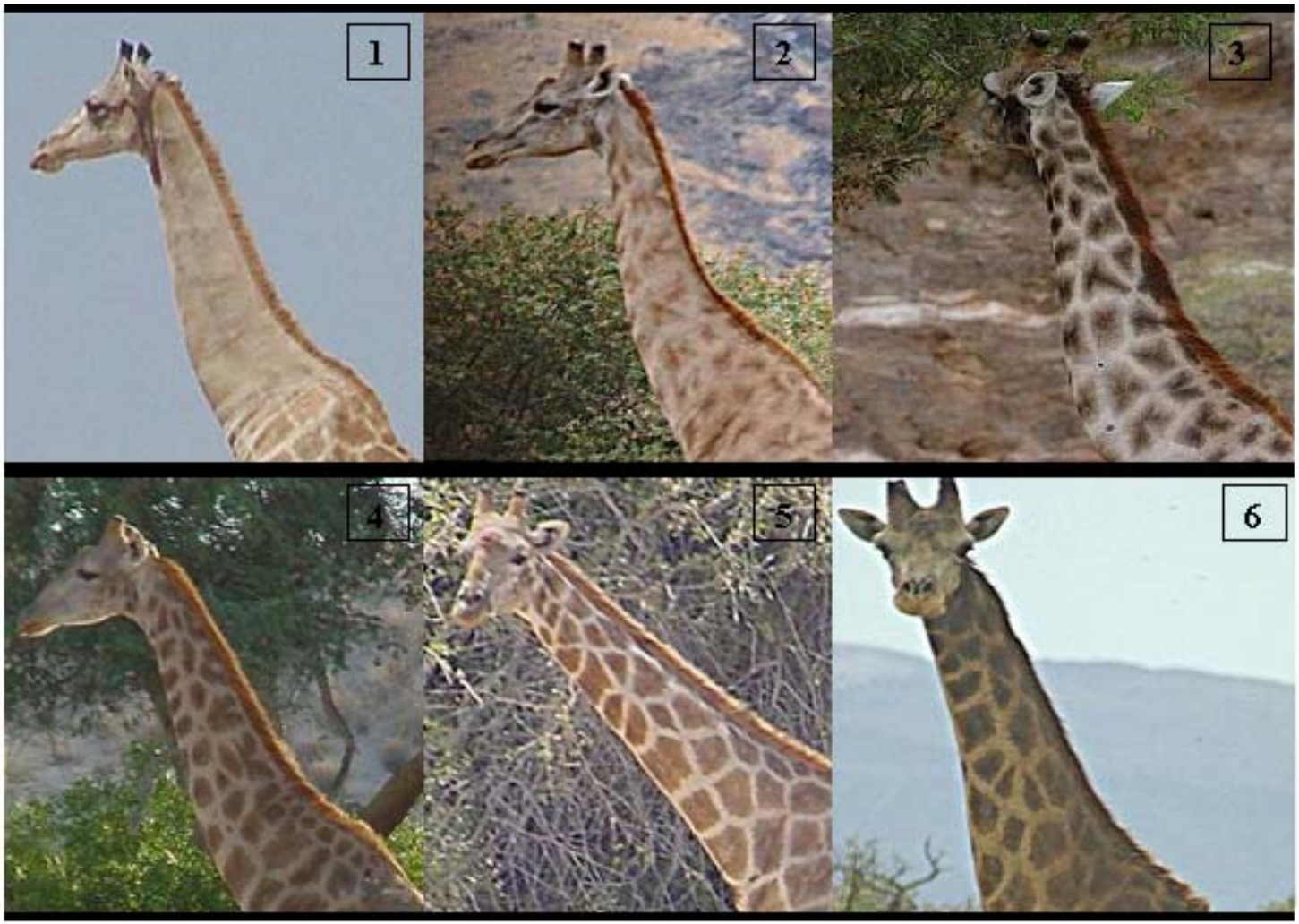
Appendix 1.



Variation in pelage pattern (colour and spots) of giraffe bulls in the study region.

Appendix 2.

Locations, nomenclature, sex and age class of giraffe DNA biopsy samples obtained from giraffe from the study region and Etosha NP, October 2002.

Namibian Giraffe Genetic Samples

Location	Nomenclature (Genetic)	Sex	Age	GPS	
				South	East
Etosha NP	ENP M1	M	Adult	-18.5858	16.88842
Etosha NP	ENP M2	M	Adult	-18.6775	16.89789
Etosha NP	ENP M3	M	Adult	-18.8176	16.93242
Etosha NP	ENP M4	M	Adult	-19.1611	15.99076
Etosha NP	ENP M5	M	Adult	-19.312	15.93868
Etosha NP	ENP M6	M	Adult	-19.1785	15.92287
Etosha NP	ENP M7	M	Adult	-19.3097	15.94291
Etosha NP	ENP F1	F	Adult	-18.7106	16.90167
Etosha NP	ENP F2	F	Adult	-18.7372	16.91571
Etosha NP	ENP F3	F	Sub Adult	-18.8208	16.92979
Etosha NP	ENP F4	F	Adult	-18.8216	16.92885
Etosha NP	ENP F5	F	Juvenile	-18.8149	16.9344
Etosha NP	ENP F6	F	Juvenile	-18.9177	16.72452
Etosha NP	ENP F7	F	Adult	-19.3092	15.93385
Etosha NP	ENP F8	M	Adult	-19.3069	15.9417
Hoanib River	HNB M1	M	Sub Adult	-19.2421	13.37168
Hoanib River	HNB M2	M	Adult	-19.3083	13.2676
Hoanib River	HNB M3	M	Adult	-19.3477	13.17382
Hoanib River	HNB M4	M	Adult	-19.2655	13.32759
Hoanib River	HNB M5	M	Adult	-19.3842	31.07459
Hoanib River	HNB M6	M	Adult	-19.3471	13.17762
Hoanib River	HNB M7	M	Adult	-19.2424	13.37185
Hoanib River	HNB F1	F	Sub Adult	-19.2685	13.32778
Hoanib River	HNB F2	F	Adult	-19.2922	13.2886
Hoanib River	HNB F3	F	Juvenile	-19.2922	13.28854
Hoanib River	HNB F4	F	Adult	-19.336	13.32759
Hoanib River	HNB F5	F	Adult	-19.3468	13.17888
Hoanib River	HNB F6	F	Adult	-19.3378	13.19799
Hoanib River	HNB F7	F	Adult	-19.1344	13.39611
Khumib River	KHB F1	F	Sub Adult	-18.6636	13.63874
Khumib River	KHB M1	M	Adult	-18.6543	12.65753
Khumib River	KHB M2	M	Sub Adult	-18.6543	12.65753
Khumib River	KHB M3	M	Sub Adult	-18.6638	12.64076

Appendix 3.

