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IS YOUR RHINO PREGNANT? INFRARED-THERMOGRAPHY IN ZOO ANIMALS: PRELIMINARY EXPERIENCES FROM ITS USE IN MAMMALIAN PREGNANCY DIAGNOSIS

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Introduction

A preliminary report of the use of infrared-thermography in zoo and wild animals was given by EULENBERGER at the 36. International Symposium on the Diseases of Zoo and Wild Animals (EULENBERGER and KÄMPFER, 1994). HILSBERG et. al. (1997) presented the first results in pregnancy diagnosis using infrared in rhinos, elephants and other animals. In this report this new area of application of infrared is presented for pregnancy stages up to birth in rhinos and asien elephants.

Thermography offers the possibility to investigate an animal from a distance of one to a maximum of 20 meters without having to sedate or anaesthetize the animal. This technique measures the heat-radiation (between 3 and 5 µm wave length) a body reflects on a surface into the Environment.

Methods

The infrared-camera THERMOVISION 470 from AGEMA is cooled electrically to -80°C. The lens has a silicon surface, a semiconductor, which converts infrared radiation into photooptical signals in an optimum way. This signal is then converted to digital black and white pictures, which then can be converted into color (FELIX and RAMM, 1988).

At a wavelength of 10^{-4} to 10^{-6} λ/m (EULENBERGER and KÄMPFER, 1994) and a frequency of 10^{14} Hz (OREAR, 1985) infrared-cameras today are able to differentiate surface-temperature-differences of 0,1 °C (AGEMA, 1996). High resolution monitors and computer-graphic hardware produce an accordingly precise presen-tation of the pictures. Measurements are only executed in the long wave band, since these rays are not damped so quickly in their intensity as short waved ones, so that measured values can be achieved over long distances. Long wave infrared radiation (● = 3 -5 µm) is reflected by a coefficient of emission m_s of nearly 1 from hairless skin, which is comparable to a black body (SCHMIDT and THEWS, 1990). Due to the more or less thick hair of animal bodies thermography has its limits (EULENBERGER and KÄMPFER, 1994).

The best results can be achieved if the investigated structure is placed in a region of up to 2 cm under the skin-surface, which applies for e.g. Skin-tumors and abscesses. But also greater structures situated deeper inside a body can be investigated with infrared, as long as they transmit heat to the surface, which than is measured as heat-area or -spots (FELIX and RAMM, 1988). This feature is used here to diagnose pregnancies in mammals

In thermoregulatory processes, small inflammations or heat-producing tumors, more or less heat is transmitted to the bodysurface, so that in a thermogramm a temperature difference can be measured (FELIX and RAMM, 1988; AGEMA, 1996). In the Thermogramm yellow and red colors show warmer areas, green and blue cooler areas. In black and white graphic representations the warmer areas are light, the cooler dark. In human medicine infrared thermography is mainly used in Neurology, Orthopedic diagnostics, Rheumatology, Oncology (especially Skin- and Mammatumor-diagnostic), as well as in „pain-research" (AGEMA, 1996).

Results

In the search of new non-invasive technologies in veterinary medicine, we at the Zoological Garden of Berlin and Leipzig, Germany, started this new research project with the goal to gain an easy to apply method for pregnancy diagnosis in zoo animals. Our preliminary results with using this new method revealed, that animals with no or short hair are well suited for this technique. A Uterus filled with a fetus and its fluids will get in contact with the body-surface layers. The fetus produces heat with its metabolism that the mother has to cope with and try to eliminate. The shortest way of doing this is the direct way through the muscle and skin layers to the outside. In animals where there is no hair , e.g. rhinos, or short hair, e.g. giraffes, on the outside to prevent thermoregulation, the uterine heat can escape directly to the surface. In animals, with a lot of hair on the surface, e.g. camels, the method is, as of now, not applicable, because these animals seem to thermoregulate entirely via the inside of their legs and the ventral bodysurface.

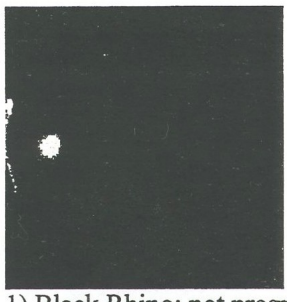
Another handicap with this technique is the lack of knowledge concerning the anatomic base of thermoregulation in exotic animals. E.g. in Babirusas, there seem to be thermoregulatory heat windows on the body surface, specific to each individual.

Pregnancy diagnosis in Black Rhinoceros (*Diceros bicornis*):

Figure 1 shows a non-pregnant Rhino, Figures 2-5 show a pregnant Black Rhino. In Figure 2 the female is about 6 month pregnant, in Figure 3 appox. 10 month, and in Figure 4 about 12 month, and in Figure 5 about 14 month. (This last picture was taken in bright midday sunlight, hence the heat on the back of the animal). Figure 6 shows the same female one day after giving birth. Figure 7 shows the neonate at one day old with its mother. The Figures show the increased heat exchange area of the uterus as the fetus grows over time. The light colored area indicates the heat transmission site of the uterus to the body surface. Over time the heat transmission area grows larger, because greater parts of the uterus come into contact with the body surface of the mother.

