

REFERENCES

- ANONYMOUS. 2002. *Atlas of Namibia Project*. 2002. Directorate of Environmental Affairs, Ministry of Environment and Tourism. http://209.88.21.36/Atlas/Atlas_web.htm Date of access: 21 November 2011.
- ANONYMOUS. 2009. Animal diseases data. OIE – World Organisation for Animal Health. http://www.oie.int/eng/maladies/en_OldClassification.htm#ListeA
Date of access: 10 Oct 2009.
- BALDET, T., DELECOLLE, J.-C., CETRE-SOSSA, H. C., MATHIEU, B., MEISWINKEL, R. & GERBIER, G. 2008. Indoor activity of *Culicoides* associated with livestock in the bluetongue virus (BTV) affected region of northern France during autumn 2006. *Preventive Veterinary Medicine*, 87: 84-97.
- BARNARD, B. J. H. 1993. Circulation of African Horse Sickness Virus in zebra (*Equus burchelli*) in the Kruger National Park, South Africa, as measured by the prevalence of type specific antibodies. *Onderstepoort Journal of Veterinary Research*, 60(2): 111-117.
- BARNARD, B. J. H. 1998. Epidemiology of African horse sickness and the role of the zebra in South Africa. *Archives of Virology. Supplementum*, 14:13-19.
- BARNARD, B.J., BENGIS, R., KEET, D & DEKKER, E.H. 1994. Epidemiology of African horsesickness: duration of viraemia in zebra (*Equus burchelli*). *Onderstepoort Journal of Veterinary Research*, 61(4):391-393.
- BINEPAL, V.S., WARIRU, B.N., DAVIES, F.G., SOI, R. & OLUBAYO, R. 1992. An attempt to define the host range for African Horse Sickness Virus (Orbivirus, Reoviridae) in east Africa, by a serological survey in some Equidae, Camelidae, Loxodontidae and Carnivore. *Veterinary Microbiology*, 31(1): 19-23.
- BORKENT, A. 2004. The biting midges, the Ceratopogonidae (Diptera). (*In*: Marquardt, W. C. & Kondratieff, B. C., eds. 2005. *Biology of Disease Vectors*, 2nd Ed. London: Elsevier Academic Press. Pp. 113–126.)
- BRAVERMAN, Y. & CHECHIK, F. 1996. Air stream and the introduction of animal diseases borne on *Culicoides* (Diptera Ceratopogonidae) into Israel. *Revue Scientifique et Technique de L'Office International des Epizooties*. 15(3): 1037-1052.

- BRAVERMAN, Y. & MUMCUOGLU, K.Y. 2009. Newly emerged nulliparous *Culicoides imicola* Kieffer (Diptera: Ceratopogonidae) with pigmented abdomen. *Medical and Veterinary Entomology (Oxford)*. 160: 356-358.
- BROWN, C.C., MEYER, R.F. & GRUBMAN, M.J. 1994. Presence of African Horse Sickness Virus in equine tissues, as determined by in situ hybridization. *Veterinary Pathology*, 31(6): 689-694.
- CHIAM, R., SHARP, E., MAAN, S., RAO, S., MERTENS, P., BLACKLAWS, B., DAVIS-POYNTER, N., WOOD, J. & CASTILLO-OLIVARES, J. 2009. Induction of Antibody Responses to African Horse Sickness Virus (AHSV) in Ponies after Vaccination with Recombinant Modified Vaccinia Ankara (MVA). *PLoS ONE* 4(6): e5997. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2694985/?tool=pubmed> Date of access: 13 May 2010
- CILLIE, B. 2004. The pocket photoguide to mammals of southern Africa. Cape Town: Sunbird Publishing. Pp 69.
- CLIFT, S.J., & PENRITH, M.L. 2010. Tissue and Cell Tropism of African Horse Sickness virus demonstrated by Immunoperoxidase Labeling in Natural and Experimental Infection in Horses in South Africa. *Veterinary Pathology*, 47: 690-697.
- COETZER, J.A.W & ERASMUS, B. J. 1994. African horse sickness. (*In*: Coetzer, J.A.W & Tustin. R.C., eds. 1994 Infectious Disease of Livestock with Special Reference to Southern Africa. Cape Town: Oxford University Press. Vol. 1: 460-475)
- COETZER, J.A.W. & GUTHRIE, A.J. 2004. African Horse Sickness. (*In*: Coetzer, J.A.W & Tustin. R.C., eds. 2004. Infectious Diseases of Livestock. Cape Town: Oxford University Press. Vol. 2: 1231- 1246.)
- CONTE, A., GOFFREDO, M., IPPOLITI, C. & MEISWINKEL, R. 2007. Influence of biotic and abiotic factors on the distribution and abundance of *Culicoides imicola* and the Obsoletus Complex in Italy. *Veterinary Parasitology*, 150: 333-344.
- DANA, P. H. 1995. Geodetic Datum Overview. http://www.colorado.edu/geography/gcraft/notes/datum/datum_f.html Date of access: 28 October 2011.
- GIESS, W. 1970. A preliminary vegetation map of South West Africa. *Dinteria*, 4: 1-114.