GenePop results (Hardy Weinberg probability test) of the sampled Etosha National Park giraffe populations.

			FIS.		
Locus	*P*	±s.e.	W&C	R&H	Matr.
Etosha National Park					
NECK73	0.0314	0.0015	-0.016	+0.081	-
NECK102	1	0.0000	-0.037	-0.038	-
NECK334	0.0005	0.0001	+1	+1	-
NECK443	0.0063	0.0009	+0.451	+0.482	-
NECK447	-	-	-	-	-
NECK480	-	-	-	-	-
NECK484	0.0822	0.0044	-0.012	-0.039	-
NECK550	0.0192	0.0033	+0.205	0.102	-
NECK561	0.9146	0.0032	+0.038	0.022	-
NECK562	0.2127	0.0059	+0.467	+0.341	-
NECK567	-	-	-	-	-
NECK582	0.0029	0.0006	-0.742	-0.413	-
NECK626	0.0647	0.0039	+0.317	+0.438	-
NECK665	0.0178	0.0015	+0.397	+0.361	-
NECK748	0.0003	0.0002	+0.769	+0.638	-
NECK835	0.6386	0.0050	-0.340	-0.186	-
NECK1004	-	-	-	-	-

N.B. All (Fisher's method): χ^2: 90.9225; d.f. 26; P<0.001

GenePop results (Hardy Weinberg probability test) of the sampled Hoanib River study area giraffe population.

			FIS.		
Locus	P	±s.e.	W&C	R&H	Matr.
Hoanib River study area					
NECK73	0.0007	0.0002	+0.438	+0.531	-
NECK102	1	0.0000	-0.037	-0.038	-
NECK334	0.0099	0.0005	+0.717	+0.761	-
NECK443	0.2886	0.0067	+0.188	+0.166	-
NECK447					-
NECK480	1	0.0000	-0.037	-0.038	-
NECK484	0.2268	0.0020	-0.400	-0.408	-
NECK550	0.0051	0.0007	+0.596	+0.555	-
NECK561	0.5579	0.0065	-0.098	-0.055	-
NECK562	1	0.0000	-0.050	-0.022	-
NECK567	0.1048	0.0014	+0.650	+0.688	-
NECK582	0.0005	0.0003	-0.780	-0.482	-
NECK626	0.0345	0.0021	+0.500	+0.036	-
NECK665	0.1404	0.0037	+0.344	+0.319	-
NECK748	0.0617	0.0036	+0.317	+0.438	-
NECK835	0.8915	0.0041	-0.098	-0.055	-
NECK1004	1	0.0000	-0.037	-0.038	-

N.B. All (Fisher's method): χ^2: 76.9695; d.f. 32; P<0.001

GenePop results (Hardy Weinberg probability test) of the sampled Hoarusib River study area giraffe population.

			FIS.		
Locus	P	±s.e.	W&C	R&H	Matr.
Hoarusib River study area					
NECK73	0.1998	0.0036	+0.600	+0.6677	-
NECK102	-	-	-	-	-
NECK334	-	-	-	-	-
NECK443	0.5969	0.0075	+0.200	+0.111	-
NECK447	-	-	-	-	-
NECK480	-	-	-	-	-
NECK484	-	-	-	-	-
NECK550	0.2012	0.0018	+1	+2	-
NECK561	-	-	-	-	-
NECK562	-	-	-	-	-
NECK567	1	0.0000	-0.333	-0.375	-
NECK582	0.4015	0.0021	-1	-1	-
NECK626	1	0.0000	-0.143	-0.062	-
NECK665	0.2013	0.0016	+1	+2	-
NECK748	-	-	-	-	-
NECK835	1	0.000	-0.500	-0.375	-
NECK1004	-	-	-	-	-

N.B. All (Fisher's method): χ2:12.4907; d.f. 16; P=0.7096

GenePop results (Hardy Weinberg probability test) of the sampled Khumib River study area giraffe population.

			FIS.		
Locus	*P*	±s.e.	W&C	R&H	Matr.
Khumib River study area					
NECK73	0.1407	0.0035	+0.625	+0.633	-
NECK102	-	-	-	-	-
NECK334	0.1434	0.0018	+1	+1	-
NECK443	0.03034	0.0068	+0.368	+0.361	-
NECK447	-	-	-	-	-
NECK480	-	-	-	-	-
NECK484	-	-	-	-	-
NECK550	0.1439	0.0018	+1	+1	-
NECK561	0.1424	0.0042	+0.500	+0.167	-
NECK562	-	-	-	-	-
NECK567	-	-	-	-	-
NECK582	0.3213	0.0019	-1	-1	-
NECK626	1	0.0000	-0.091	-0.028	-
NECK665	1	0.0000	-0.091	-0.028	-
NECK748	1	0.0000	-0.500	-0.533	-
NECK835	1	0.0000	-0.200	-0.222	-
NECK1004	-	-	-	-	-

N.B. All (Fisher's method): χ^2: 20.2953;d.f. 20; *P*=0.4396

Appendix 4.

Nomenclature and names of giraffe cows in the study region.*

Hoanib River				Hoarusib River		Khumib River	
HNBF1	Butterfly	HNBF27	Prego	HSBF1	Betty	KMBF2	Super Girl
HNBF2	Exclamation	HNBF28	Pseudovalentine	HSBF2	Etosha	KMBF3	Evelyn
HNBF3	Beany	HNBF29	Tornado	HSBF3	Bettunia	KMBF4	Cheli
HNBF4	Hannah	HNBF30	Windy	HSBF4	Fetosha	KMBF5	Bonnie
HNBF5	3-D	HNBF31	Pinwheel	HSBF5	G Spot	KMBF6	Minnie M
HNBF6	Beadie	HNBF32	Wednesday	HSBF6	Les	KMBF7	Bad Girl
HNBF7	Colloseum	HNBF33	Morticia	HSBF7	Bowling	KMBF7	Ghost
HNBF8	Daisy	HNBF34	Stephster	HSBF8	Porkchop		
HNBF9	Sandy	HNBF35	Swara	HSBF9	Kunene		
HNBF10	FOSA	HNBF36	Tuna	HSBF10	Salvadora		
HNBF11	Clover	HNBF37	Ice-Cream	HSBF11	Auntie Em		
HNBF12	FTD	HNBF38	Pebbles	HSBF12	Namibia		
HNBF13	Ragedy Ann	HNBF40	Deva	HSBF13	Dorothy		
HNBF14	Sailor	HNBF41	Ana				
HNBF15	S. A	HNBF42	July				
HNBF16	Angel	HNBF43	Cause				
HNBFF17	BAM	HNBF44	London				
HNBF18	Suzie Q	HNBF45	Tag-Y				
HNBF19	Ace	HNBF46	Pisa				
HNBF20	Bookie	HNBF47	Spiderwomen				
HNBF21	Fungus	HNBF48	May				
HNBF22	Thing	HNBF49	ABS				
HNBF23	Peach	HNBF50	Vert				
HNBF24	Madam X	HNBF51	Bellybutton				
HNBF25	Mutti	HNBF52	IT 1				
HNBF26	Parcel	HNBF53	IT 2				

*Grey box denotes adult, white subadult.

