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# **ROLLE DES PARASITISMUS IN DER N'DAMA VIEHZUCHT IN DER FEUCHTSAVANNE DER CÔTE D'IVOIRE**

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## Die Rolle des Parasitismus in der N'Dama Viehhaltung in der Feuchtsavanne der Côte d'Ivoire

Lea Knopf

Die Feuchtsavanne des V-Baoulé an der Grenze zum Regenwald, ist sehr geeignet für die Viehzucht durch ihre ganzjährig verfügbare, ausreichende Futtergrundlage. Mögliche, vor allem parasitäre Gesundheitsrisiken sind weitgehend unbekannt und müssen für die Planung der Viehzucht in Betracht gezogen werden. Das Ziel der vorliegenden Arbeit war eine verbesserte Kenntnis der saisonalen Epidemiologie der Zecken und zeckenübertragenen Krankheiten, sowie deren Relevanz für die Herdengesundheit bei N'Dama Rindern unter extensiven Haltungsbedingungen. In einer longitudinalen Kohortenstudie wurden 3 zufällig ausgewählte Dorfviehherden und 25 Herden aus der Region während 20 Monaten regelmässig untersucht. Im Hinblick auf zukünftige antiparasitäre Interventionen, wurden auch Basisdaten zur Produktivität der trypanotoleranten N'Dama Rinder erhoben. Einer der wichtigsten die Produktivität hemmenden Faktoren ist die hohe Kälbersterblichkeit (0-12 Monate) von  $19.3 \pm 6.3\%$  ( $\pm$ s.e.), deren Ursache unter Feldbedingungen nicht eruiert werden konnte. Die jährliche Abkalberate beträgt in diesen Herden  $52.3 \pm 0.09\%$ . Stierkälber hatten ein durchschnittliches Geburtsgewicht von  $16.54 \pm 0.9$  kg, Kuhkälber  $15.72 \pm 1.1$  kg. Eine adulte N'Dama Kuh (>4 Jahre) wiegt im Durchschnitt 197,3 kg.

Es konnte gezeigt werden, dass Zecken einen Grossteil der Parasitenbürde ausmachen. Die Trypanosomen Prävalenz ist relativ tief (<5%). Gastrointestinale Parasiten sind hauptsächlich Strongyloiden (Prävalenz 45.9%). Ein direkter Einfluss der gastrointestinalen Nematoden auf das Gewicht der Tiere konnte nicht nachgewiesen werden. Unter natürlichen Bedingungen, ohne Ektoparasiten Bekämpfung, sind alle Tiere ganzjährig mit Zecken befallen. Total wurden 9 verschiedene Zeckenspezies von den 4 Genera *Amblyomma*, *Boophilus*, *Hyalomma* und *Rhipicephalus* auf den Rindern gefunden. *A. variegatum* war die dominanteste Zeckenspezies während des ganzen Jahres. In Herden ohne Akarizidbehandlung, tragen die meisten Tiere eine Zeckenbuerde <300 Zecken/Tier (max. 1000). Es konnten hoch signifikante Unterschiede, zwischen den Herden, den Altersgruppen und Jahreszeiten festgestellt werden. Für die schädlichste Zeckenart in diesem Gebiet, *Amblyomma variegatum*, wurden Befallsspitzen der Tiere während den 2 Regenzeiten gefunden. *A. variegatum* durchläuft in der Feuchtsavanne 2 Lebenszyklen im Jahr. Die Zeckenreinfestation ist bei Ektoparasiten Bekämpfung nach 8 Tagen fast vollumfänglich wiederhergestellt. Zeckenübertragene Krankheiten, wie *Babesia bovis* (1% Prävalenz im Blutausstrich) oder *Cowdria ruminantium* ( $30.9 \pm 2.6\%$  Prävalenz serologisch), sind klinisch von geringerer Bedeutung, bedingt durch die endemische Stabilität. Durch die natürliche, längere Selektion auf Krankheitsrobustheit, sind N'Dama Rinder sehr gut angepasst an die Extensivhaltung und können beträchtliche Parasitenbürden verkraften.

## **Einführung in die Thematik**

Die Viehzucht gewährt der ländlichen Bevölkerung im südlichen Westafrika ein zusätzliches Einkommen und eine ganzjährige finanzielle Reserve. Ganz im Gegensatz zu den saisonalen Einkünften des Landbaus, welche im Zuge der Preisliberalisierung starken Schwankungen ausgesetzt sind (Kaffe, Kakao). Da die grosse Dürre der 70er Jahre ein Ausweichen in südlichere (=fruchtbarere) Gebiete bedingte, wurde die Viehzucht im Feuchtsavannengürtel, unter anderem in der Côte d'Ivoire, stark gefördert. Zudem importiert die Côte d'Ivoire die Hälfte ihres Rotfleischbedarfes aus dem Ausland (Sahelländer u.a.), weil die Eigenproduktion der traditionellen Viehzuchtgebiete im Norden des Landes nicht ausreicht. Milchprodukte werden zu 90% importiert. Im Gegensatz zu den nördlicheren, trockeneren Gegenden, verfügt die Feuchtsavannenzone während des ganzen Jahres über eine ausreichende Grünfütter Grundlage, deren qualitative Aspekte jedoch nicht bekannt sind. Bedingt durch die Tsetse-Fliegen Dichte, ist in der Feuchtsavanne die Haltung von spezifisch angepassten Rinderrassen bevorzugt (z.B. erhöhte Toleranz gegenüber gewissen infektiösen Krankheiten und Trypanosomiose). Die meisten bedeutenden viralen Tierseuchen sind heute in der Côte d'Ivoire mehr oder weniger unter Kontrolle. Dies und die klimatischen Bedingungen lassen parasitologische Probleme als Produktivität limitierende Faktoren in den Vordergrund treten. Es wurden kaum Untersuchungen zur Situation in den extensiven Viehzuchten durchgeführt, obwohl diese in der Feuchtsavanne der Côte d'Ivoire stärker vertreten sind, als die moderneren, halbintensiven Viehhaltungssysteme.

Das Ziel des Projektes war die Suche nach Möglichkeiten, die Produktivität dieser Rinder in der Feuchtsavanne zu steigern. Dies soll hauptsächlich über die Verbesserung des Gesundheitszustandes erreicht werden.

Die Feldarbeit fand in der Region von Toumodi, im südlichen Zentrum (V-Baoulé) der Côte d'Ivoire statt.

Die Durchführung des Projektes basierte auf der Forschungspartnerschaft mit dem ivoirianischen Landwirtschaftsministerium (LANADA) und der ivoirianischen Projektpartnerin Dr. C. Komoin-Oka. Anlässlich eines ersten Besuches vor Ort anfangs 1997 war es möglich, die zuständigen Behörden und Fachleute zu kontaktieren, welche die Projektplanung und Zielsetzung massgeblich beeinflusst haben.

Die Projektpartnerin untersuchte im Vorfeld in einer Schlachthofstudie Spektrum und Saisonalität der Magen-Darm Parasiten. In einer gemeinsamen Longitudinalstudie, wurden parasitologische Basisdaten (Zecken, Blut- und Magen-Darm Parasiten) in Viehherden der Region erhoben. In einer lokalen Longitudinalstudie (siehe vorliegende Publikationsmanuskripte) wurden 1. Spektrum und Saisonalität der Zecken als Basis für ein zukünftiges antiparasitäres Behandlungsschema erhoben; 2. der Einfluss des Zeckenbefalls auf die allgemeine Herdengesundheit untersucht, einschliesslich zeckenübertragenen Krankheiten, sowie Basisdaten zur Produktivität erhoben; 3. die Herden auf die Zoonosen Tuberculose und Brucellose untersucht (auch regional).

Alle beteiligten Viehhalter wurden zusätzlich zur Bedeutung ihrer Viehzucht (sozio-ökonomische Aspekte) mittels Fragebogen interviewt.