- GOFFREDO, M. & MEISWINKEL, R. 2004. Entomological surveillance of bluetongue in Italy: methods of capture, catch analysis and identification of *Culicoides* biting midges. *Veterinaria Italiana*, 40: 260-265.
- HAMBLIN, C., ANDERSON, E. C., MELLOR, P. S., GRAHAM, S. D., MERTENS, P. P. C. & BURROUGHS, J. N. 1992. The detection of African horse sickness virus antigens and antibodies in young equidae. *Epidemiology and Infection*, 108:193-201
- HAMBLIN, C., MERTENS, P.P., MELLOR, C., BURROUGHS, J. & CROWTHER J. 1991. A serogroup specific enzyme-linked immunosorbent assay for the detection and identification of African horse sickness viruses. *Journal of Virological Methods*, 31(2-3), 285– 292.
- HENNING, M.W. 1956. Animal diseases of South Africa, 3rd Ed. Pretoria: Central News Agency Ltd. Pp 785-808.
- HIGGS, S. & BEATY, B.J. 2005. Natural cycles of vector-borne pathogens. (*In*: Marquardt, W.C. & Kondratieff, B.C., eds. 2005. *Biology of Disease Vectors*, 2nd Ed. London: Elsevier Academic Press. Pp 167-185)
- HOWELL P.G. 1960. The 1960 epizootic of African horse sickness in the Middle East and SW Asia. *Journal of the South African Veterinary Association*, 31: 329-334.
- HOWELL, P.G. 1962. The isolation and identification of further antigenic types of African horse sickness virus. *Onderstepoort Journal of Veterinary Research*, 29:139-149.
- HOWELL, P. G. 1963. African horse sickness. *In: Emerging Diseases of Animals*. FAO Rome: *FAO Agricultural Studies*, 61:71-108.
- JOUBERT, E. 1972. Activity patterns shown by Hartmann zebra *Equus zebra hartmannae* in South West Africa with reference to climatic factors. *Madoqua*, 5(1):33-52.
- JOUBERT, E. 1973. Habitat preference, distribution and status of the Hartmann zebra *Equus zebra hartmannae* in South West Africa. *Madoqua*, 7(1):5-15.
- JOUBERT, E. 1974. Notes on the reproduction in Hartmann zebra *Equus zebra hartmannae* in South West Africa. *Madoqua*, 8(1):17-56
- KHEIR, R, S.M. 2010. Seasonal Activity of *Culicoides bahrainensis* Boorman, 1989 (Diptera: *Ceratopogonidae*) in Saudi Arabia. *Journal of King Saud University*, 22 (3): 167-172.

- KUNO, G. & CHANG, G.J. 2005. Biological transmission of arboviruses: re-examination of and new insights into components, mechanisms, and unique traits as well as their evolutionary trends. *Clinical Microbiology Reviews*, 18:608–637.
- LORD, C.C., WOOLHOUSE, M.E.J. & BARNARD, B.J. 1997. Transmission and Distribution of Virus Serotypes: African Horse Sickness in Zebra. *Epidemiology and Infection*, 118: 43-50.
- LUBROTH, J. 1988. African horsesickness and the epizootic in Spain 1987. *Equine Practice*, 10: 26-33.
- MAREE, S. & PAWESKA, J.T. 2005. Preparation of recombinant African horse sickness virus VP7 antigen via a simple method and validation of a VP7-based indirect ELISA for the detection of group-specific IgG antibodies in horse sera. *Journal of Virological Methods*, 125(1): 55-65.
- MARGALEF, R. 1958. Information theory in Ecology. *General Systematics*. 3:36-71
- MATSUO, E., CELMA, C.C. & ROY, P. 2010. A reverse genetics system of African horse sickness virus reveals existence of primary replication. *FEBS Lett.* 584(15): 3386-3391.
- MCINTOSH, B.M. 1958. Immunological types of horsesickness virus and their significance in immunization. *Onderstepoort Journal of Veterinary Research*, 27:465-470.
- MEISWINKEL, R. & PAWESKA, J.T. 2003. Evidence for a new field *Culicoides* vector of African horse sickness in South Africa. *Preventative Veterinary Medicine*, 60: 243-253.
- MEISWINKEL, R. 1996. Unpublished.
- MEISWINKEL, R., VENTER, G.J. & NEVILL, E.M. 2004a. Vectors: *Culicoides* spp. (In: COETZER, J.A.W & TUSTIN, R.C., eds. 2004. *Infectious diseases of livestock with special reference to southern Africa*. Cape Town: Oxford University Press. Vol 1: 93-136.)
- MEISWINKEL, R., GOMULSKI, L., DELÉCOLLE, J.-C., GOFFREDO, M. & GASPERI, G. 2004b. The taxonomy of *Culicoides* vector complexes - unfinished business. *Veterinaria Italiana*, **40**: 151–159.
- MELLOR P.S. 1993. African horse sickness: transmission and epidemiology. *Veterinary Research*, 24(2):199-212.
- MELLOR, P.S. 1994. Epizootiology and vectors of African horse sickness virus. *Comparative Immunological and Microbiological Infectious Disease*, 17: 287-296.