Nomenclature and names of giraffe bulls in the study region.*

Hoanib River	Hoarusib River	Khumib River
HNBM1 Ambiguous	HSBM1 Blackjack	KMBM1 Wilber
HNBM2 Angelo	HSBM2 Bucket	KMBM2 Ryma
HNBM3 Big D	HSBM3 Andy	KMBM3 V
HNBM4 Birdman	HSBM4 Double V	KMBM4 Orion
HNBM5 George	HSBM5 Franky	KMBM5 KB
HNBM6 Sandman	HSBM6 Goofy	KMBM6 Longhorn
HNBM7 Geronimo	HSBM7 Jester	KMBM7 Shrubbery
HNBM8 Grey	HSBM8 Mr Big	KMBM8 Stubby
HNBM9 Leffelhund	HSBM9 Mr Brown	KMBM9 OJ
HNBM10 Obi 1	HSBM10 NFL	
HNBM11 One Spot	HSBM11 Oz	
HNBM12 Scarface	HSBM12 Picasso	
HNBM13….Sharky	HSBM13 Pretzel	
HNBM14 Spotty	HSBM14 Rocketman	
HNBM15 U-Bolt	HSBM15 Scratchy	
HNBM16 Vader	HSBM16 Shoulders	
HNBM17 Chopper	HSBM17 Six Pack	
HNBM18 Fuzzhead	HSBM18 SSS	
HNBM19 Capone	HSBM19 Sting	
HNBM20 Criss-Cross	HSBM20 New Guy	
HNBM21 Red	HSBM21 Big Spot	
HNBM22 Elvis	HSBM22 Tower	
HNBM23 T2	HSBM23 Tumor	
HNBM24 Goober	HSBM24 Lone Ranger	
HNBM25 Retic	HSBM25 Dr Doom	
HNBM26 A2	HSBM26 Batman	
HNBM27 Harry	HSBM27 Bluey	
HNBM28 Maple	HSBM28 Pinto	
HNBM29 Rugby	HSBM29 Toto	
HNBM30 V-Neck	HSBM30 Nawa	
HNBM31 Tags	HSBM31 Fenno	
HNBM32 Bender		
HNBM33 Drummer		

*Grey box denotes adult, white subadult.

Nomenclature and names of juvenile giraffe in the study region.

Hoanib River	Hoarusib River	Khumib River
HNBJ1 Small Fly	HSBJ2 Kaoka	KMBJ3 Gilly
HNBJ6 Lil' Beadie	HSBJ4 Savannah	
HNBJ8 Pettle	HSBJ? Hair	
HNBJ11 Lucky		
HNBJ34 JJ		
HNBF39 Robin		
HNBJ? Squirt		
HNBJ? Sears		

Appendix 5.

Sex ratios of giraffe in the study region and Africa-wide.

Area	Sex Ratio			Source
	Bull		Cow	
Henderson Ranch, Zimbabwe	1	:	1.94	Dasmann, 1960*
Luangwa Valley, Zambia	1	:	1.67	Berry, 1973
Hoanib River, Namibia	1	:	1.6	Scheepers, 1992
Nairobi NP, Kenya	1	:	1.56	Bourliere, 1961
Wankie (Hwange) NP, Zimbabwe	1	:	1.27	Dasmann, 1960*
Arusha NP, Tanzania	1	:	1.1	Pratt & Anderson, 1982
Nairobi NP, Kenya	1	:	1	Foster, 1966
Nairobi NP, Kenya	1	:	1	Foster & Dagg, 1972
Niger	1	:	1	Le Pendu & Ciofolo, 1999
Lake Manyara NP, Tanzania	1	:	1	van der Jeugd & Prins, 2000
Northern Namib Desert, Namibia	1	:	0.99	This study
Tsavo East NP, Kenya	1	:	0.833	Leuthold & Leuthold, 1978
Amboseli GR, Kenya	1	:	0.69	Bourliere, 1961
Skeleton Coast Park, Namibia	1	:	0.6	Cooper, 1980
Luangwa Valley, Zambia	1	:	0.5	Berry, 1978
Fleur de Lys, South Africa	1	:	0.45	Innis, 1958

N.B: Adult/subadult combined, juveniles excluded. Source: *Foster & Dagg, 1972

Appendix 6.

Estimated giraffe densities Africa-wide.

Study Area	Size (km^2)	Density (n/km^2)	Source
Main camp area, Wankie (Hwange) NP, Zimbabwe		14.1	Dasmann, 1960*
El Karama Ranch, Kenya	37	6-12	Moore, 1974†
Arusha NP, Tanzania	119	3.96	Pratt & Anderson, 1982
Timbavati PNR, South Africa	183	3.4	Langman, 1973
Seronera, Serengeti NP, Tanzania	175-240	1.42-2.64	Pellew, 1983
Kruger NP, South Africa	19 500	2.5	Mills & Hes, 1997
Sweetwaters, Kenya	*ca*100	1.9	Birkett, 2002
Eldoret, Kenya	72	1.45	MacTaggart*
Fleur de Lys, Sth. Africa	80	1.2	Innis, 1958
Tarangire, Tanzania	*ca*100	1.13	Lamprey, 1964*
Isiolo, Kenya	1140	0.87	Stewart & Zaphiro, 1963
Lake Manyara NP, Tanzania	100	0.85	van der Jeugd & Prins, 2000
Serengeti NP, Tanzania	9 576	0.76	Sinclair, 1969*
Nairobi NP, Kenya	114	0.75	Foster & Dagg, 1972
Nairobi NP, Kenya	122	0.72	Foster, 1966
Lake Manyara NP, Tanzania	100	0.60	Prins & Douglas-Hamilton, 1990
Serengeti NP, Tanzania	12 800	0.56	Schaller, 1969*
Ruaha NP, Tanzania	9 640	0.34	Barnes & Douglas-Hamilton, 1982
Mara Plains, Kenya	2 560	0.27	Darling, 1960
Wambo, Congo	1 680	0.22	Stewart & Zaphiro, 1963
Tarangire + GCAs, Tanzania	8 359	0.17	Campbell & Huish, 1991∞
Kruger NP, South Africa	19 500	0.16	Hall-Martin, 1975
Sth of Garamba NP, Congo		0.16	Backhaus, 1961
Tsavo East NP, Kenya	*ca*75	0.3	Leuthold, 1979
Masai Ecosystem	35 000	0.07	van der Jeugd & Prins, 2000
Baragoi, Kenya	2 040	0.01	Stewart & Zaphiro, 1963
Niger		0.01	Le Pendu *et al*., 2000
Northern Namib Desert, Namibia	72 000	0.01	This study

Sources: *Foster & Dagg, 1972; †Leuthold & Leuthold, 1978; ∞van der Jeugd & Prins, 2000

Appendix 7.