Die Grundlagendaten der Saisonalität und des Spektrums der Parasiten zusammen mit den Kenntnissen der viehwirtschaftlichen ökonomisch relevanten Rahmenbedingungen in diesem Gebiet erlauben es nun, weiterführende Interventionsstudien (Behandlungsversuche) und ein einfach anwendbares, gezieltes Parasitenbekämpfungsschema auszuarbeiten. Dies könnte den Einsatz von (teuren) Medikamenten bei maximalem Nutzen auf ein Minimum reduzieren.

Die lokalen Behörden und Viehzüchter können mittels der Kenntnis der Produktivität limitierenden Faktoren gezielter eingreifen und damit ihre Viehzucht in ökonomisch

günstigere Bahnen lenken. Eine gezielteres Behandlungsschema ist auch im Hinblick auf die geplante Entwicklung und staatliche Förderung der Milchwirtschaft in dieser Zone, sowie der Resistenzlage der verschiedenen Parasiten gegen die verfügbaren Antiparasitika sinnvoll.

**An diesem Projekt beteiligte Institute:**

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- CIRDES (Centre International de Recherches-Développement en Zone Subhumide)  
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# **SEASONAL EPIDEMIOLOGY OF TICKS AND ASPECTS OF TICK-BORNE DISEASES IN N'DAMA VILLAGE CATTLE IN THE CENTRAL GUINEA SAVANNAH OF CÔTE D'IVOIRE**

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## Abstract

In the central guinea savannah of Côte d'Ivoire, cattle breeding started only about 30 years ago. A study was conducted in close collaboration with national veterinary institutions and local farmers to establish spectrum, burden and seasonal epidemiology of ticks including aspects of tick-borne diseases on N'Dama village cattle, in view of the development of strategic interventions. Knowledge about the impact of parasitism on the overall health status and productivity of the frequently used trypanotolerant N'Dama cattle in this area is lacking. In a longitudinal study 3 randomly selected village cattle herds were examined repeatedly for ticks and other parasites. Spectrum, burden, seasonal epidemiology of ticks and their relevance for general herd-health and tick-borne diseases were assessed. In these village herds without ectoparasite management, the tick prevalence rises up to 100% all over the year. A total of 5 different tick species were identified, 4 genera in order of frequency of occurrence *Amblyomma*, *Boophilus*, *Hyalomma* and *Rhipicephalus*. *Amblyomma variegatum* was the most abundant tick in all seasons. Overall prevalences, of animals infested by *Amblyomma variegatum*, *Boophilus spp.*, *Hyalomma spp.* and *Rhipicephalus spp.* are reported separately: 95.6%, 47.1%, <1% and <1%. *Babesia bovis* prevalence was <1%. Serological prevalence of *Cowdria ruminantium* was  $30.9 \pm 2.6$  %. Most of the animals carry low tick burdens.

Keywords: N'Dama cattle - ticks - tick-borne diseases - Côte d'Ivoire

## Introduction

In contrast to the more arid savannah areas of West Africa, the climate in the central guinea savannah (V-Baoulé) of Côte d'Ivoire doesn't show any important forage shortage during the dry season. Since the 1970s, the Ivorian government undertook considerable efforts to increase local cattle-breeding activities (Bombo, pers. comm.) in this area, which is suitable for trypanotolerant livestock production. Major contagious diseases, such as Contagious Bovine Pleuropneumonia, Rinderpest and Foot and Mouth disease of livestock are under supervision today, but there is a lack of knowledge on the parasitic constraints in this area except for trypanosomiasis control programs. Gastrointestinal parasites of local N'Dama cattle have been investigated in an abattoir study in 1997 (Komoin, 1999). The present study on ticks and tick-borne diseases should complete a broader view of N'Dama parasitism in this area.

Ticks and tick-borne diseases are often present in enzootic stability, dependent on the season and the regional density of cattle and can cause important economic losses (Fasanmi & Onyima., 1990). Assessing the impact of *Amblyomma variegatum* in Cameroon, Stachurski et al. (1997), found significantly improved live weights in acaricide treated against untreated controls. Beside their trypanotolerance, N'Dama cattle are well adapted to the environment and also resist the attachment of long hypostome-ticks (*Amblyomma spp.* and *Hyalomma spp.*)

better than Zebu breeds (Mattioli et al., 1993 / 1995). This natural resistance induces a reduction in the number of ticks engorged, reduced weights of engorged females and a reduction in tick fecundity (Willadsen & Jongejan., 1999). Furthermore, Starkey (1984), mentioned a certain tolerance of N'Dama to babesiosis and dermatophilosis, as well as to other tick-borne diseases (Mattioli et al., 1995). Several studies on tick epidemiology have been carried out in other West African countries such as Mali (Teel et al., 1988), Senegal (Gueye et al., 1989 / 1994), The Gambia (Claxton & Leperre, 1991), Benin (Pangui & Salifou., 1992) and Ghana (Koney et al., 1994). Except for the Senegalese studies, all authors designated *A.variegatum* to be the most abundant tick. Aeschlimann & Morel (1967) carried out the only general tick study available for Côte d'Ivoire, more than 30 years ago, investigating the spectrum and ecology of ticks, present on different mammals and reptiles. The present study tackled to investigate the relevance of ticks and tick-borne diseases in N'Dama cattle in the central guinea savannah of Côte d'Ivoire. Under traditional farming conditions, we established baseline data on the spectrum, burden and seasonal epidemiology of ticks.

## Material and methods

### *Study site*

The study was carried out in the district of Toumodi, central Côte d'Ivoire. The village of Bringakro is situated at 6.4° latitude North and 5.1° longitude West. Its humid savannah climate (guinea savannah) is characterised by a mean annual rainfall of 955 mm, with a mean temperature of 29.6 °C and an average relative air humidity of 72.6% (LAMTO). Two rainy seasons, with a first peak in May/June, a second, minor peak in September/October and two dry seasons can be distinguished (Spichiger, 1975).

### *Experimental design*

A longitudinal cohort study of three village cattle herds was carried out from November 1997 to June 1999. The herds were selected randomly from a list of the 14 functional correos located in the community of the village Bringakro; the cattle owners were resident in Bringakro. Inclusion criteria were no acaricide treatment during the whole study period and the consent to participate in the study. All animals of the 3 selected herds (144 animals initially), were ear tagged. We carried out 6 seasonal samplings on blood and faeces and the herds were followed up for tick collection monthly (table 1, study design). On average animals were examined 7.9 times (range: 1-14) for ticks. Live weights were assessed four times during the study period.

## Methods

In view of the monitoring of productivity parameters and its relation to the tick burden, tick counts on all animals in the herd were necessary. For this purpose a rapid assessment method was developed and was validated against half body counts of some animals:

Ticks were collected at an individual level on one side of the animal's body surface, divided into 9 sectors (head, ear, neck and dewlap, back, abdomen, foreleg and shoulder, hindleg, ano-genital area and tail). On each sector, if available, by convenience two ticks were searched in a tactile way and collected. In this way, overestimation of the easily visible *Amblyomma* ticks

was avoided. Additionally a semi-quantitative rapid assessment of the tick burden was done by counting all ticks in a square of 7cm-side length (49cm<sup>2</sup>) on the mid-dew lap (square count). This square count was then compared to entire half-body counts on some (n=52) animals, see figure 1. The collected ticks of each sampling and animal were stored separately in tubes of ethanol 70° for further speciation.

