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SHORT COMMUNICATION

# Lion – prey relations in West and Central Africa

Hans Bauer[a,b,c,*], Nathalie Vanherle[a,b,c], Iliara Di Silvestre[a,b,c], Hans H. De Iongh[a,b,c]

[a]*Centre of Environmental Science, Leiden University, Leiden, The Netherlands*
[b]*ECOPAS Project, Niamey, Niger*
[c]*CURESS, NDjamena, Tchad*

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## Introduction

Most studies on the lion (*Panthera leo*) have been conducted in East and southern Africa. Information from West and Central Africa is scarce, probably because densities are generally lower: lion densities are typically between 1 and 3 lions/100 km$^2$ (Bauer and Van Der Merwe 2004). This corresponds with low standing biomass or prey densities in West and Central Africa (East 1984; De Bie 1991). Here, we examine the sparsely available information on lion–prey relations, in particular prey preferences and predator-prey biomass ratio, in relation to ecological conditions in West and Central Africa. Our discussion is mainly based on data from six study areas in the Soudano-sahelian savannah belt: Niokolo Koba National Park (NP) in Senegal, 'W' NP in Niger, Pendjari NP in Benin, Zakouma NP in Chad and Waza NP and Bouba Njida NP in Cameroon. For comparison, we used available data from the Serengeti, Manyara and Kruger ecosystems in East and southern Africa (Schaller 1972; Mills and Funston 2003).

Many publications describe lion–prey relations and hunting behaviour in East and southern Africa (e.g. Schaller 1972; Packer and Pusey 1997; Funston et al. 2001; Ogutu and Dublin 2002; Mills and Funston 2003). In the absence of data from West and Central Africa, many textbooks, fieldguides and reviews have generalised these findings into the species' characteristics (e.g., Macdonald 1983; Van Orsdol et al. 1985; Kingdon 1997; Stuart and Stuart 1997; Bothma 1998). We have previously described how social behaviour in West and Central Africa differs from textbook characteristics (Bauer et al. 2003). Here we examine region-specific lion–prey relations.

The aforementioned literature indicates that lions are opportunistic feeders, but they get the bulk of their diet from middle-sized (between 50 and 200 kg) and large mammals (over 200 kg but excluding the rare prey species elephant, giraffe and hippopotamus). Among the other large carnivores, the spotted hyena (*Crocuta crocuta*) is the only serious competitor, especially for the middle-sized prey, and it is therefore also taken into account.

## Material and methods

All carcasses found in the study areas were inspected and those fed on by lions or with lion traces present were considered lion kills, although some may have been carrion. We could not estimate carcass weight, alternatively we used mean adult female weight mentioned in Kingdon (2003) in our biomass calculations while excluding very large prey. We used prey counts from unpublished mammal surveys. Carcass data are for 1995–97 in Niokolo Koba and for 2003–05 in all other areas. Predator, prey and carcass numbers for Serengeti and Manyara were taken from Schaller (1972), prey numbers for Kruger were mean figures for 1980–93 presented by

*Corresponding author. Centre of Environmental Science, Leiden University, PO Box 9518, 2300 RA Leiden, The Netherlands.
Tel.: +31 71 527 7482; fax: +31 71 527 7496.
*E-mail address:* bauer@cml.leidenuniv.nl (H. Bauer).

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Owen-Smith and Ogutu (2003) while predator and carcass data were taken from Mills and Funston (2003). Prey numbers do not include migratory prey and represent lean season biomass.

Lion population size in each of the study areas was assessed with call-ups during the same periods. Lion group size was assessed from records of occasional lion sightings in Zakouma, W-Niger and Bouba Njida; group size for the others was published recently (Bauer et al. 2003). Hyena population size was assessed during call-ups in Zakouma, Bouba Njida and Pendjari. We have no reliable hyena population figures for the other areas.

Prey preference was calculated from carcass data following Jacobs (1974), with $\log(Q)$ giving positive values for preference and negative for avoidance. Difference in frequency of medium versus large carcasses between the regions was tested with a $\chi^2$-test. A $t$-test was performed to compare mean group size in West and Central African sites with eastern and southern African sites mentioned here combined with data for the Kalahari, Ngorongoro and Queen Elisabeth protected areas (Van Orsdol et al. 1985). Linear and log-linear regression analyses were performed on lion vs. prey density and on lion group size vs. the ratio large/medium prey biomass (SPSS 12.0.1)

## Results

Numbers of carcasses found and preference indices are presented in Table 1. In West and Central Africa, 49% of prey is medium size and 51% is large, significantly different ($p<0.01$) from eastern and southern Africa where 35% is medium size and 65% is large. Table 2 gives predator and prey biomass ratios and mean lion group sizes. Mean group size in West and Central African sites is significantly lower than in eastern and southern African sites ($p<0.001$).