Observed herd sizes of giraffe, expressed as percentages, from selected populations Africa-wide.

	Fleur de Lys South Africa†	Nairobi NP Kenya∞	Serengeti NP Tanzania+	Other areas Africa wide+
Herd Size	151	439	147	75
1	44.4%	23.0%	16.3%	24.0%
2	13.2	17.1	10.9	13.3
3	8.6	13.7	8.9	9.3
4	1.0	10.7	10.2	16.0
5	8.6	9.8	8.9	6.7
6	6.6	7.1	8.9	2.7
7	2.6	4.5	0.7	6.7
8	2.0	4.5	2.0	2.7
9	1.3	1.9	6.1	6.7
10	0.7	1.9	3.4	1.3
11	0.7	1.6		
12		0.7	2.7	1.3
13		1.0	2.7	1.3
14		0.4	0.7	
15	1.3	1.4	3.4	
16		0.4	0.7	2.7
17		0.2		
18		0.2	0.7	
19			2.0	
20			1.4	
21			1.4	
22			1.4	1.3
23				
24				
25			0.7	1.3
26			0.7	
27			0.7	
28			1.4	
29				
30			2.0	
31				
32				
33				1.3
34				
35			0.7	
≈				
45				1.3
46				
47			0.7	

†Innis, 1958; ∞Foster, 1966; +Foster & Dagg, 1972

Appendix 8.

GPS satellite collar configurations and specifics for study of giraffe.

Internal configuration data	
• Data generated from the unit's ports, inputs and outputs • Pre-scheduled reporting of GPS data (i.e. latitude, longitude, speed, heading), digital • Input status, analogue input level, input voltage and temperature • Event-triggered reporting of GPS data, RS 232 short message input, or digital or analogue input conditions	
Physical characteristics	
• Dimensions (W x H x D)	15,7 x 10.6 x 3.5 (cm)
• Weight	< 900mg
• Receive frequency band	1525 to 1559 MHz
• Transmit frequency band	1626.5 to 1660.5 MHz
• Power consumption	Sleep, Transmit, Receive
• Processing	0.4 mA, 2200 mA, 125 mA, 40 mA
Receive antenna	
• Element type	Microstrip PCB patch
• Polarisation	RHC
• Number of elements	1
• Azimuth antenna coverage	0° to 360°
• Elevation coverage for	20° to 60°
• Elevation coverage for GPS communications link	0° to 90°
Transmit antenna	
• Element type	Microstrip PCB patch
• Polarisation	RHC
• Number of elements	1
• Azimuth antenna coverage	0° to 360°
• Elevation coverage	25° to 60°
GPS subsystem	
• GPS receive band	1575.42 plus / minus 1 MHz
Parameter	
• Location accuracy	100m 2° RMS
• Speed accuracy	1 m/s; (2.2 mph)
• Heading accuracy	5°
Mean time to position fix	
• Cold initialise	< 2 minutes @ 20° C
• Hot initialise	< 30 seconds @ 20° C
Main input power port	
• Input voltage	4 to 9 VS. DC
• Peak input current	2 A
• Reverse power survival	15 VS. DC for external resistance greater than 3ohms
Collar	
• 3 ply machine belting	

Appendix 9.

Specifications of GPS satellite collared giraffe, including nomenclature, age, sex, date collared, collaring time, collaring frequency and drugs used, September, 2002.

Nomenclature (Name)	Sex	Age Class	Collared Date	Location	GPS °S	GPS °E	Collar No.	Collar Frequency	Dosage* (A3080)	Blood & Genetics	Down Time**
HNBM17 (Chopper)	Bull	Subadult	30/09/02	Hoanib River	-19.34653	13.16715	1	148.150	16 mg	Yes	4.30 min
HNBF18 (Suzie Q)	Cow	Adult	30/09/02	Hoanib/Mudorib	-19.33013	13.23291	2	148.200	13 mg	Yes	4.20 min
HSBM12 (Picasso)	Bull	Adult	28/09/02	Gomatum River	-18.78531	12.97938	3	148.300	14 mg	Yes	<6 min
HSBM3 (Andy)	Bull	Adult	28/09/02	Gomatum River	-18.78531	12.97938	4	148.360	14 mg	Yes	<6 min