Descriptive statistics of prevalences of tick species were calculated in EPI-Info. To validate the tick burden, measurements of entire half body counts against the square count, we used the concordance correlation (Lin, 1989). The concordance correlation coefficient measures both, the accuracy and the precision of the relationship and in this way its reproducibility. Because the frequency distribution of square count data are overdispersed and highly skewed and general linear models allow multivariate modelling, a negative binomial regression (with a random effect for the individual animal) in the frame work of general estimated equations (STATA, XTNBREG) was used with the following equation:

$$Y_{ijklm} = \mu + \text{herd}_i + \text{sex}_j + \text{agegr}_k + \text{year}_l + \text{month}_m + \text{id}_n$$

Explanation of the variables:

$Y_{ijklm}$	Square count (tick burden) of an animal <sub>ijklm</sub> at monthly <sub>m</sub> collection of year <sub>l</sub>
$\text{herd}_i$	three different herds
$\text{sex}_j$	male or female
$\text{agegr}_k$	age of the animal in years, six levels (0.5, 1, 2, 3, 4, 5 years and older)
$\text{year}_l$	sampling year, (1997, 1998, 1999)
$\text{month}_m$	sampling month (1 –12)
$\text{id}_n$	random effect for the individual animal

Giemsa stained blood smears were examined by microscopy (magnification of 1000x with immersions oil during at least 15 minutes) to check for tick-borne parasites. To test animals for *Cowdria ruminantium* infections, serology was carried out in one seasonal sampling (sera from June 1998) using the MAP1-B (recombinant major antigenic protein, fragment B) ELISA kit from Utrecht, The Netherlands (Mboloji et al., 1999). Measurements were read at 405 nm, 30 minutes after incubation in the dark. The means of the duplicate measurements were calculated and the optical density was expressed as a percentage positive value of the reference positive control for each plate. The cut-off value of 31.0 % (95% CI 27-50%) of the reference positive control, which was validated by Mboloji et al., is based on sheep sera of artificially infected European animals. Doubtful reactions were based on the upper confidence limit of the original cut-off of 31 %. Additionally, a screening for cowdriosis was done in dead calves (maximum 24 hours post mortem) macroscopically on necropsies, and microscopically on Giemsa-stained squashed brain smears of the same animals, according to instructions of the Centre International de Recherches-Développement en Zone Subhumide (CIRDES), 1998. The necropsies included the macroscopical examination of all organs for pathognomonic signs of infective diseases or other possible causes of death, which may be detected macroscopically.

## Results

Herds were composed of 45.8% animals younger than 4 years and the proportion of sexes was 75.2% females to 24.8% males.

On the animals 5 species of 4 genera of ticks were found: *Amblyomma variegatum*, *Boophilus geigy*, *Boophilus annulatus*, *Rhipicephalus sanguineus* and *Hyalomma rufipes*. *Amblyomma variegatum* was the most abundant tick, followed by *Boophilus geigy* and *Boophilus annulatus*. Other genera and species were found only in small numbers (table 1).

The concordance correlation coefficient ( $\rho$ ) of the number of ticks in the square count and half body counts was  $0.029 \pm 0.006$ , see also figure 1. The majority of the controlled animals (74.8%) had square counts of  $< 3$  and the geometric mean was at 0.964 ticks in the square (range: 0-28). Regression of half body counts for the square counts results in an adjusted  $r^2=0.78$  and a slope of  $41.6 \pm 3.06$  (CI 95%) ticks per square count of the whole animal's tick burden. The maximum of observed ticks on the half of the body surface was 501, only 3 animals were free of ticks on the occasion of tick controls.

Figure 2A and 2B represent the seasonal mean prevalences of *A. variegatum* and *Boophilus spp.* From April to June, in the rainy season, high proportions of animals were infested by *A. variegatum* adults. A small peak was found in October, at the end of the small rainy season. The *Amblyomma* nymphs follow the inverse seasonal trend. *Boophilus* ticks showed several peaks.

The negative binomial regression analysis of the tick burden (square count) showed highly significant influence of herd ( $p=0.01$ ), year ( $p<0.01$ ), month ( $p<0.01$ ) and age group ( $p<0.01$ ) effects. There was no significant difference between the two sexes ( $p=0.07$ ), although a trend for males to have higher square counts was present. Figure 3 shows the age dependence of the tick burden, older animals carried a higher burden than the younger ones. In a general linear model, the effect of tick burden (square count) on the live weight gain was investigated in two groups, animals of all three herds at the age of 0-24 ( $n=15$ ) and 25-48 ( $n=50$ ) month. No significant effect on weight gain ( $p>0.05$ ) could be shown in either of these groups.

By examination of thin blood smears ( $n=809$ ) 7 cases of *Babesia bovis* were detected. Five cases were found in the dry season (January 1998), 2 cases in the rainy season (June 1998) and no cases at all during 1999. The serological tests for *Cowdria ruminantium* demonstrated, that in the whole study area,  $30.9 \pm 2.6$  % of the animals ( $n=314$ ) had positive reactions, independent of age or sex ( $p>0.05$ ). Including the doubtful reactions (the upper confidence limit of the cut-off value)  $40.8 \pm 2.8$ % of the animals were positive for *Cowdria ruminantium* serology. At necropsy of 12 calves, macroscopical and microscopical examination were negative for typical cowdriosis signs and cowdria organisms. No other tick-borne rickettsiae, such as *Anaplasma spp.* and *Ehrlichia spp.* were found on the blood smears of these herds.

## Discussion

Our findings on the general spectrum of ticks corresponded to the findings of other authors in West Africa (Teel et al., 1988; Gueye et al., 1989, 1994; Claxton & Leperre, 1991; Koney et al., 1994). *A. variegatum* was the dominant species throughout the year. The diversity of the tick species found on cattle is not very high and is in line with the findings of other West African countries (Teel et al., 1988; Gueye et al., 1989 and 1994; Koney et al., 1994; and Claxton & Leperre, 1991).

Since the animals were not treated against ticks, all animals carried ticks during the whole study period, only 3 animals were found to be free of ticks at monthly tick collection. The square count correlated better with the tick burden on the group level, than on the individual level. Nevertheless it is a simple and efficient tool to assess the tick burden on animal group level in a semiquantitative way. In contrast to helminth infections (Zinsstag et al., 2000),

N'Dama cattle do not seem to develop a better resistance to ticks with increasing age. In view of the natural behavioural patterns of different age groups and sexes of grazing cattle in the savannah, higher exposure probably has more impact on the tick burden, than the acquired immunity. Although N'Dama cattle seem to tolerate the tick burden, secondary effects, like infected tick wounds and as a possible consequence myiasis and abscess, can stress the animals additionally.

Adults of *A.variegatum* are more commonly found on cattle in the rainy seasons (Koney et al., 1994), (Stachurski et al., 1993), which was confirmed in the study area by the findings in the 3 herds of Bringakro. The number of cycles *Amblyomma* ticks are running in one year is strongly dependent on climatic factors and increases with humidity and temperature (Aeschlimann & Morel, 1967). In our study site, two annual cycles could be observed, a more important one from December to June and a smaller one from July to October with a tendency to overlap.

The *Boophilus spp.* showed a different seasonal pattern, smaller, less distinctive infestation peaks, which could be explained through their biology (one-host-tick and several cycles per year). The seasonal prevalence of *Boophilus* nymphs has to be excluded, due to small size their collection on the animals is not reliable.

So far, using simple diagnostic techniques, protozoan tick-borne diseases, such as babesiosis, can be considered to have low prevalences, which may reflect enzootic stability. No clinical signs for these diseases were evident in the three study herds. The cowdriosis serology, has to be interpreted cautiously, since the test was validated on small ruminants sera and it is less sensitive in cattle, true prevalence might even be higher (Stachurski pers. comm.). In cowdriosis-endemic areas, where it is very difficult to obtain negative reference sera from the local animal population, the diagnostic accuracy of the cut-off value may not be completely satisfactory (Mboloi et al., 1999). The presence of cowdriosis in Central Côte d'Ivoire, has also been confirmed by a few serological investigations in some herds (cattle and sheep) by the National Veterinary Laboratory (Zogbo, pers. comm.).

In conclusion, N'Dama cattle are well adapted to their environment and can resist a considerable tick burden under traditional farming conditions. With the choice of a tick tolerant cattle breed, like N'Dama, the cost for antiparasitic treatment may can be kept lower in traditional farming systems. The results of these studies serve as baseline information on tick infestation in the guinea savannah, available for the veterinary authorities in order to develop cost effective treatment schemes. The impact of current practices as well as of reduced treatment schemes should be further investigated. Especially, in view of the recently started crossbreeding activities and the intensification of the present farming systems, further comparative investigations should be carried out, including a controlled treatment trial and a socio-economic analysis on the cost-benefit ratio of acaricidal treatments. The development of crossbreeding with exotic breeds and intensification have to be taken into account for the planning of disease and parasite resistance measures. A new equilibrium must be found between superior disease resistance of N'Dama cattle and improved productivity of crossbreeds, which are presumably highly susceptible to parasites and diseases.

