°C on the right side with a max. of 3.4°C in inguinal region and 6.8°C on the left side between the side of the body and the inguinal region, but only 1.7°C between the inguinal region and the back of the animal.

Resolution:
It should be achieved that the animals are not distressed before the investigation. This means that no transfer to unfamiliar enclosures is done before the investigation or that a training period of a few days can precede the investigation so that the animal is used to the new enclosure.

2) Inflammation diagnosis in Zoo animals
Infrared thermography can be very easily used to diagnose inflammations in Zoo animals. During the beginning stage of an inflammation, heat will be produced due to the biochemical reactions of mediators. This heat is transferred to the body surface, if the tissue involved, lies close to the surface of the body, is very large, or transmits very great amounts of heat.

In elephants e.g. an abscess in the ear can be diagnosed. An inflammation of tusks should also be visible, since the normal skin temperature surrounding the tusk is cool. Thermograms on these subjects as well as some on inflammation of joints will be shown.

3) Thermoregulation in Zoo animals and its control
Very little information is to date known about thermoregulation of Zoo- or Wild animals, only a few authors have worked on this theme (6, 7, 8, 9) examining a few mammals and birds. In a few thermal images the problem of thermoregulation in elephants will be demonstrated. The observation of thermoregulation in zoo animals is important, especially when new enclosures are investigated for there influence on the inhabitants, especially important when very different environmental temperatures are enforced. An example is given here of inadequate thermoregulation in Asian elephants. Here the inadequate thermoregulation can be observed by looking at the ears and heart region. The ears in these animals are warmer than the rest of the animals body and the heart region of a highly lactating cow is cooler that the surrounding skin. In elephants the ears should be the coldest part

of the animal, than thermoregulation is adequate. The heart region in lactating cows should be the warmest part of the animal, since in elephants heart and mammary glands are overlapping in there heatarea-location.

Discussion

Infrared-Thermography is a still a very new technique in zoo and wild animal medicine. Information on normal thermoregulation in non domestic animals is scarce. Here the first results on thermoregulation of zoo animals, especially from rhinos and elephants, are presented. The continuing pregnancy of a black rhinos is followed with infrared. Most of the data was gained from the animal in its stall. The animal was therefore in its usual surroundings. As the data in 1d) show, this fact has an influence on the stress situation of an animal. Under new and unusual circumstances stress changes the surface temperature of an animal and hence makes it more difficult to diagnose a pregnancy. This stress may also cause a shifting of internal organs, so that the filled uterus takes a new location in comparison to the intestine. As is visible in Picture 11a the uterus is shifted to a more ventral and posterior position than the uterus in the animal in 2a. This is probably due to the nervousness of the animal in new surroundings; the animal was nervous for several hours and kept running around in its stall.
Similar effects can be observed in the pictures 9a, 9b and 10a and 10b. Here the animals had been running around in the outside enclosure because they were fed there which usually is not done there. The temperature difference between the uterus and the mothers body becomes less and less, as the mother warms up. It is therefore an advantage if the animals can be kept as quiet as possible as to reduce the heat production from muscle exercise.
Another requirement for thermography is adequate time allowance for acclimatization of the animal before investigation. As can be seen in pictures 8a to 8c too short time allowance for acclimatization will cause false results and hence might lead to the diagnosis not pregnant. These results presented here indicate that, like in other methods, a complete investigation of all sources of errors must be completed before the method is useful for everyday work.
The other applications such as studies of general surface temperature measures in exotic animals and the diagnosis of inflammation are already very valuable. The surveillance of thermoregulatory behaviour and ability to thermoregulate under given environmental conditions is very important. If the animals are unable to lose excessive heat than they could die of heatstroke. This might have been the cause of death in two elephants in a zoo where thermoregulation was diagnosed to be inadequate in this species. A lot more information about thermoregulation in zoo animals must however be gained in order to make a final diagnosis with good reference data to compare the findings with and to differentiate physiological from pathological findings.

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