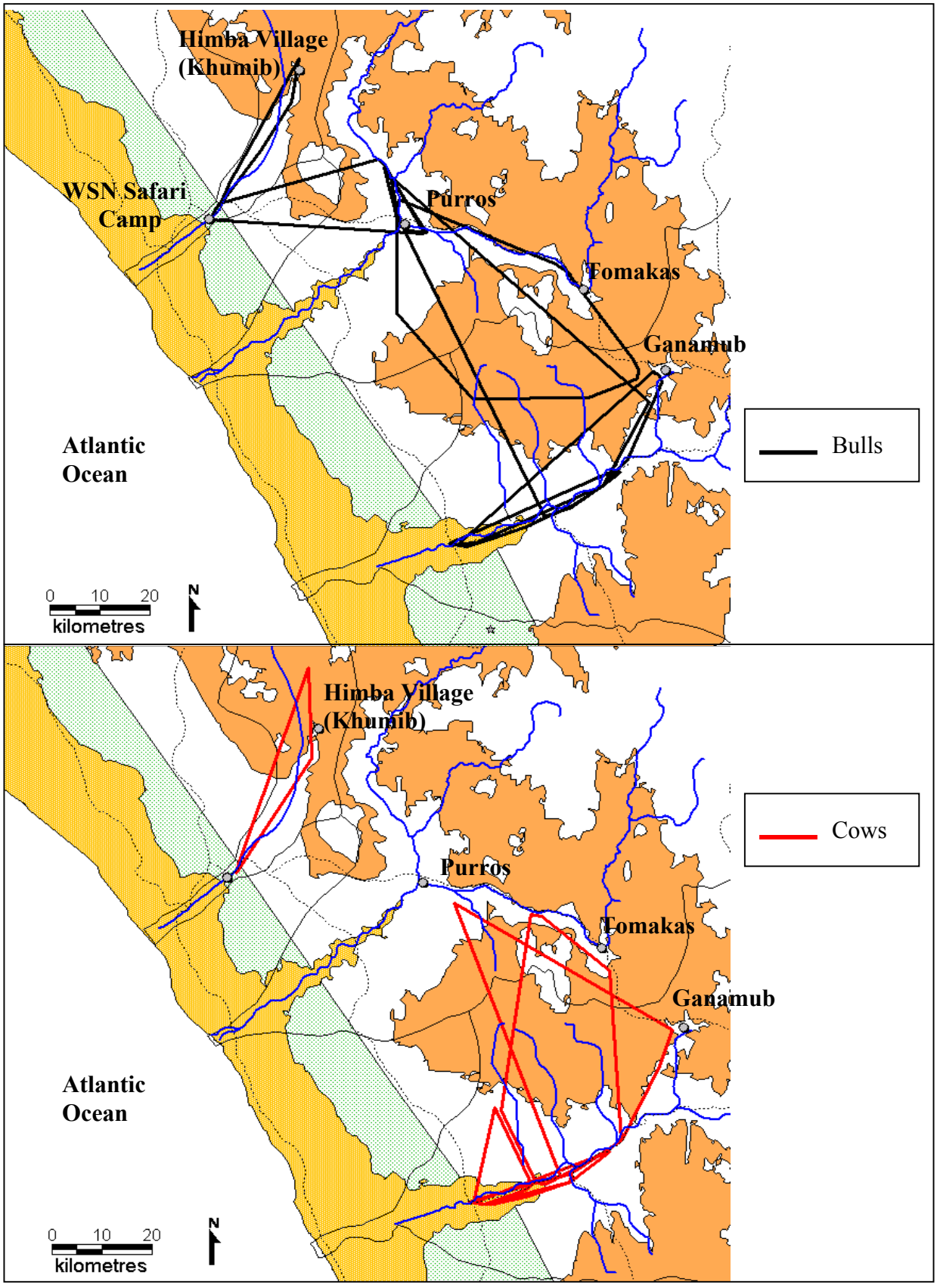
*Dosage – drug used to sedate the giraffe was A3080; **Down Time – period for which the giraffe were sedated.

Appendix 10.

Giraffe bull home range estimates (km^2) of bull giraffe in the study region.

	Hoarusib River			Hoanib River			Khumib River	
	MCP			MCP			MCP	
	100%	95%		100%	95%		100%	95%
HSBM1	111.5	25.07	HNBM1	1173	26.9	KMBM2	68.09	23.68
HSBM2	800	32.4	HNBM2	320.2	43.97	KMBM3	66.06	21.78
HSBM3	1260	1092	HNBM3	920.8	862.1			
HSBM4	805.8	20.59	HNBM4	72.83	46.79			
HSBM5	397.2	50.83	HNBM5	402.7	348.6			
HSBM6	611.9	490.9	HNBM6	445.3	28.89			
HSBM7	822.7	378.2	HNBM7	235.9	32.2			
HSBM8	3377	226.4	HNBM8	1538	1290			
HSBM9	878.7	701.5	HNBM9	94.23	79.81			
HSBM10	805.8	19.64	HNBM10	1950	1773			
HSBM11	219.3	71.77	HNBM11	539.6	97.22			
HSBM12	2962	784.3	HNBM12	356.6	305.7			
HSBM13	1532	1492	HNBM13	508.4	264.7			
HSBM14	1627	63	HNBM14	128.3	11.46			
HSBM15	1102	1059	HNBM17	222.2	214.9			
HSBM17	800.6	18.3	HNBM18	282.4	136			
HSBM18	915.2	669.4	HNBM19	1278	999.8			
HSBM19	437.6	274	HNBM22	26.67	14.87			
HSBM20	231.2	49	HNBM23	953.2	273.4			
HSBM21	589.7	18.78	HNBM26	1169	242.8			
HSBM24	1303	1295						
HSBM26	33.97	14.93						
Mean	982.92	402.14		652.38	362.01		67.08	22.73

Appendix 11.



Selected home ranges of giraffe bulls and cows in the study region.

Appendix 12.

Home range size estimates of giraffe populations Africa-wide.

Study Area	Density (n/km^2)	Home Range (km^2) Mean	Range	n	Source (Year)
Bulls					
Niger (non-resident)	0.01	992	202-1564	8	Le Pendu & Ciofolo, 1999
(resident)	0.01	641	127-1559	6	
Tsavo NP [K]	0.1-0.3	164	5-654	60	Leuthold & Leuthold, 1978
Luangwa Valley [Z]		82	-145	14	Berry, 1978
Nairobi NP [K]	0.72	62		10	Foster & Dagg, 1972*
Timbavati PNR [S]	3.28	23		2	Langman, 1973
El Karama Ranch [K]	6-12	16.5			Leuthold & Leuthold, 1978
Lake Manyara [T]	0.85	5.2	0.1-21.5		van der Jeugd & Prins, 2000
Cows					
Niger (non-resident)	0.01	487	200-1307	5	Le Pendu & Ciofolo, 1999
(resident)	0.01	324	151-1378	14	
Kruger NP [S]		282		1	du Toit, 1990
Tsavo NP [K]	0.1-0.3	162	9-484	50	Leuthold & Leuthold, 1978
Serengeti NP, [T]	1.47	120			Pellew, 1984b
Nairobi NP [K]	0.72	85		10	Foster & Dagg, 1972*
Luangwa Valley [Z]	?	68	-82	4	Berry, 1978
Timbavati PNR [S]	3.28	25		3	Langman, 1973
	3.28	41		1	Langman, 1977
El Karama Ranch [K]	6-12	13			Leuthold & Leuthold, 1978
Lake Manyara [T]	0.85	8.6	0.5-27		van der Jeugd & Prins, 2000
Juveniles					
Timbavati PNR [S]	3.28	13			Langman, 1973

NB: [K] - Kenya; [S] – South Africa; [T]- Tanzania; [Z] – Zambia; All home ranges calculated by convex polygon, except *Foster & Dagg used dot grid method.

Appendix 13.

Seasonal diurnal activities of giraffe cows in the study region expressed as a percentage, standard deviation and range.