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## Annex

**Figure 1:** Linear regression of log square count to half body tick counts (95% CI) on N'Dama tick burden

**Figure 2A:** Mean monthly prevalence of *A. variegatum* ticks on cattle

**Figure 2B:** Mean monthly prevalence of *Boophilus spp.* ticks on cattle

**Figure 3:** Geometric means of tick square counts in different age groups of N'Dama village cattle

**Table 1:** Study design

**Table 2:** Mean prevalences of tick species found in three N'Dama village cattle herds over the whole sampling period

**Figure 1: Linear regression of log square count to half body tick counts (95% CI) on N'Dama tick burden**

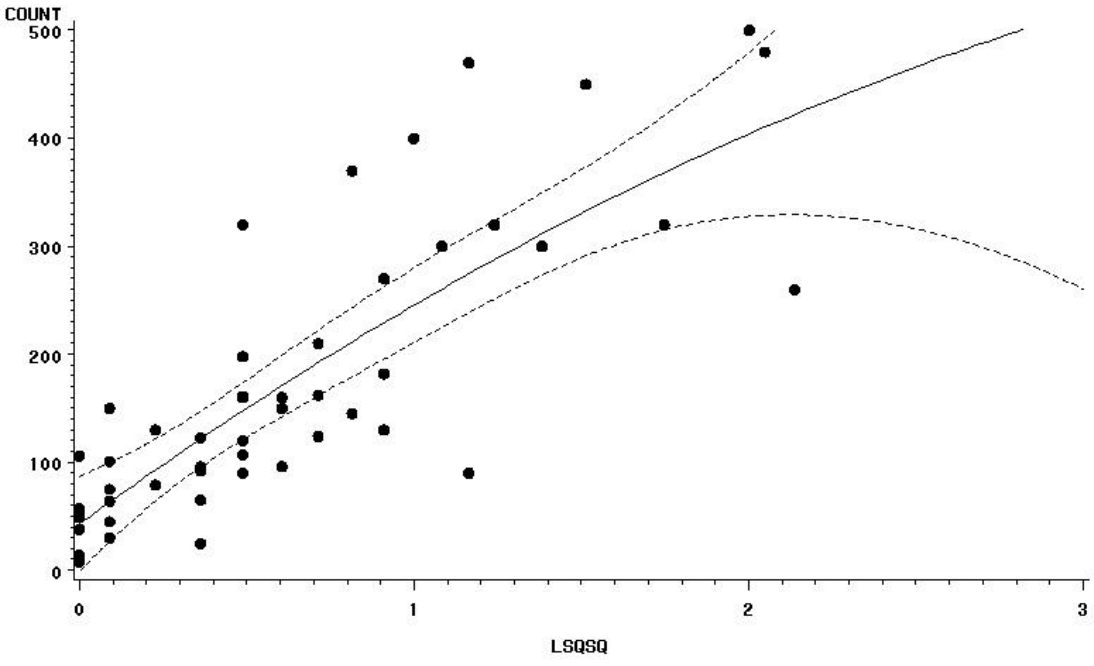
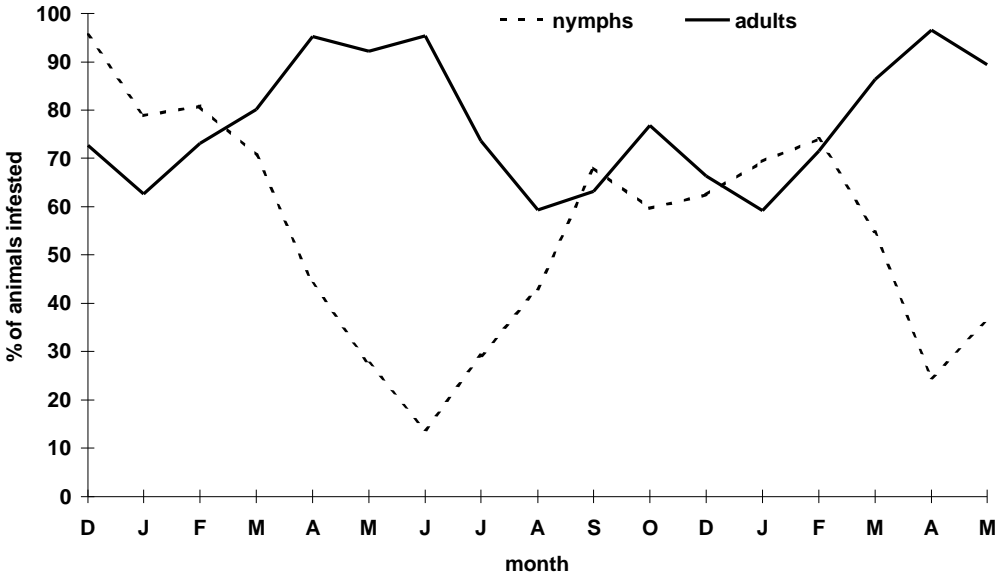
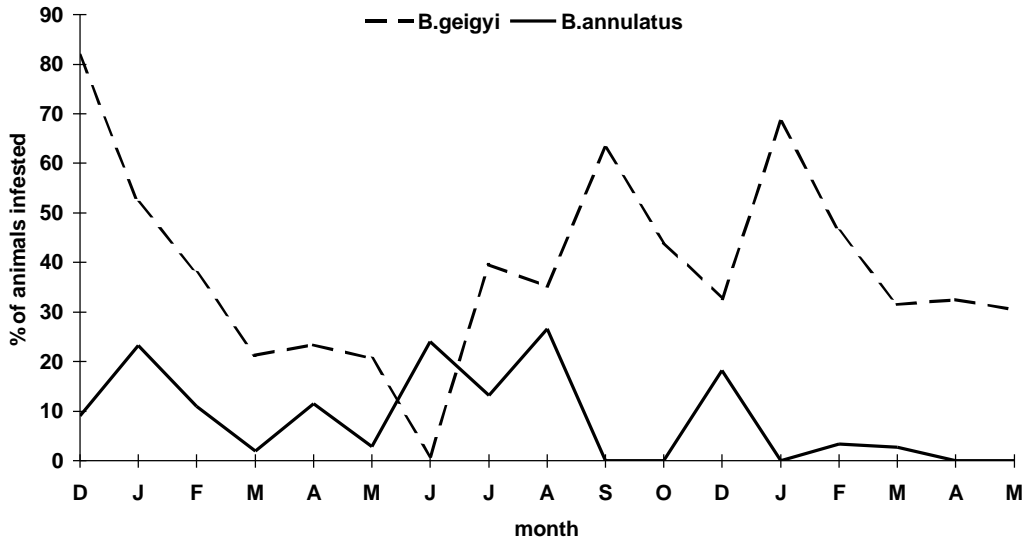


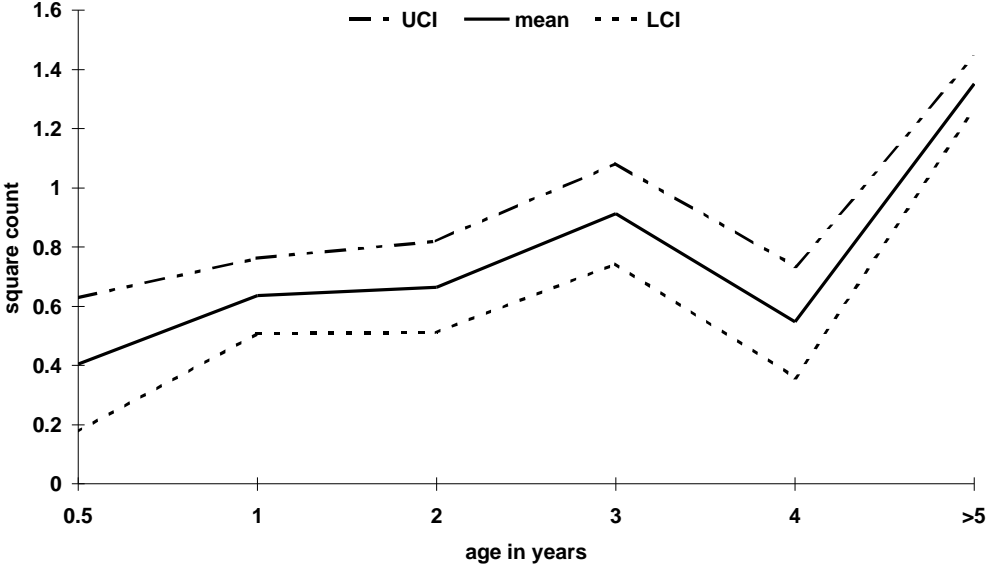
Figure 2A: Mean monthly prevalence of *A. variegatum* ticks on cattle