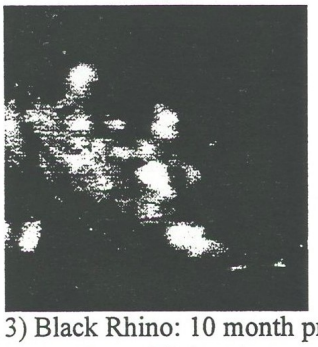
Pregnancy diagnosis in Asien elephants (*Elephas maximus*):

Figure 8 shows a non-pregnant elephant cow. Figure 9 an about 10 month, Figures 10 and 11 each an about 15 month, and Figure 12 an about 20 month pregnant cow. In late pregnancy the heat area becomes less obvious as the uterus spreads over a large

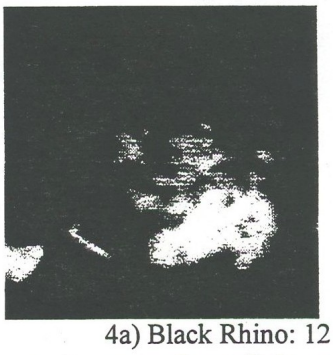


1) Black Rhino: not pregnant
no light area noticable

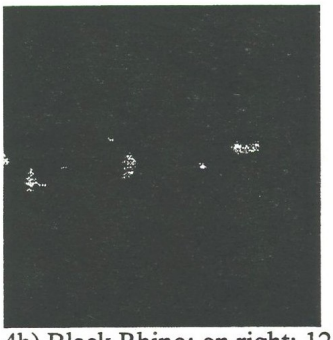
2) Black Rhino: 6,5 month pregnant
note light area in centre of stomach



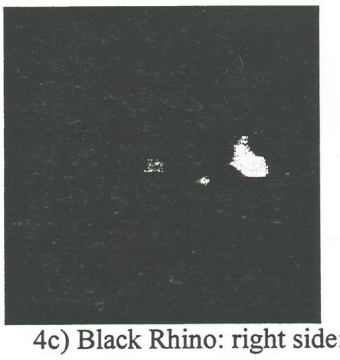
3) Black Rhino: 10 month pregnant
note enlarged light area on stomach



4a) Black Rhino: 12 month pregnant
note increase of very light area on stomach

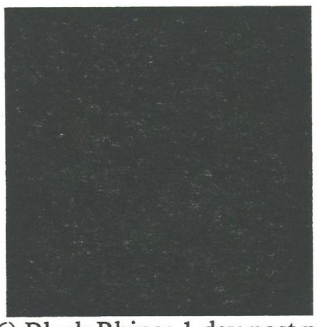


4b) Black Rhino: on right: 12 month pregnant
left animal not pregnant
note large light area on stomach
of the right animal: pregnant

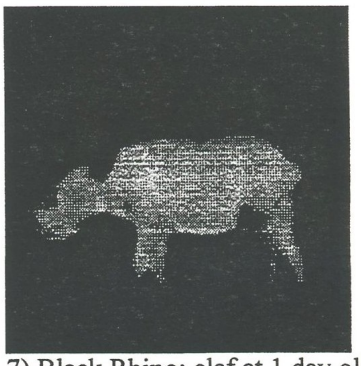


4c) Black Rhino: right side: 12 month pregnant
Distance: 25m; note large light area
on stomach

5) Black Rhino: 14 month pregnant
centre of stomach is very light
back is light from sun shine



6) Black Rhino: 1 day post partum
no light area noticable



7) Black Rhino: claf at 1 day old
calf is much lighter than mom

8) Asian Elephant: right
not pregnant
no area light

9) Asian Elephant: left
10 month pregnant
left: heart light
centre of stomach light

10) Asian Elephant: right
15 month pregnant
notice fetus on bottom
of stomach

11) Asian Elephant: left
20 month pregnant
heart and mammary gland very light
they overlap in elephants;
stomach is lighter than rest of central body

bodysurface area and hence the cow must put more general effort into thermoregulation and is not able any more to give up heat just locally.

Discussion

As the results presented above indicate, infrared-thermography is a useful technique for zoo and wild animal medicine (HILSBERG et al., 1997). It could be used for population management in rhinos and elephants by helping the zoo or wildlife biologist or veterinarian to diagnose pregnancies at a distance and hence give a better overview of happenings in populations. To date the method is still in the process of being standardized, but once this is concluded, it is obviously a very useful tool in zoo and wildlife medicine. No narcosis or sedation is necessary to do this test and hence it is well suited for flighty animals as well. The only disadvantage is the limits to species with short or no hair. Also the person using this method has to learn to differentiate between surface structures, such as slight scratches etc. and true heat areas from uterus thermoregulation. This method gives new possibilities for population management and gaining of easy information concerning rates of pregnancies in mammals. This would therefore finally be a method to easily acquire more basic data concerning the reproductive biology and performance of wild animals.

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