	Season								
	Wet			Cold-dry			Hot-dry		
Activity	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)
Cows									
Feeding	60.94	±11.70	39-73	65.71	±10.30	53-81	55.95	±14.20	31-69
Ruminating	7.00	±6.70	0-21	8.34	±6.10	1-24	9.46	±5.80	2-19
Resting	13.19	±11.20	1-33	7.92	±6.60	2-22	16.20	±13.60	3-40
Walking	15.88	±5.90	8-26	14.97	±4.20	11-24	15.71	±6.10	9-29
Grooming	0.73	±0.80	0-3	0.66	±2.20	0-4	0.53	±0.30	0-1
Vigilance	1.98	±2.90	0-10	1.92	±2.20	0-7	1.26	±0.60	0-2
Interaction	0.18	±0.39	0-0.14	0.10	±0.10	0-0.4	0.14	±0.13	0-0.3
Sex. behaviour	0.01	±0.04	0-0.14	0.04	±0.04	0-0.2	0.02	±0.04	0-0.1
Excretion	0.09	±0.12	0-0.4	0.24	±0.24	0-0.13	0.13	±0.13	0-0.4
Drinking	0	0	0	0.10	±1.10	0-1	0.58	±2.00	0-7

Seasonal diurnal activities of giraffe bulls in the study region expressed as a percentage, standard deviation and range.

Activity	Season								
	Wet			Cold-dry			Hot-dry		
	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)
Bulls									
Feeding	48.74	±15.20	25-79	50.44	±8.30	37-60	53.12	±12.90	33-68
Ruminating	14.13	±5.60	1-21	14.52	±6.50	7-23	10.67	±7.10	1-23
Resting	14.87	±12.80	1-46	11.30	±8.00	3-25	13.68	±14.00	1-40
Walking	18.11	±7.60	8-39	17.01	±5.70	9-26	18.15	±6.70	9-32
Grooming	0.89	±0.60	0-2	0.55	±0.20	0-1	0.86	±0.50	0-2
Vigilance	1.96	±1.30	0-5	2.57	±3.30	0-12	1.35	±0.80	0-2
Interaction	0.79	±1.00	0-3	3.41	±2.60	0-10	1.33	±2.00	0-7
Sexual Behaviour	0.21	±0.20	0-1	0.07	±0.10	0-0.2	0.51	±0.60	0-2
Excretion	0.20	±0.20	0-0.6	0.13	±0.10	0-0.3	0.04	±0.10	0-0.3
Drinking	0.12	±0.40	0-1	0	0	0	0.29	±1.00	0-3

Seasonal diurnal activities of juvenile giraffe in the study region expressed as a percentage, standard deviation and range.

	Season								
	Wet			Cold-dry			Hot-dry		
Activity	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)	Mean (%)	±S.D	Range (%)
Juveniles									
Feeding	60.15	±14.70	31-79	±47.38	±15.40	19-68	45.26	±23.00	12-78
Ruminating	6.42	±7.30	0-21	3.14	±4.10	0-14	8.90	±10.30	0-31
Resting	14.36	±14.30	1-42	±30.99	±22.60	6-68	25.40	±25.40	0-66
Walking	15.44	±6.90	7-27	±14.54	±10.40	1-38	15.09	±9.80	4-31
Grooming	0.77	±0.90	0-3	1.98	±2.90	0-10	1.06	±1.10	0-4
Vigilance	2.55	±2.80	0-10	0.77	±1.10	0-3	3.40	±2.90	0-10
Interaction	0.22	±0.40	0-1	1.20	±1.50	0-5	0.70	±1.30	0-4
Sex. behaviour	0	0	0	0	0	0	0	0	0
Excretion	0.09	±0.14	0-0.4	0	0	0	0.19	±0.31	0.09
Drinking	0	0	0	0	0	0	0	0	0

Appendix 14.

Publication:

- Fennessy, J. 2003. Palewinged Starling gleaning on desert dwelling Giraffe, northwestern Namibia. *Bird Numbers*. **12(1)**: 20-21.

The Yellowbilled Oxpecker *Buphagus africanus*, Redbilled Oxpecker *B. erythrorhynchus,* Cattle Egret *Ardeola ibis* and Forktailed Drongo *Dicrurus adsimilis* have all been observed in direct feeding association with Giraffe *Giraffa camelopardalis* (Innis 1958; Berry 1973; Tilson 1977; Dean & MacDonald 1981; Maclean 1993). While the first two are highly adapted obligate ectoparasite gleaners, the latter two species are facultative ectoparasite gleaners that otherwise actively prey upon insects incidentally flushed by mammals (Dean & MacDonald 1981).

The allopatric Palewinged Starling *Onychognathus nabourup* has been observed to have an affinity with Klipspringer *Oreotragus oreotragus,* similar to that of the Redwinged Starling *O. morio* in the southern part of its distribution range (Tilson 1977). Starling/Klipspringer feeding relationships are a commonly observed bird/mammal feeding association (Tilson 1977; Dean & MacDonald 1981; Maclean 1993). The feeding strategy of such ectoparasite gleaners is almost entirely restricted to open habitats and areas of increased biomass of large mammals. Therefore areas such as Namibia offer increased potential for the development of bird/mammal feeding associations (Dean & MacDonald 1981).

A number of recent observations of Palewinged Starlings gleaning from giraffe *Giraffe camelopardalis angolensis* in northwestern Namibia, are the first known annotated records, although observations of their gleaning on Klipspringers and other mammals have been recorded (Tilson 1977; Dean & MacDonald 1981; Maclean 1993). Both Redbilled and Yellowbilled Oxpeckers regularly glean giraffe, as well as a host of other wildlife and livestock species throughout Africa. These birds, however, do not occur in the study area. In Namibia, Palewinged Starlings have been observed occasionally gleaning on other mammals, including klipspringer, Hartmann's mountain zebra *Equus zebra hartmannae* (Joubert 1972) and gemsbok *Oryx gazella* (Dean & MacDonald 1981), while Cape Glossy *Lamprotornis nitens* and Wattled Starlings *Creatophora cinerea* have been seen gleaning from gemsbok in the Skeleton Coast Park (Bridgeford, 1985b).

It has been suggested that starlings occupy the feeding niche filled elsewhere by Oxpeckers (Bean *in* Tilson 1977). Gargett (*in* Tilson 1977) postulated that in areas where Redwinged Starling and klipspringer cohabitat, starlings will exploit the gleaning niche, but only in environs where Oxpeckers are excluded. The Palewinged Starling's distribution, unlike that of the Redwinged Starling, does not overlap that of the oxpeckers (Tilson 1977; Harrison *et al*. 1997).

Of the four separate observations, the following is an account of the first occasion. Two Palewinged Starlings were observed, for c.15 min, gleaning arthropod ectoparasites from two giraffe cows (one adult and one sub-adult), in the Hoanib River study area (19.30523°S, 13.27019°E) in the cold-dry season 2002.

The giraffe were content while the Palewinged Starlings were gleaning, except when the ears and head were the target areas. The starlings concentrated their gleaning activities on the mane and back of the giraffe, as well as the underbelly and tail hair.