Predator and prey densities are shown in Table 2. There is a strong linear relationship between lion and prey density ($p<0.001$, $R^2 = 98\%$); the log–log relation is also significant ($p<0.01$, $R^2 = 69\%$). There is a significant relationship between the log of group size and the log of the ratio between large and medium prey biomass ($p<0.05$, $R^2 = 62\%$, Fig. 1).

## Discussion

We identified important but not critical shortcomings to our data. First, we grouped and compared areas with different ecological conditions. We argue that the most important factor is prey assemblage, however, and this differs more between than within regions. Second, carcass counts are biased towards larger prey species which are easier and longer detectable. Since kills are hard to observe, however, carcasses are a good proxy to determine prey preference. Third, data were not

**Table 1.** Number of carcasses attributed to lion kills found in various National parks, between brackets Jacobs' log preference index

| | Species | Bouba Njida | Niokolo Koba | Pendjari | W-Niger | Zakouma | Kruger | Serengeti | Manyara |
|---|---|---|---|---|---|---|---|---|---|
| <200 kg | Duiker | | | 1 (−0.28) | | | | | |
| | Baboon[a] | | | | 1[a] | | | | 6[a] |
| | Warthog | | | | 4 (0.69) | 3[c] | 14 (1.17) | 21 (−0.54) | |
| | Bushbuck | 4 (0.72) | 1 (−0.75) | | 3 (1.26) | | | 1[b] | |
| | Redunca | 7 (0.35) | | | | 1 (−0.01) | | 7[b] | |
| | Kob | | 1 (−0.49) | 3 (0.36) | 2 (0.75) | 1 (0.06) | | | |
| | Impala[d] | – | – | – | – | – | 32 (−0.30) | 4 (−2.01) | 11 (−0.50) |
| | Gazelle (Thomson) | | | | | | | 331 (0.80) | |
| | Topi | | | | | 1 (−0.62) | | 34 (−0.60) | |
| | Hartebeest | 3 (0.17) | 3 (1.54) | 2 (0.20) | | 7 (0.04) | | 6 (−1.17) | |
| >200 kg | Waterbuck | | 1 (0.72) | | 1 (1.04) | 7 (0.88) | | 1 (−1.15) | 1 (0.22) |
| | Roan | 5 (1.14) | 2 (0.99) | 3 (0.16) | 7 (0.16) | 3 (−0.03) | | | |
| | Zebra[d] | – | – | – | – | – | 18 (0.24) | 255 (0.57) | 16 (0.98) |
| | Wildebeest[d] | – | – | – | – | – | 16 (0.58) | 409 (1.12) | 2[c] |
| | Buffalo | | 3 (0.99) | 6 (0.71) | 2 (−0.96) | 8 (−0.40) | | 65 (−0.63) | 62 (0.04) |
| | Eland | | | | | | | 13 (−0.01) | 2[c] |
| | Giraffe[a] | | | | | | | 9[a] | |
| | Elephant (calf)[a] | | | | | 12[a] | | | |

Data for Kruger from Mills and Funston (2003) and for Serengeti and Manyara from Schaller (1972).

[a]Not taken into account in preference and biomass calculations.

[b]Prey availability figures for these species are lumped, the lumped preference index is −0.78.

[c]Prey availability not known.

[d]Species do not occur in West and Central Africa.