**Figure 2B: Mean monthly prevalence of *Boophilus spp.* ticks on cattle**



**Figure 3: Geometric means of tick square counts ( $\pm$  95% CI) in different age groups of N'Dama village cattle**



**Table 1: Study design**

Period		Number of animals sampled			
year	month	ticks	blood	faeces	weight
97	dec	22			142
98	jan	93	134	130	
	feb	59			
	mar	63			
	apr	96			
	may	36	132	135	132
	jun	108			
	jul	106	139	133	
	aug	128			
	sep	103		137	
	oct	106			
	nov				
	dec	82			
99	jan	98	146	137	118
	feb	124			
	mar	74	139	136	
	apr	117			
	may	66	141	118	118

**Table 2: Mean prevalences of tick species found in three N'Dama village cattle herds over the whole sampling period on the occasion of monthly tick collection**

<b>SPECIES</b>	<b>% animals infested</b>	<b>n(1475)</b>
<b>Amblyomma variegatum adults</b>	<b>76.5</b>	<b>1128</b>
<b>Amblyomma variegatum nymphs</b>	<b>55.1</b>	<b>812</b>
<b>Boophilus geigy</b>	<b>34.0</b>	<b>501</b>
<b>Boophilus annulatus</b>	<b>14.0</b>	<b>207</b>
<b>Rhipicephalus sanguineus</b>	<b>0.3</b>	<b>5</b>
<b>Hyalomma rufipes</b>	<b>&lt;0.1</b>	<b>1</b>

# **PRODUCTIVITY PARAMETERS OF N'DAMA VILLAGE CATTLE IN RELATION TO PARASITISM IN THE GUINEA SAVANNAH OF CÔTE D'IVOIRE**

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## Abstract

In the central guinea savannah of Côte d'Ivoire cattle breeding started only about 30 years ago. The pressure of tsetse flies favours farming of trypanotolerant livestock and the area is very suitable for cattle breeding due to the abundance of forage throughout the year and its easy accessibility from economically important centres. Very little is known on the productivity and the overall health status of N'Dama cattle under traditional farming conditions in the humid savannah of Côte d'Ivoire. This study aimed to investigate productivity parameters of local N'Dama cattle in order to create a baseline data set on productivity parameters including aspects of parasitism under traditional farming conditions in this area. In a longitudinal study 3 randomly selected village cattle herds were followed up during a period of 20 month. Demography, live weight, tick counts, tick-borne diseases, gastrointestinal faecal egg count (epg) and overall health status were assessed. Under this traditional farming conditions, the annual calving rate was  $52.3 \pm 0.91$  % (mean  $\pm$  standard error). The cumulative mortality of calves <1 year was  $19.3 \pm 6.2$ %. Birth weights were  $16.54 \pm 0.95$  kg for males and  $15.72 \pm 1.12$  kg for females. Adult females achieved a mean weight of  $197.7 \pm 4.7$  kg. Live weight of young N'Dama cattle showed no significant relationship with tick and strongyle burden. N'Dama cattle can resist the difficult traditional farming conditions and be productive in this environment, but the local production of milk and beef is still insufficient for the consumers demand. As a consequence, crossbreeding activities with Montbeliard, which may change host susceptibility to parasitic diseases considerably, started recently through national and private programs. The data will serve as a baseline for the appraisal of the profitability of antiparasitic treatment schemes in traditional and crossbred cattle herds.

Keywords: cattle – productivity - parasitism - N'Dama cattle - Côte d'Ivoire-West Africa

## Introduction

In contrast to the more arid Savannah areas of West Africa, the central Guinea Savannah (V-Baoulé) of Côte d'Ivoire doesn't show any important forage shortage during the dry season. Since the 1970s the Ivorian government undertook considerable efforts to increase local cattle-breeding activities in this area, which is suitable for trypanotolerant livestock production. Trypanosomiasis control programs have been running since the 1970s (Bombo, pers. comm.). Through these efforts, among others, Côte d'Ivoire could improve its beef supply. But still today, 50% of red meat consumed has to be imported from Sahelian countries (Wiese, 1988; Bombo, pers. comm.) and Europe. Moreover 90% of milk (products) are imported from various countries (Bombo, pers. comm.). Cattle breeding is welcome as a secondary activity, to diversify from cash crop production, like coffee and cacao, subject to continuously dropping prices. But it is also of interest for people working in the public and private services in the nearby cities. In contrast to northern Côte d'Ivoire, the farmers of the humid savannah do not make use of cattle draught power so far, particularly because the technical knowledge is still lacking in the whole area. Most of

the data on N'Dama productivity, available for West Africa, from 'on station' managed N'Dama cattle in Ghana (Tuah & Yaa Nyamaa Danso, 1985), The Gambia (Njie and Agyemang, 1991), in Senegal (Fall et al, 1982 and 1999), in Burkina Faso (CIRDES, 1995), in Northern Côte d'Ivoire (Rowlands et al, 1996). With exception of Gambian studies (Dwinger et al., 1994; Zinsstag et al., 1997; Itty et al., 1997; Agyemang et al., 1992), a study in Senegal (Agyemang et al., 1992) and Zaire (Itty et al., 1997), productivity data under traditional management conditions are scarce. Other studies on productivity of indigenous cattle, such as "West African Shorthorn" breeds, were carried out in Zimbabwe (Hall, 1998) and Benin (Hall et al., 1995). The authors of these studies strengthen on the underestimation of the indigenous cattle's productivity under traditional farming conditions.

Since the Central humid savannah area of Côte d'Ivoire (V-Baoulé) should become a national dairy centre, the veterinary authorities are interested in the productivity of local trypanotolerant N'Dama cattle (Bombo, pers.comm.). The study aimed to create a baseline data set on N'Dama cattle performance in the humid savannah of Côte d'Ivoire under traditional farming conditions with special emphasis on productivity parameters and parasitism. The data will serve for a first appraisal of the profitability of antiparasitic treatment schemes in traditional and crossbred cattle herds and facilitate future antiparasitic intervention trials.

The project planning and the fieldwork were carried out in close partnership with the LANADA (Laboratoire National d'Appui au Développement Agricole) and local farmers.

## Material and methods

### *Study site*

The present study was carried out in the district of Toumodi, central Côte d'Ivoire (V-Baoulé). The main study site, the village of Bringakro is situated at 6.4° latitude North and 5.1° longitude West. Its humid savannah climate (Guinea savannah) is characterised by a mean monthly rainfall of 955mm, with a mean temperature of 29.6°C and relative air humidity of 72.6% in average (LAMTO, 1998/99). Two rainy seasons, with a first peak in May/June, a second, minor peak in September / October and two dry seasons can be distinguished. This area is very suitable for cattle farming in terms of the abundance of its pastures throughout the year, there is hardly any forage shortage and a multitude of water ponds is scattered in the area. The V-Baoulé is a suitable site for the development of dairy industry, near to economically important market places and has well-developed roads and transport facilities.

### *Farming system and animals*

All cattle herds are managed under traditional conditions: During the day, they are led to communal, natural pastures by herdsman or let free and in the night, they are kept in private or communal paddocks throughout the year. With exception of minerals, no other supplementary feeding is practised. Various artificial and natural water ponds are accessible within less than 5 km. Most of the farmers of the village of Bringakro do not practise prophylactic treatment schemes against parasites or other diseases. Veterinary services provide the regular vaccination against Rinderpest and contagious pleuropneumonia, but are hardly ever called for other purposes, such as herd health problems and individually sick animals.