- MELLOR, P.S. & HAMBLIN, C. 2004. African horse sickness. *Veterinary Research*, 35:445-466
- MELLOR, P.S., BOORMANN, I. & BAYLIS, M. 2000. *Culicoides* biting midges: their role as arbovirus vectors. *Annual Review of Entomology*, 45: 307-340.
- MENDELSON, J.M., JARVIS, A.M., ROBERTS, C.S. & ROBERTSON, T. 2002. Atlas of Namibia. Cape Town: David Philip Publishers.
- NEVILL, E.M. 1967. Biological studies on some South African *Culicoides* species (Diptera: Ceratopogonidae) and the morphology of their immature stages. MSc (Agric) thesis. University of Pretoria, South Africa.
- NEVILL, E.M., VENTER, G.J. & EDWARDES, M. 1992. Potential *Culicoides* vectors of livestock orbivirus. (In: Walton, T.E & Osburn, B.I., eds. 1992. *Bluetongue, African Horse Sickness and Related Orbiviruses*. Boca Raton, Fla.: CRC Press. Pp 306–313.)
- PAWESKA J.T., PRINSLOO S.A. & VENTER G.J. 2003. Oral susceptibility of South African *Culicoides* species to live-attenuated sero-type-specific vaccine strains of African horse sickness virus (AHSV). *Medical and Veterinary Entomology*, 17: 436-447.
- QUAN, M., LOURENS, C.W., MACLACHLAN, N.J., GARDNER, I.A. & GUTHRIE, A.J. 2010. Development and optimisation of a duplex real-time reverse transcription quantitative PCR assay targeting the VP7 and NS2 genes of African horse sickness virus. *Journal of Virological Methods*, 167: 45–52.
- RODRIGUEZ, M., HOOGHUIS, H. & CASTAÑO, M. 1992. African horse sickness in Spain. *Veterinary Microbiology*, 33(1-4):129-142.
- ROTHMAN, K.J. & GREENLAND, S. 2005. Incidence Proportions and Survival Proportions. (In: AHRENS, W. & PIGEOT, I., eds. 2005. *Handbook of epidemiology*. New York: Springer. Pp 65-66)
- SAILLEAU, C., MOULAY, S., CRUCIERE, C., LAEGREID, W.W. & ZIENTARA, S. 1997. Detection of African horse sickness virus in the blood of experimentally infected horses: comparison of virus isolation and a PCR assay. *Research in Veterinary Science*, 62: 229-232.
- SCACCHIA, M., LELLI, R., PECCIO, A., DI MATTIA, T., MBULU, R.S., HAGER, A.L., MONACO, F., SAVINI, G. & PINI, A. 2009. African horse sickness: a description of outbreaks in Namibia. *Veterinaria Italiana*. 45 (2): 265-274.