While gleaning on both the mane and back, the starlings perched for up to 30 seconds at a time. On four separate occasions, the giraffe shrugged its body to displace the birds. However, they returned to the host and continued gleaning immediately. On another six occasions, while hovering and gleaning from the tail hair of the giraffe, the starlings flew off into nearby branches of the *Faidherbia albida* between bouts. Gleaning from tail hair has been observed in other bird/ mammal feeding associations (Dean & MacDonald 1981; Maclean 1993). In this observation, however, concentration on the whole tail rather than the base and nearby orifices, was significant.

The desert dwelling giraffe populations in the study area do not appear to rely heavily upon the gleaning of ectoparasites by birds for grooming, although observations suggest that it is not uncommon. However, they have been regularly observed using small shrubs and bushes, for example *Colophospermum mopane, Salvadora persica* and *Pechuel-Loeschea leubnitziae*, and tree branches of, for example, *F. albida, Acacia erioloba* and *A. tortilis,* to scratch themselves (pers. obs.). This behaviour is assumed to assist in the removal of ectoparasites as large ticks are obvious and parasite load, although not measured, is estimated high.

A number of other ectoparasite gleaning observations in northwestern Namibia have been recorded. Both Pied Crow *Corvus albus* and Black Cows *C. capensis* were observed gleaning ectoparasites from gemsbok in the study area (Bridgeford, 1985b; J. Bartlett & B. Paterson pers. comm.). Both crow species have been observed in feeding associations with other mammals throughout their range (Dean & MacDonald 1981; Maclean 1993), included records of perching on giraffe in the study area (R. Braby pers.comm.), although no gleaning behaviour was reported.

It is assumed that the feeding association of African Sturdinae (Starlings and Oxpeckers) with mammals evolved when prey were flushed out by mammals. This subsequently led to the birds perching on the host mammals, and finally evolved to gleaning of ectoparasites on the host mammals (Dean & MacDonald 1981). The evolution of bird/ mammal feeding associations in areas where facultative ectoparasite gleaning is commonly observed, positively correlates with the absence of specialist ectoparasite gleaners from the same habitat (Dean & MacDonald 1981). Such a scenario is observed in Namibia's arid northwest where it is assumed that the evolutionary process is dynamic. The feeding niche of the Palewinged Starling and other facultative ectoparasite gleaners may become more obvious with increased research.

Appendix 15.

Preferred forage use of giraffe in the Hoanib River study area.

Season	←Hot-dry→		←— Wet —→			←Cold-dry→			←— Hot-dry —→					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Combined Mean (%)	Seasonal use comparisons (P)*
Faidherbia albida	34	10	23	26	18	45	25	23	12	17	9	46	24	0.145
F. albida (pods)	17	4	4	5	8	4	4	2	2		3	21	(6.2)	(0.041)
Acacia erioloba & tortillis	31	23	42	28	18	20	36	33	31	17	35	21	27.9	0.487
Salvadora persica	17	17	7	14	24	22	18	28	23	22	32	20	20.3	0.026
Combretum wattii	3	8		4	13	1	6	3		13		4	4.6	0.330
Cordia sinensis		3	4		1	1	5	4	2		3	1	2	0.121
Colophospermum mopane	11	15	4	3	9	3		2	2	17	16	9	7.6	<0.001
Maerua schinzii		9				1	2	2	8		3		2.1	0.180[a]
Euclea pseudebenus	3	13	21				1	3		4			3.8	<0.001
Termanalia prunioides		1											<0.1	*i*
Combretum imberbe				1	1	1	2	1					0.5	*i*
Tamarix usneoides				3	1	2			3	4			1.1	0.735
Parkisonia africana							1		7				0.7	*i*
Mundulea sericea								2	7	4			1.1	0.206
Catophractes alexandrii				1									<0.1	*i*
Pechuel-Loeschea leubnitziae						1							<0.1	*i*
Calicorema capitata									2				0.2	*i*
Adenolobus gariepina													<0.1	*i*
Commiphora spp.													<0.1	*i*
Grass spp.				5					2				0.6	0.034[∞]
Tribulus zeyheri				13	16	1	2						2.7	<0.001
Zygophylum maxima									2				0.2	*i*
Zygophylum simplex						3							0.2	*i*
Forb (annnual)		1					2	1					0.3	*i*
Forb (annual)				1									<0.1	*i*

*χ^2 test; $P<0.05$; all seasonal; [†]cold-dry vs. hot-dry season only; *i*, insufficient data; [∞]wet vs. hot-dry season; *i*, insufficient data

Appendix 16.

Preferred forage use of giraffe in the Hoarusib River study area.

Season	←Hot-dry→		← Wet →		← Cold-dry →			← Hot-dry →						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Combined Mean (%)	Seasonal use comparisons (P)*
Faidherbia albida	9		23		13	14	13	2	16	2		6	8.9	0.338
F. albida (pods)	3				3								(0.5)	*(i)*
Acacia erioloba & tortillis	62		23	55	40	50	45	47	44	22	30	51	42.6	0.591
Salvadora persica	15		15	36	11	9	8	20	28	16	20	14	17.4	0.568
Combretum wattii			8			5		1	3	31		17	5.9	<0.001
Colophospermum mopane	6				7	9		4	3	16	5		4.6	0.417
Maerua schinzii					2		3	5		4	10		2.2	0.497
Euclea pseudebenus							3	11					1.2	0.004†
Balanites welwitschtii	6		15	9	19	14	21	10	6	4	30	6	12.7	0.057
Combretum. imberbe			15				5			6		6	2.9	0.607
Tamarix usneoides					2		3						0.4	*i*
Mundulea sericea											5		0.4	*i*
Calicorema capitata													<0.1	*i*
Adenolobus gariepina													<0.1	*i*
Commiphora spp.													<0.1	*i*
Grass spp.					2								0.2	*i*
Tribulus zeyheri					3								0.3	*i*
Forb (annual)					3								0.3	*i*

*χ^2 test; $P<0.05$; all seasonal; †cold-dry vs. hot-dry season only; *i*, insufficient data