A longitudinal cohort study of three village cattle herds was carried out from November 1997 to June 1999. The herds were selected randomly from a list of the 14 functional paddocks located in the community of the village Bringakro and of which the cattle owners were resident in Bringakro. Inclusion criteria were willingness to participate in the study. The herd size ranged from 36 to 82 animals per herd.

### *Methods*

All animals of the three selected herds, 144 animals initially, were ear-tagged. Blood and faecal samples were collected six times, between January 1998 to June 1999 (see table 1). Blood samples were used for blood smears and dark ground / phase contrast buffy coat microscopy to check the animals for blood parasites. Faecal samples were analysed by the McMaster technique (epg, eggs per gram faeces). Ticks were collected monthly using a rapid assessment method (Knopf et al., 2000) and the herds were followed up weekly for demographic parameters (birth, deaths, off-take). Live weight was measured 4 times during the study period. The calves were weighed maximum 20 days after birth. No prophylactic herd treatment against parasites took place. The socio-economic status of cattle breeding in this area was assessed by farmer interviews (questionnaire adapted from Itty, 1994).

The age of the animals was estimated by dentition, number of calvings and herd history. Young calves, which were born before the start of the study, were not

included in the calculation of calf mortality rates or calving rates. We treated clinically sick animals individually and recorded them separately. Herd structure and descriptive data were calculated in EPI-Info. Calf mortality was analysed using a survival analysis (proc lifetest, SAS) and proportional hazard regression. Calving rate was calculated, based on a cumulative incidence formula assuming mean age at first conception of 41 month (Zinsstag et al., 1997b). The effect of variables (see table 2) on live weights of animals older than one year was analysed by a mixed model (SAS proc mixed) with a random effect for the individual animal, nested in herd. A similar model was used to test the effect of gastrointestinal parasitism (epg) on live weight (all animals). Effects of the tick burden on the live weights of animals younger than 4 years were analysed using a general linear model (SAS Proc GLM).

## Results

Farmer interviews on the role of cattle breeding indicate that the main role of cattle was its savings function. But off-take rates (figure 1), show market-oriented sale of young bulls for slaughter (mean age at off-take 3.5 years). Old females are sold or slaughtered only in case of disease. All other purposes were mentioned to be of minor importance, like availability of meat for occasional home consumption and sale of young heifers. In this area the use of draught oxen is not practised and animal products like hides for leather industry or manure, as fertiliser are neither used nor commercialised, although most of the cattle owners have plantations. All decisions concerning herd management are taken by the owner, who hires generally a Fulbe herdsman to take daily care of the cattle. In the study site, milk is milked and commercialised exclusively by the Fulbe herdsman to their own benefit.

During the whole study period no additional cattle were bought. One owner entrusted two young heifers to another herd and two animals had to be put down because of severe disease and accident, no natural death occurred in animals >14 month.

Under traditional farming conditions the calving rate was  $52.3 \pm 0.91\%$  (mean  $\pm$  standard error), assuming that cows start the fertile stage at the age of 41 month. There were two calving peaks during the year (figure 2) one in March / April and a second one in November. Only two dams have calved a second time during the observation period, the calving-intervals were 419 (calf alive) and 429 days (first calf died <3 month).

Cumulative calf mortality from birth to 1 year is  $19.3 \pm 6.2\%$ ; the course is presented in figure 3. Neither sex nor herd differences affected significantly calf survival for the first 530 days after birth. The adjusted birth weights are  $16.54 \pm 0.96$  kg for males and  $15.72 \pm 1.12$  kg for females. In the first 20 days the daily weight gain is  $0.257 \pm 0.089$  kg per day. In figure 4, live weight development shows that female achieve the adult weight plateau around the age of 4.5 years. The difference of weight between the two sexes were significant ( $p= 0.04$ ) from the age of 4 years onwards and it can be assumed that female maturity is reached then. In the group of one-year-old and three-year-old cattle, significant herd differences could be shown, but not in the others (see also table 2).

Since no prophylactic treatment was applied, the global parasite burden in these trypanotolerant cattle can be considered natural: The findings of 6 seasonal samplings resulted in an overall prevalence of *Trypanosoma brucei* of 2.7% and *Trypanosoma*

*congolense* 1%. Strongyles are the most common gastrointestinal parasites with a global prevalence of  $45.9 \pm 16\%$  in all animals (926 faecal samples), followed by Coccidias ( $9.2 \pm 1.0\%$ ), *Strongyloides papillosus* ( $3.3 \pm 0.6\%$ ), *Monezia spp.* ( $2.5 \pm 0.5\%$ ) and *Toxocara vitulorum* ( $1.8 \pm 0.4\%$ ).

In calves < 1 year, *Strongyloides papillosus* was observed in  $22.1 \pm 8.6\%$  of the animals, whereas *Toxocara vitulorum* reaches only a prevalence of  $12.3 \pm 5.1\%$ . Generally the animals carried low burdens of gastrointestinal parasites, with the exception of some clinical cases in young calves, that carried high burdens of *T.vitulorum* (max. 77'600 epg) or *S.papillosus* (max. 26'000 epg). The geometric means of strongyle faecal egg counts decrease from 19.88 epg in one-year-old cattle to 8.34 epg at three years and stay below 9 epg after the age of 5 years. There was no significant difference in live weight between faecal excretors and animals excreting no gastrointestinal nematode eggs. Furthermore all animals carried an important tick burden all over the year, nevertheless the prevalence of tick-borne diseases in capillary blood smears was low (*Babesia bovis* 1%). In an analysis comparing heavily and lightly tick-infested young animals (<4 years), no significant difference in weight gain could be demonstrated.

## Discussion

The productivity results are in line with the findings of other authors (see below) in similar studies, assuming that the management conditions with very little inputs are comparable. In view of the limited study period, fertility parameters can only be estimated approximately. The calving rates in N'Dama cattle in West Africa range from 28% to 68% in The Gambia (Itty et al., 1997; Dwinger et al., 1994; Zinsstag et al., 1998), 53% in Senegal (Agyemang et al., 1992), 65% in Zaire and northern Côte d'Ivoire (Itty, 1992). Station managed N'Dama herds can reach calving rates superior to 70%, which can be explained mainly by a lower age at first calving (Matthewman & Perry, 1985), (Zinsstag et al., 1997b) and lower calving intervals. A bi-annual calving peak may indicate that there is no nutritional influence on fertility in the study area in contrast to observations in the Gambias (Zinsstag et al., 1997b). The observed calf mortality (0-1 year) in this study is higher than those, observed on station (Senegal, Fall et al. 1982), (Ghana, Tuah et al., 1985), (The Gambia, Njie et al., 1991), but within the range of reported data of village cattle mortality (Senegal, Agyemang et al., 1992), (The Gambia, Dwinger, 1994). Death in young calves occurred mostly within the first 100 days. Although we carried out 12 necropsies, the causes of death couldn't be specified with the techniques available in the field, no pathognomonic signs of cowdriosis (including microscopy of smashed brain smears) or heavy gastrointestinal parasitism were observed, although the serological prevalence of cowdriosis is  $30.9 \pm 2.6\%$ , which may reflect enzootic stability. No correlation of cowdria positive serology with mortality could be found. Since the sample size and power of this analysis are small, more data are needed to support this hypothesis.

In calves alive, high faecal egg counts of *S.papillosus* and *T.vitulorum* were measured, but a significant relationship between the two parasites and mortality couldn't be demonstrated so far and more data is needed as well. *S.papillosus* and *T.vitulorum* seem not of high importance in dry savannah areas (Zinsstag et al., 1997a, The

Gambia), whereas they can contribute to calf mortality considerably in the humid tropics areas (Chartier et al. 1991, Zaire).

The milking practice of herdsmen, who commercialise milk to gain an additional income, can be in competition with the minimal needs of the calf and can favour malnutrition and hence calf's susceptibility to diseases and an increased mortality.

Since the herd differences of mortality were not significant, we assume that the current milking practice didn't have a major influence on calf mortality (one herd was never milked). More detailed investigations on high calf mortality in village cattle are needed to identify possible causes.