- SELLERS, R.F., PEDGLEY, D.E. & TUCKER, M. R. 1977. Possible spread of African horse sickness on the wind. *Journal of Hygiene, Cambridge*, 79: 279-298.
- SHANNON, C.E & WEAVER, W., 1949. *The mathematical theory of communication*. Urbana, IL:University Illinois Press
- STONE-MARSCHAT, M., CARVILLE, A., SKOWRONEK, A. & LAEGREID, W. W. 1994 . Detection of African horse sickness virus by reverse transcription-PCR. *Journal of Clinical Microbiology*, 32(3): 697-700.
- SWARTZ, J.J. 2001. The case for the 2001 Namibia census of population and housing. *Government Gazette* No. 2597 of 2001.
- SWEET J & BURKE A. 2000. Country pasture/Forage Resource Profiles, Namibia. <http://www.fao.org/ag/AGP/AGPC/doc/Counprof/namibia.htm> Date of access: 2 May 2011.
- VENTER G.J., HERMANIDES, K.G., BOIKANYO, S.N.B., MAJATLADI, D.M. & MOREY L. 2009a. The effect of light trap height on the numbers of *Culicoides* midges collected under field conditions in South Africa. *Veterinary Parasitology*, 166: 343-345.
- VENTER, G.J., KOEKEMOER, J.J.O. & PAWESKA, J.T. 2006. Investigations on outbreaks of African horse sickness in the surveillance zone in South Africa. *Revue Scientifique et Technique (Paris)*, 25 (3): 1097-1109.
- VENTER, G.J., LABUSCHAGNE, K., HERMANIDES, K.G., BOIKANYO, S.N.B., MAJATLADI, D.M. & MORYE, L. 2009b. Comparison of the efficiency of five suction light traps under field conditions in South Africa for the collection of *Culicoides* species. *Veterinary Parasitology*, 166: 299-307.
- VENTER, G.J., NEVILL, E.M. & VAN DER LINDE, T.C. De K. 1997. Seasonal abundance and parity of stock-associated *Culicoides* species (Diptera: Ceratopogonidae) in different climatic regions in southern Africa in relation to their vector potential. *Onderstepoort Journal of Veterinary Research*, 64: 259-271.
- VENTER, G.J., PAWESKA, J.T., WILLIAMS, R. & NEVILL, E.M. 1999. Prevalence of antibodies against African horse sickness (AHS) and equine encephalosis (EE) viruses in donkeys in southern Africa. In: WERNEY, U., WADE, J.F., MUMFORD, J.A. & KAADEN, O.R., eds. 1999. *Proc. Eighth International Conference on Equine infectious diseases*. R & W Publication (Newmarket) Limited, Newmarket. Pp 299-302.

VENTER, G.J., WRIGHT, I.M. & PAWESKA, J.T. 2010. A comparison of the susceptibility of the biting midge *Culicoides imicola* to infection with recent and historical isolates of African horse sickness virus. *Medical and Veterinary Entomology*, 24: 324-328.

VENTER, G.J., WRIGHT, I.M., VAN DER LINDE, T.C. & PAWESKA, J.T. 2009c. The oral susceptibility of South African field populations of *Culicoides* to African horse sickness virus. *Medical and Veterinary Entomology*, 23: 367–378.

VORSPRACH, B., MEISER, C.K., WERNER, D., BALCZUN & SCHAUB, B.A. 2009. Monitoring of Ceratopogonidae in Southwest Germany. *Parasitology Research*, 105:337-344

WESCOTT, K. & BRANDON, R.J. 1999. Practical applications of GIS for archaeologists: A predictive modelling kit. New York: Taylor and Francis. Pp 5-32.

WEYER, C. T. 2010. African horse sickness virus dynamics and host responses in naturally infected horses. Dissertation conducted under supervision M Quan and A Guthrie. Department of Veterinary Tropical Diseases, University of Pretoria, November 2010.

WILSON, A., MELLOR P.S., SZMARAGD, C. & MERTENS P.P.C. 2009. Adaptive strategies of African horse sickness virus to facilitate vector transmission. *Veterinary Research*. 40: 16.