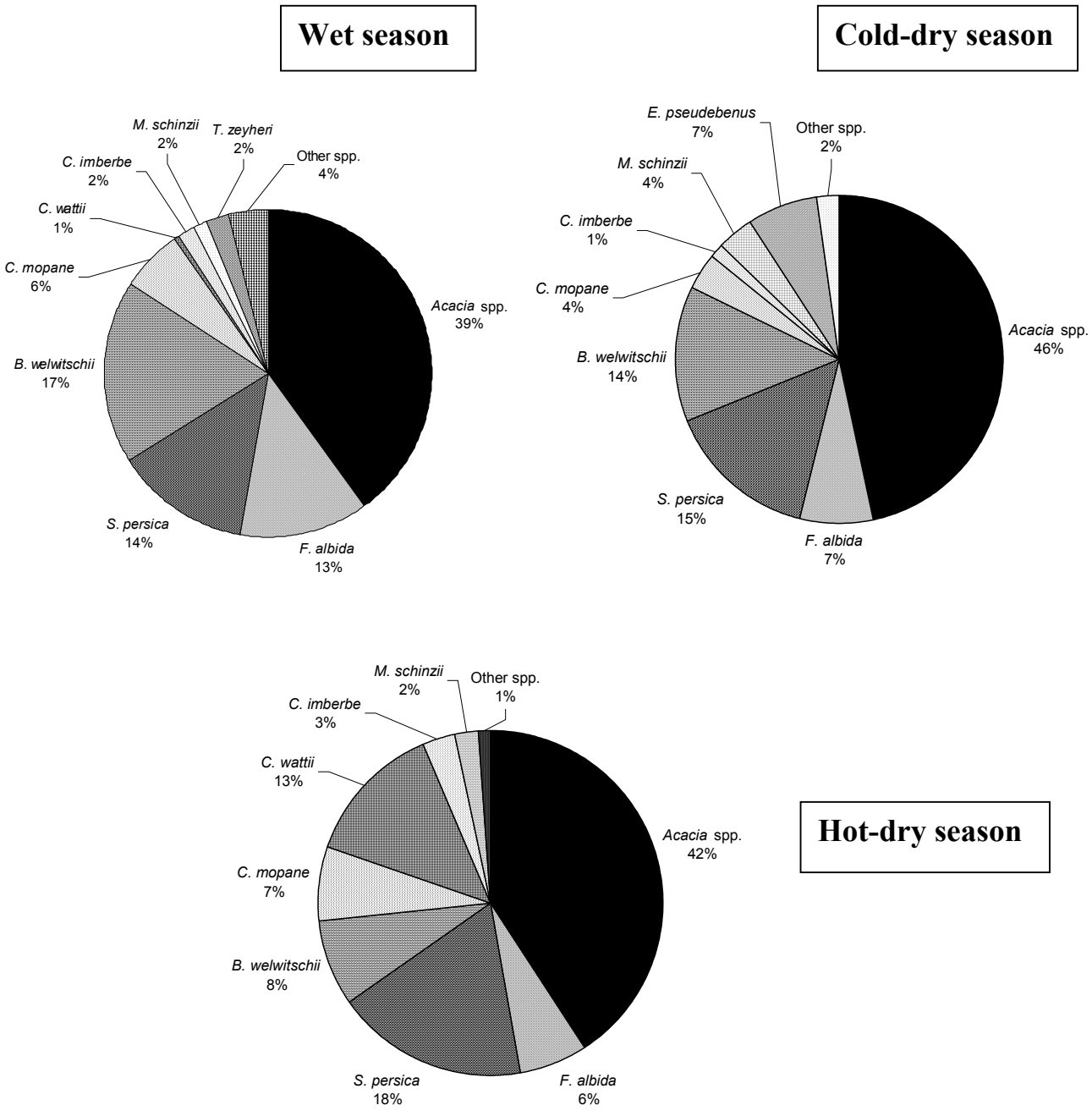
Appendix 17.

Preferred forage use of giraffe in the Khumib River study area.

Season	← Hot-dry →		← Wet →			← Cold-dry →		← Hot-dry →					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Combined Mean
Faidherbia albida								12					2
Acacia erioloba	11		50		43			4				10	19.7
Salvadora persica	17					8						15	6.6
Combretum wattii												8	1.3
Colophospermum mopane			50		57	28		32				25	32
Maerua schinzii								4				3	1.1
Balanites welwitschtii						51		20				10	13.5
Combretum imberbe	28					8		24				10	11.6
Tamarix usneoides												8	1.3
Salsola spp.						5							0.8
Acanthosicyos horrida	22							4				3	4.8
Rhigozium spp.	22											5	4.5
Forb *(Cleome)* spp.												5	0.8

N.B. Insufficient observation for seasonal forage use comparisons

Appendix 18.



Seasonal selection of different plant species by giraffe in the Hoarusib River study area, expressed as percentages of total numbers of foraging observations.

Appendix 19.

Woody plant densities, mean heights and percentage plant availability across two preferred giraffe habitat types in the study region (adapted from Viljoen , 1988).

Woody plant species	Density plant per hectare	Plant height (m) Mean ± s.d.	Percentage plant availability
Riparian woodland			
Acacia spp. (tortilis & erioloba)	3.07	5.83 ± 3.94	9.05
Balanites welwitschii	1.80	3.02 ± 1.25	5.41
Boscia foetida	1.31	1.84 ± 1.43	3.94
Colophospermum mopane	6.85	4.02 ± 2.17	20.73
Combretum imberbe	1.52	4.24 ± 4.25	4.56
Combretum wattii	0.10	1.03 ± 0.78	0.31
Cordia sinensis	0.26	2.02 ± 0.61	0.77
Euclea pseudebenus	0.46	2.63 ± 1.04	1.39
Faidherbia albida	3.68	5.62 ± 5.32	11.83
Maerua schinzii	0.28	3.61 ± 2.15	1.08
Mundulea sericea	0.33	0.82 ± 0.06	1.01
Pechuel-Loeschea leubnitzea…	2.22	1.08 ± 0.18	6.65
Salsola spp.	5.31	0.62 ± 0.21	15.93
Salvadora persica	3.09	2.52 ± 1.33	9.59
Sueda plumosa	1.03	0.58 ± 0.19	3.09
Tamarix usneoides	1.55	3.29 ± 0.99	4.64
Mountain habitat			
Colophospermum mopane	0.36	1.00 ± 0	0.18
Pachypodium lealii	1.09	1.57 ± 0.81	0.55
Sesamothamnus spp.	0.36	1.00 ± 0.00	0.18
Termenalia prunioides	4.73	1.70 ± 0.28	2.38
Boscia foetida	8.00	1.18 ± 0.81	4.03
Parkisonia africana	1.82	2.50 ± 1.41	0.92
Adenolobus spp.	2.91	0.13 ± 0.06	1.47
Commiphora kraeuseliana	19.27	0.92 ± 0.24	9.71
Commiphora multijuga	1.09	1.5 ± 0.50	0.55
Maerua schinzii	2.91	2.63 ± 1.06	1.47
Commiphora virgata	22.55	0.82 ± 0.26	11.36
Commiphora wildii	9.82	0.52 ± 0.21	5.49
Commiphora saxicola	27.27	0.61 ± 0.63	13.74
Euphorbia damarana	10.55	1.64 ± 0.51	5.31
Calicorema capitata	3.27	0.40 ± 0.18	1.65
Petalidium spp.	81.82	0.38 ± 0.19	41.21
Salvadora persica	0.36	0.50 ± 0	0.18
Catophractes alexandri	0.36	0.50 ± 0	0.18