Gastrointestinal nematode faecal egg counts in this study area are moderate despite the continuous exposure and transmission throughout the year. The continuous transmission is might actually a reason for moderate gastrointestinal parasite burdens, because of the continuous stimulation of the immune system and comparatively good nutritional status throughout the year. The former is supported by the absence of a significant age dependency of geometric means of faecal egg counts in contrast to Zinsstag et al. (2000b), who observed a significant age dependence of faecal egg counts in Gambian N'Dama cattle.

The seasonal epidemiology and the spectrum of ticks on N'Dama village cattle of this area are described in detail in Knopf et al. 2000. Previous studies have shown poor correlations within infested groups between animals of different degrees of infestation (Stachurski pers. comm.). The non-existing genuine uninfested controls in this study, may make it impossible to estimate production losses and have to be interpreted cautiously.

In conclusion, N'Dama cattle are well adapted at their environment, they are able to resist harsh conditions and parasite pressure and can remain productive even with minimal input. Anthelmintic and acaricide interventions have to be tested for their profitability prior to recommendation to the farmers. The high calf mortality appears to be a major factor affecting productivity of N'Dama cattle in this area and needs to be investigated more closely.

Introducing exotic crossbreeds in this area requires improved management strategies, including parasite control and good surveillance of young calves. A new equilibrium must be found between superior disease resistance of N'Dama cattle and higher productivity of crossbreeds (Zinsstag et al., 2000), which are presumably highly susceptible to parasites and diseases.

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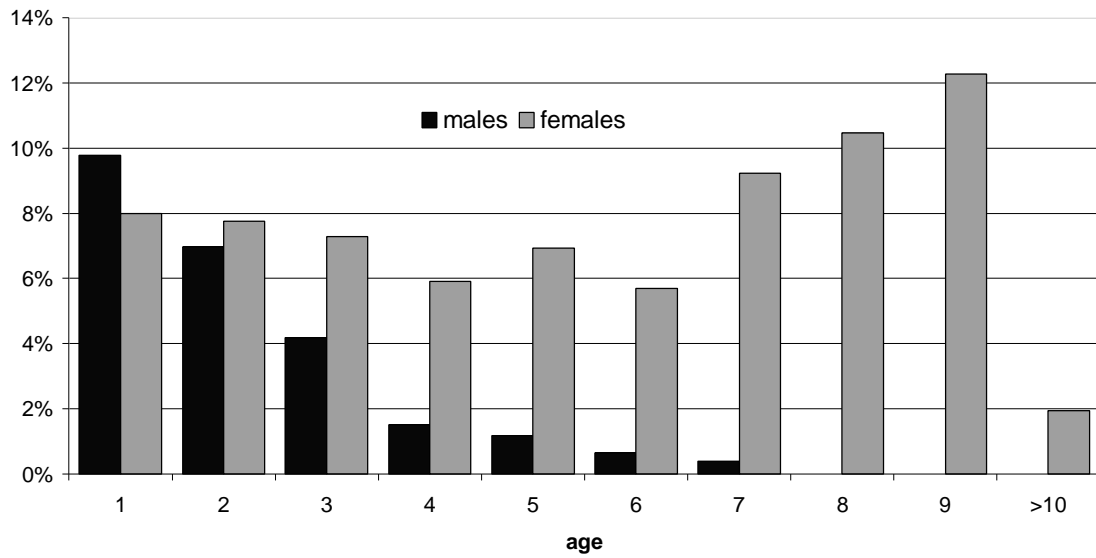
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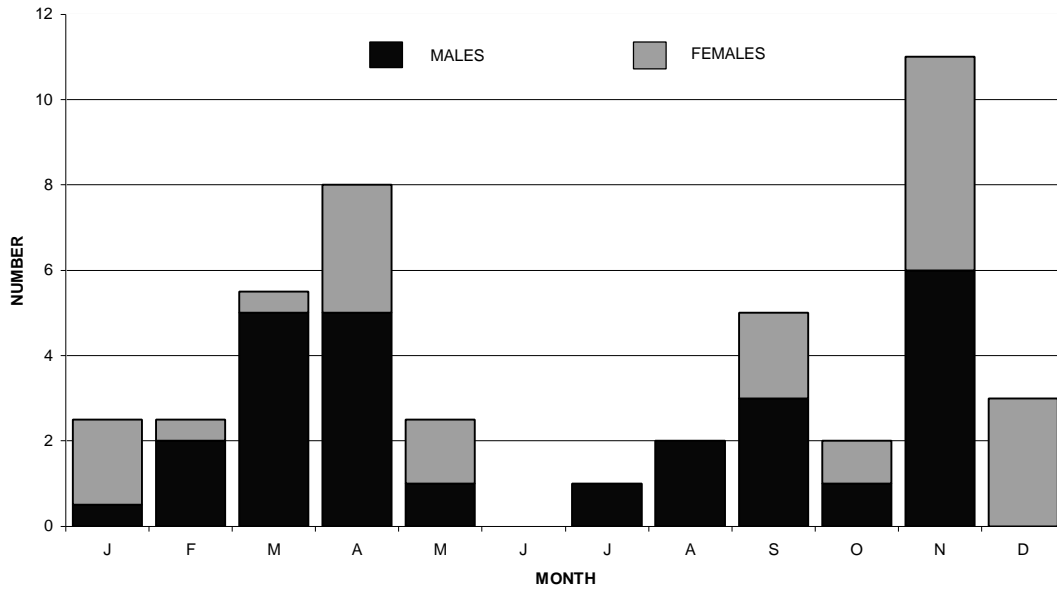
## Annex

- Figure 1:** Relative average herd structure of three N'Dama village cattle herds years 1998/99. % = frequency of animals (n=165) by age class, age = age in years
- Figure 2:** Monthly calving frequency of N'Dama village cattle in the humid savannah of Côte d'Ivoire, average of 19 month. Number = calves born
- Figure 3:** Survival of N'Dama calves in the first 530 days after birth.  
% survivors = proportion of surviving calves, day 0 = birthday
- Figure 4:** Means of live weight ( $\pm$  s.e.) of N'Dama village cattle by sex and age in years
- Table 1:** Study design
- Table 2:** Summary on variable effects on live weight of N'Dama village cattle (p-values of F-tests type III)

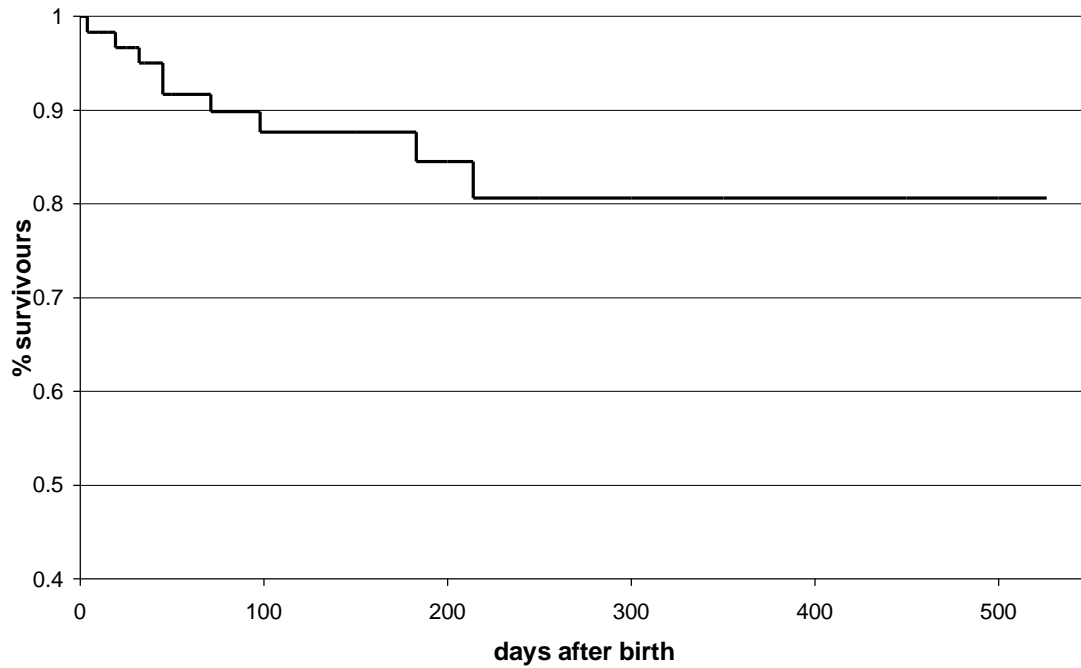
**Figure 1: Relative average herd structure of three N'Dama village cattle herds years 1998/99: % = frequency of animals (n=165) by age class, age = age in years**