APPENDIX 1: RAINFALL FIGURES FOR FARM ISABIS, 1971 – 2009

The annual rainfall recorded for Isabis farm from 1970/1971 to 2008/2009

Year	Jan	Feb	Mar	April	May	June	Jul	Aug	Sept	Oct	Nov	Dec	Total rainfall (mm) for one year
1971	27.5	80	33.5	14	9	0	0	0	0	0	0	3.5	167.5
1972	43.5	0	173	78.5	0	0	0	0	0	5.5	2	0	302.5
1973	0	5	91.5	24.5	0	0	0	0	0	4	2	0	127
1974	127.5	124.5	136	85	0	0	0	0	0	0	0	0	473
1975	20.5	7	129.5	18	0	0	0	0	0	0	0	5	180
1976	157	139.5	73.5	19	0	0	0	0	0	0	0	0	389
1977	37.5	164.5	33.5	52.5	0	0	0	0	0	0	0	0	288
1978	74	45	83.4	0	8.5	0	0	0	0	0	20.9	20	251.8
1979	82.9	106.5	0	13.2	15	16.3	0	4.2	8.3	1	4.5	8.7	260.6
1980	6.9	36.8	78.6	0	0	0	8.1	8.5	0	7.1	4	33.3	183.3
1981	0	1.7	21.2	8.5	0	0.3	0	0	0	0	0	0	31.7
1982	8	22.2	50.1	19.5	2.3	7.3	5.2	0	1.5	0	0.5	28.8	145.4
1983	35.1	0	14.2	0	0	4.6	0	0	0	4.9	16.4	2.5	77.7
1984	14	20.3	75.8	13	0	0	0	0	0	2.5	6.5	0	132.1
1985	35.9	106.7	30.9	11	0	0	0	0	0	16.5	40	26.1	267.1
1986	104.2	22.4	103.6	14.2	0	7.1	0	0	2.1	51.4	0	0	305
1987	0	77.4	4	61.1	8.2	0	2.5	0	0	16.9	0	7.5	177.6
1988	151	42.5		40.5	0	2.4	0	0	0	2.5	0	4.6	243.5
1989	55.1	69.9	5	86.3	0	0	0	0	0	0	0	0	216.3
1990	16.1	51.6	53.5	23.5	0	0	0	0	0	0	1	0	145.7
1991	44.4	22.4	21.5	0	0	0	0	0	0	0	21.9	11.5	121.7
1992	59.3	9	20	0	0	0	0	0	0	1	0	11.9	101.2
1993	32	78.6	30.9	14.3	0	0	0	0	0	0	0	6	161.8
1994	72.9	37.9	0	11.8	0	0	0	0	0	0	8	12	142.6
1995	0	40.5	1.5	0	0	0	0	0	0	0	10	0	52
1996	29.1	23.7	32.5	2	0	0	0	0	0	0	23	4.5	114.8
1997	227.1	50.5	42	0	13	0	2	0	0	0	0	75	409.6
1998	57.5	5.5	0	0	0	0	1	14	7.5	0	0	0	85.5
1999	22	35.5	11.5	14.8	14.5	3.5	0	0	0	0	16	67	184.8
2000	19.5	169	88.5	20	0	0	0	0	0	0	0	6.5	303.5
2001	84	20.5	57	74.5	0	0	0	0	0	0	0	0	236
2002	27.5	84	74.2	29	0	0	0	0	0	0	12	0	226.7
2003	8	30	26	80.5	0	0	0	0	0	0	14	3	161.5
2004	125	87.5	0	60.5	0	0	0	0	0	26	73.5	6	378.5
2005	16.5	56.5	31	11	10	0	0	0	0	9	7.5	5	146.5
2006	134.5	204	10	42	0	0	0	0	0	9	18.5	0	418
2007	62.5	13.5	0	0	0	0	0	0	0	0	0	0	76
2008	13	113	126	28	0	0	0	0	0	8.2	106	37.9	432.1
2009	2.2	296.3	28.9	0	0	0	0	0	0	4.4	10.7	10.2	352.7
Total Rainfall (mm)													8470.2632
Average Yearly Rainfall (mm/a)													222.9

APPENDIX 2: YEAR 2000 ANIMAL POPULATIONS IN NAMIB NAUKLUFT PARK

Species	Number Seen	Estimate	Lower	Upper	Density (no./km²)
Gemsbok	378	4653	2872	6435	0.1
Giraffe	1	9	1	25	0
Kudu	1	9	1	26	0
Ostrich	234	2531	1545	3518	0.05
Springbok	697	9433	1736	17131	0.19
Mountain Zebra	365	3502	1444	5560	0.07
Cattle	35	1043	35	2227	0.02
Goats	109	4203	109	10112	0.09
Horse	2	33	2	76	0

Data collected by sampling over a line transect in Namib Naukluft Park, over an area of 48 981 km²

APPENDIX 3: MIDGES CAPTURED OVER THE PERIOD 6 JULY TO 21 SEPTEMBER 2009

Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 1										
06/07/2009	<i>exspectator</i>	3	No data*		No data		No data		null**	0
	<i>imicola</i>	17								
	<i>pycnostictus</i>	3								
	<i>ravus</i>	30								
	<i>subschultzei</i>	4								
	Sample total	57							Sample total	0
Week 2										
13/07/2009	<i>exspectator</i>	12	<i>imicola</i>	309	No data		No data		null	0
	<i>herero</i>	3	<i>leucostictus</i>	2						
	<i>imicola</i>	57	<i>pycnostictus</i>	2						
	<i>leucostictus</i>	1	<i>subschultzei</i>	4						
	<i>pretoriensis</i>	1	<i>tropicalis</i>	1						
	<i>pycnostictus</i>	12								
	<i>ravus</i>	105								
	<i>subschultzei</i>	34								
	Sample total	225	Sample total	318					Sample total	0
Week 3										
20/07/2009	<i>exspectator</i>	21	<i>imicola</i>	309	<i>pretoriensis</i>	2	No data		null	0
	<i>herero</i>	15	<i>leucostictus</i>	1	<i>pycnostictus</i>	73				
	<i>imicola</i>	67	<i>pycnostictus</i>	1	<i>ravus</i>	86				
	<i>leucostictus</i>	1	<i>subschultzei</i>	4	<i>subschultzei</i>	38				
	<i>pycnostictus</i>	9			<i>tropicalis</i>	1				
	<i>ravus</i>	101			<i>tutti frutti</i> (#30)	1				
	<i>subschultzei</i>	39								
	<i>tropicalis</i>	1								
	Sample total	254	Sample total	315	Sample total	201			Sample total	0

Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 4										
27/07/2009	<i>cornutus</i>	1	<i>imicola</i>	418	#89	2	No data		null	0
	<i>exspectator</i>	5	<i>nivosus</i>	1	#94	2				
	<i>herero</i>	3	<i>pycnostictus</i>	1	<i>herero</i>	7				
	<i>imicola</i>	14	<i>subschultzei</i>	6	<i>imicola</i>	20				
	<i>leucostictus</i>	1			<i>leucostictus</i>	7				
	<i>pycnostictus</i>	3			<i>pycnostictus</i>	20				
	<i>ravus</i>	31			<i>ravus</i>	17				
	<i>subschultzei</i>	14			<i>subschultzei</i>	12				
					<i>tropicalis</i>	2				
	Sample total	72	Sample total	426	Sample total	89			Sample total	0
Week 5										
02/08/2009	No data		<i>imicola</i>	78	<i>brucei</i>	3	<i>imicola</i>	1	null	0
			<i>leucostictus</i>	1	<i>herero</i>	13	<i>leucostictus</i>	1		
			<i>pycnostictus</i>	1	<i>imicola</i>	65	<i>pycnostictus</i>	2		
			<i>schantzei</i>	1	<i>leucostictus</i>	3				
			<i>subschultzei</i>	3	<i>macintoshi</i>	1				
					<i>pycnostictus</i>	70				
					<i>ravus</i>	63				
					<i>schantzei</i>	1				
					<i>subschultzei</i>	38				
					<i>tropicalis</i>	1				
			Sample total	84	Sample total	258	Sample total	4	Sample total	0

Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 6										
10/08/2009	<i>eriodendroni</i>	1	<i>herero</i>	1	<i>brucei</i>	4	<i>imicola</i>	5	<i>imicola</i>	8
	<i>exspectator</i>	29	<i>imicola</i>	301	<i>eriodendroni</i>	2	<i>pycnostictus</i>	9	<i>kanagai</i>	1
	<i>herero</i>	115	<i>leucostictus</i>	1	<i>herero</i>	61	<i>ravus</i>	3	<i>leucostictus</i>	1
	<i>imicola</i>	62	<i>pycnostictus</i>	4	<i>imicola</i>	126			<i>pycnostictus</i>	1
	<i>leucostictus</i>	6	<i>ravus</i>	3	<i>leucostictus</i>	8			<i>ravus</i>	4
	<i>pycnostictus</i>	16	<i>schantzei</i>	1	<i>magnus</i>	1			<i>schantzei</i>	2
	<i>ravus</i>	224	<i>schantzei</i>	20	<i>pycnostictus</i>	76				
	<i>schantzei</i>	1			<i>ravus</i>	161				
	<i>schantzei</i>	119			<i>schantzei</i>	85				
	<i>tropicalis</i>	2			<i>tropicalis</i>	6				
					<i>tutti frutti</i> (#30)	3				
	Sample total	575	Sample total	331	Sample total	533	Sample total	17	Sample total	17
Week 7										
17/08/2009	<i>bedfordi</i>	4	<i>brucei</i>	1	#94	5	<i>herero</i>	3	#90	1
	<i>exspectator</i>	44	<i>exspectator</i>	2	<i>accraensis</i> group	3	<i>imicola</i>	5	<i>imicola</i>	22
	<i>herero</i>	285	<i>herero</i>	2	<i>brucei</i>	5	<i>leucostictus</i>	1	<i>kanagai</i>	1
	<i>imicola</i>	127	<i>imicola</i>	220	<i>herero</i>	103	<i>macintoshi</i>	1	<i>leucostictus</i>	4
	<i>leucostictus</i>	22	<i>leucostictus</i>	5	<i>imicola</i>	317	<i>pycnostictus</i>	7	<i>pycnostictus</i>	12
	<i>macintoshi</i>	13	<i>nivosus</i>	1	<i>leucostictus</i>	28	<i>ravus</i>	24	<i>ravus</i>	6
	<i>nivosus</i>	4	<i>pycnostictus</i>	3	<i>macintoshi</i>	5	<i>schantzei</i>	1	<i>schantzei</i>	1
	<i>pycnostictus</i>	28	<i>ravus</i>	5	<i>pycnostictus</i>	88	<i>tropicalis</i>	3		
	<i>ravus</i>	838	<i>schantzei</i>	16	<i>ravus</i>	419	<i>tutti frutti</i> (#30)	1		
	<i>remerki</i>	4	<i>tropicalis</i>	2	<i>similis</i>	3				
	<i>schantzei</i>	4			<i>schantzei</i>	115				
	<i>schantzei</i>	307			<i>tropicalis</i>	33				
	<i>tropicalis</i>	7			<i>tutti frutti</i> (#30)	8				
	Sample total	1687	Sample total	257	Sample total	1132	Sample total	46	Sample total	47