**Table 2.** Predator numbers and biomass and prey biomass in various National Parks in West and Central Africa

| | Lion estimate | Hyena estimate | Prey density (kg/km$^{-2}$) | Lion density (100 km$^{-2}$) | Mean lion group size | Large prey biomass/medium prey biomass | Reference |
|---|---|---|---|---|---|---|---|
| Waza | 60 | 100 | 274[a] | 3.53 | 1.5 | 0.154 | Scholte (2005); Unpubl. Data De Iongh (2000) |
| Bouba Njida | 60 | 120 | 1143 | 3.75 | 2.0 | 0.651 | Unpubl. Data Gomse (2001); Unpubl. Data Bauer and Seiny (2004) |
| Niokolo Koba | 50 | – | 361 | 0.26 | 1.9 | 0.730 | Unpubl. Data Novelli and Di Silvestre; Di Silvestre et al. (2000) |
| Pendjari | 45 | 94 | 398 | 0.69 | 2.3 | 2.82 | Unpubl. Data Di Silvestre (2004) |
| *W*-Niger | 110 | – | 713 | 3.69 | 3 | 38.5 | Unpubl. Data Di Silvestre (2005) |
| Zakouma | 120 | 200 | 1209[b] | 4.00 | 2.7 | 5.84 | Unpubl. Data Vanherle (2005) |
| Serengeti | 2200 | 3500 | 1818[c] | 8.63 | 4.0 | 4.28 | Schaller (1972) |
| Manyara | 35 | 10 | 9560[c] | 38.5 | – | 310 | Schaller (1972) |
| Kruger | 2200 | 3300 | 1331 | 9.28 | 5.0 | 11.1 | Funston, pers. comm. (2005); Mills and Funston (2003); Owen-Smith and Ogutu (2003) |

[a]Lions in Waza also prey substantially on livestock around the NP, figure including cattle is 3872.
[b]Lions in Zakouma also prey substantially on young (<10 yr) elephants which are not included in prey figures, real figures are therefore higher.
[c]Figures exclude migratory prey but encompass resident prey in both woodland and plains and were recalculated from prey census data in Schaller (1972).

complete for some species in some areas and did not account for sex-specific prey preference (Funston et al. 1998).

These biases are probably small compared to the overall inaccuracy inherent in census data obtained with varying methods under difficult circumstances in immense areas, which nevertheless led to significant results. We only find the carcass detection bias unacceptable when comparing elephant (*Loxodonta africana*) with ungulate prey. The high number of observed elephant carcasses in Zakouma (all juveniles or sub-adults) points to a peculiar pattern of high elephant consumption, but our data should not be interpreted as elephant being the main prey species there.

Comparison of our carcass data between the regions shows a significantly lower percentage of large carcasses in West and Central Africa. As indicated by the preference indices, this is rather an effect of availability than preference. The correlation between lion group size and the ratio large/medium prey biomass indicates a link which is not necessarily directly causal; however, with prey size influencing proximate determinants of lion group size such as aggression during feeding, hunting efficiency, interspecific carcass protection and, indirectly, communal cub rearing (Van Orsdol et al. 1985; Packer et al. 1990; Hemson 2003).

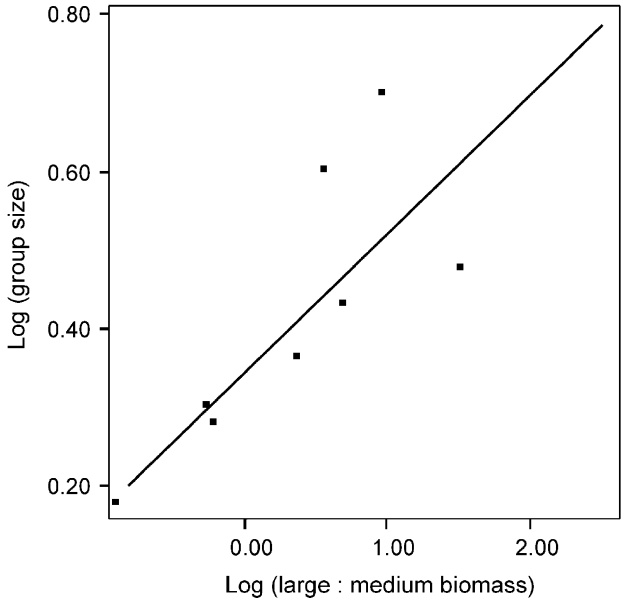


**Fig. 1.** Regression of mean group size versus large: medium prey biomass (log–log scale).

Van Orsdol et al. (1985) found a linear correlation between lion density and lean season prey density in eastern and southern Africa, whereas Hemson (2003)

found an exponential relationship. For our data, linear correlation gave a better fit than log–log, but both are significant and since we have less data over a small range of low densities we find our data inconclusive for the type of relationship.

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