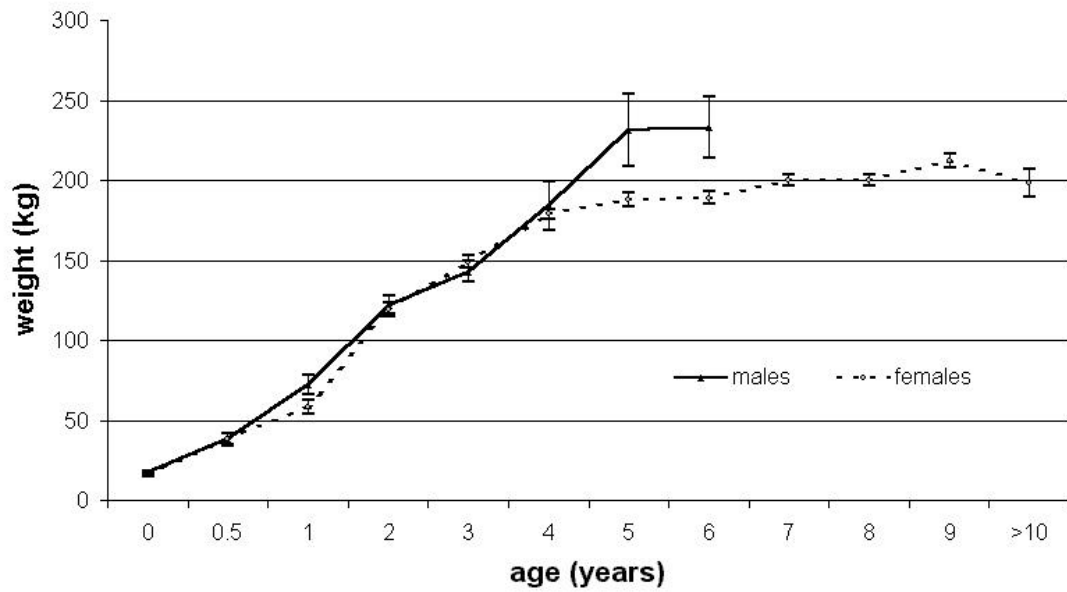
**Figure 2: Monthly calving frequency of N'Dama village cattle in the humid savannah of Côte d'Ivoire, average of 19 month. Number = calves born**



**Figure 3: Survival of N'Dama calves in the first 530 days after birth.**  
**% survivors = proportion of surviving calves, day 0 = birthday**



**Figure 4:** Means of live weight ( $\pm$  s.e.) of N'Dama village cattle by sex and age in years



**Table 1: Study design**

Period		Number of animals sampled			
year	month	ticks	blood	faeces	weight
97	dec	22			142
98	jan	93	134	130	
	feb	59			
	mar	63			
	apr	96			
	may	36	132	135	132
	jun	108			
	jul	106	139	133	
	aug	128			
	sep	103			137
	oct	106			
	nov				
	dec	82			
99	jan	98	146	137	118
	feb	124			
	mar	74	139	136	
	apr	117			
	may	66	141	118	118

**Table 2: Summary on variable effects on live weight of N'Dama village cattle (p-values of F-tests type III)**

Variable	Age group						
	Birth	1 year	2years	3 years	4 years	5 years	6 years and older
Sex	*ns	ns	ns	ns	ns	0.044	0.003
Herd	*ns	0.001	ns	ns	ns	ns	ns
Year		0.025	ns	ns	0.039	ns	0.009
n	60	78	65	39	35	28	68

ns : not significant

\*p-value of Wald-Chi-square test

## Curriculum vitae of Lea Knopf

Citizen of Basle and Niederglatt (Switzerland)

Born 15th of May 1970 in Basle (Switzerland)

- 1977 - 1984 Schools in Kölliken (AG), Switzerland
- 1984 - 1989 High School with general certificate of education Type B in Basle
- 1990 - 1996 Studies of Veterinary Medicine at the University of Berne
- 1992 / 1993 Student assistant (practical teaching) in the Institute of Veterinary Anatomy
- 1990 - 1994 Work in the Communal Hospital of Berne (Dept. of Surgery) beside the studies
- 1995 Scholarship (ERASMUS) for the National Veterinary School of Nantes (France) and practical veterinary training (France)
- Nov. 1996 Diploma
- 1997 Practical veterinary training, Identification of the DVM Project and a counterpart in Côte d'Ivoire (West Africa) through the Swiss Tropical Institute (STI) and the Centre Suisse de Recherches Scientifiques  
First exploratory trip to Côte d'Ivoire, Proposal writing and identification of funding possibilities under supervision of Dr. J. Zinsstag (STI, CSRS), Prof. M.Tanner (STI), Prof. B.Gottstein (University of Berne) and Prof. B.Betschart (Univ. of Neuchâtel)
- 1997 - 1999 DVM project at the field station of the CSRS in Côte d'Ivoire.  
Duties:  
-Assessment of the importance of ticks, tick-borne diseases and zoonoses in N'Dama cattle of Guinea savannah in Côte d'Ivoire.  
-Studies on the overall parasitism, productivity and socio-economic status of cattle farming in this area in close collaboration with the counterpart, local veterinary institutions/ organisations and the farmers.  
-Investigations on the presence of the zoonoses tuberculosis and brucellosis.  
-Training of 3 village research assistants, a veterinary technician and 2 technicians of CSRS in parasitology and parasitological laboratory techniques.  
-Supervision of the fieldwork of a microbiology diploma student of the Institut Pasteur, Abidjan.  
-Training of local farmers on problems of parasitism and zoonoses in cattle.
- Since 1999 Finalising of the DVM thesis at the STI.  
(July) Planning of a West African zoonoses network with Dr. J. Zinsstag and different West and Central African partners including co-organisation of a international zoonosis- workshop in Burkina Faso, March 2000.

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**Languages:**

German: mother tongue  
French, English: written and spoken  
Notions in Italian and Spanish

**Postgraduate training:***Doctoral thesis*

Role of parasitism in village N'Dama cattle of the humid savannah (V-Baoulé) of  
Côte d'Ivoire

Courses in advanced epidemiology at the STI  
Training in Epi-Info and SAS data analysis

*Conference contributions:***Multiparasitism of N'Dama cattle in the guinean savannah of Côte d'Ivoire**

L.Knopf, C.Komoin, J.Zinsstag, B.Betschart, M.Tanner, B.Gottstein  
SGTMP, Zofingen, Switzerland, 1998

**African regional project on public health importance of milk-borne diseases,  
with special emphasis on *Mycobacterium bovis***

L. Knopf & J. Zinsstag; Swiss Tropical Institute, Basle  
IUATLD conference Madrid, Spain, 1999

**Epidemiology and seasonality of ticks and tick-borne diseases in N'Dama cattle  
in the guinean savannah of Côte d'Ivoire**

L.Knopf, C.Komoin, B.Betschart, B.Gottstein, M.Tanner, J.Zinsstag  
SGTMP, Solothurn, Switzerland, 1999

**Groupe de Réflexion, de coopération et de Recherche sur les Zoonoses en  
Afrique de l'ouest et centrale**

International workshop organised by J.Zinsstag & L.Knopf, Bobo-Dioulasso, Burkina  
Faso, 1999

**African regional project on public health importance of zoonosis, with special emphasis on *Mycobacterium bovis***

L.Knopf & J.Zinsstag

14<sup>th</sup> international congress of IAAMRH, Pécs, Hungary, 2000

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