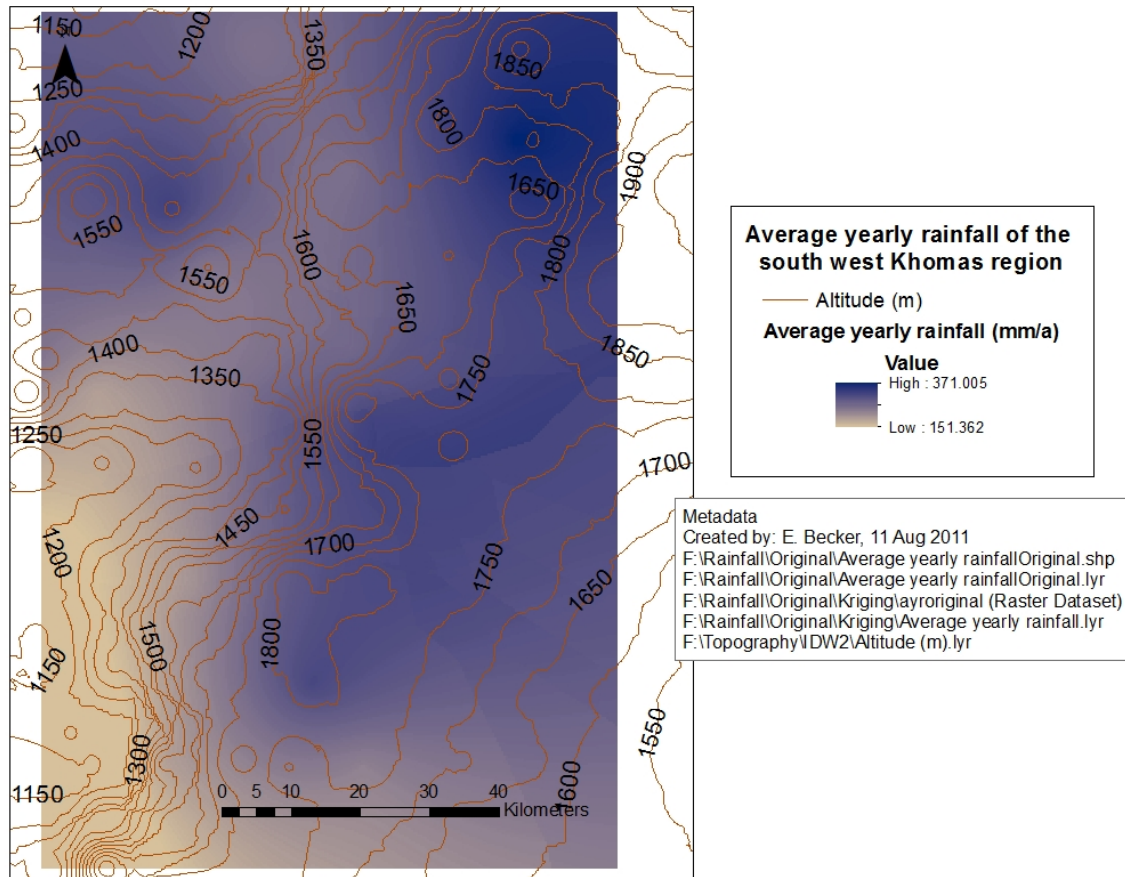
Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 8										
24/08/2009	<i>exspectator</i>	41	No data		<i>brucei</i>	4	<i>imicola</i>	9	<i>herero</i>	1
	<i>herero</i>	128			<i>eriodendroni</i>	1	<i>pycnostictus</i>	2	<i>imicola</i>	11
	<i>imicola</i>	216			<i>herero</i>	38	<i>ravus</i>	7	<i>leucostictus</i>	2
	<i>leucostictus</i>	41			<i>imicola</i>	139			<i>pycnostictus</i>	14
	<i>macintoshi</i>	21			<i>leucostictus</i>	18			<i>ravus</i>	10
	<i>nivosus</i>	14			<i>pycnostictus</i>	55			<i>subschultzei</i>	3
	<i>pycnostictus</i>	74			<i>ravus</i>	271				
	<i>ravus</i>	1406			<i>subschultzei</i>	70				
	<i>schantzei</i>	7			<i>tropicalis</i>	15				
	<i>subschultzei</i>	330								
	<i>tropicalis</i>	7								
	Sample total	2285			Sample total	611	Sample total	18	Sample total	41
Week 9										
31/08/2009	<i>exspectator</i>	151	No data		<i>brucei</i>	7	<i>herero</i>	2	<i>imicola</i>	32
	<i>herero</i>	259			<i>herero</i>	9	<i>imicola</i>	85	<i>leucostictus</i>	11
	<i>imicola</i>	431			<i>imicola</i>	115	<i>leucostictus</i>	5	<i>nivosus</i>	1
	<i>leucostictus</i>	33			<i>leucostictus</i>	13	<i>pycnostictus</i>	25	<i>pycnostictus</i>	39
	<i>nivosus</i>	11			<i>macintoshi</i>	2	<i>ravus</i>	143	<i>ravus</i>	73
	<i>pycnostictus</i>	140			<i>magnus</i>	1	<i>schantzei</i>	1	<i>subschultzei</i>	8
	<i>ravus</i>	1842			<i>olyslageri</i>	1	<i>subschultzei</i>	12	<i>tropicalis</i>	1
	<i>subschultzei</i>	517			<i>pycnostictus</i>	28	<i>tropicalis</i>	8		
	<i>tropicalis</i>	33			<i>ravus</i>	107	<i>tutti frutti</i> (#30)	17		
					<i>subschultzei</i>	23				
					<i>tropicalis</i>	5				
	Sample total	3417			Sample total	311	Sample total	298	Sample total	165

Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 10										
07/09/2009	<i>bedfordi</i>	22	No data		#94	44	<i>brucei</i>	1	<i>brucei</i>	1
	<i>exspectator</i>	131			<i>herero</i>	95	<i>herero</i>	2	<i>herero</i>	1
	<i>herero</i>	76			<i>imicola</i>	512	<i>imicola</i>	118	<i>imicola</i>	69
	<i>imicola</i>	456			<i>leucostictus</i>	74	<i>leucostictus</i>	18	<i>leucostictus</i>	10
	<i>leucostictus</i>	76			<i>macintoshi</i>	37	<i>nivosus</i>	1	<i>nivosus</i>	1
	<i>nivosus</i>	11			<i>neavei</i>	8	<i>pycnostictus</i>	78	<i>pycnostictus</i>	70
	<i>pycnostictus</i>	98			<i>nivosus</i>	8	<i>ravus</i>	356	<i>ravus</i>	144
	<i>ravus</i>	2324			<i>pycnostictus</i>	161	<i>similis</i>	3	<i>subschultzei</i>	20
	<i>schantzei</i>	11			<i>ravus</i>	643	<i>subschultzei</i>	15		
	<i>subschultzei</i>	1119			<i>subschultzei</i>	263	<i>tropicalis</i>	9		
	<i>tropicalis</i>	33			<i>tropicalis</i>	44	<i>tutti frutti</i> (#30)	16		
					<i>tutti frutti</i> (#30)	8				
	Sample total	4357			Sample total	1897	Sample total	617	Sample total	316
Week 11										
14/09/2009	#89	114	No data		#94	12	<i>imicola</i>	63	No data	
	#94	57			<i>bedfordi</i>	16	<i>leucostictus</i>	7		
	<i>bedfordi</i>	227			<i>exspectator</i>	4	<i>macintoshi</i>	1		
	<i>exspectator</i>	511			<i>herero</i>	24	<i>pretoriensis</i>	1		
	<i>herero</i>	114			<i>imicola</i>	299	<i>pycnostictus</i>	76		
	<i>imicola</i>	1361			<i>leucostictus</i>	84	<i>ravus</i>	270		
	<i>leucostictus</i>	341			<i>nivosus</i>	4	<i>subschultzei</i>	3		
	<i>nivosus</i>	114			<i>pycnostictus</i>	60	<i>tropicalis</i>	7		
	<i>pycnostictus</i>	227			<i>ravus</i>	640				
	<i>ravus</i>	11909			<i>subschultzei</i>	112				
	<i>schantzei</i>	114			<i>tropicalis</i>	24				
	<i>subschultzei</i>	2722								
	<i>tropicalis</i>	171								
	Sample total	17982			Sample total	1279	Sample total	428		

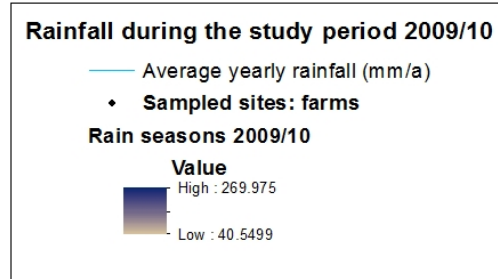
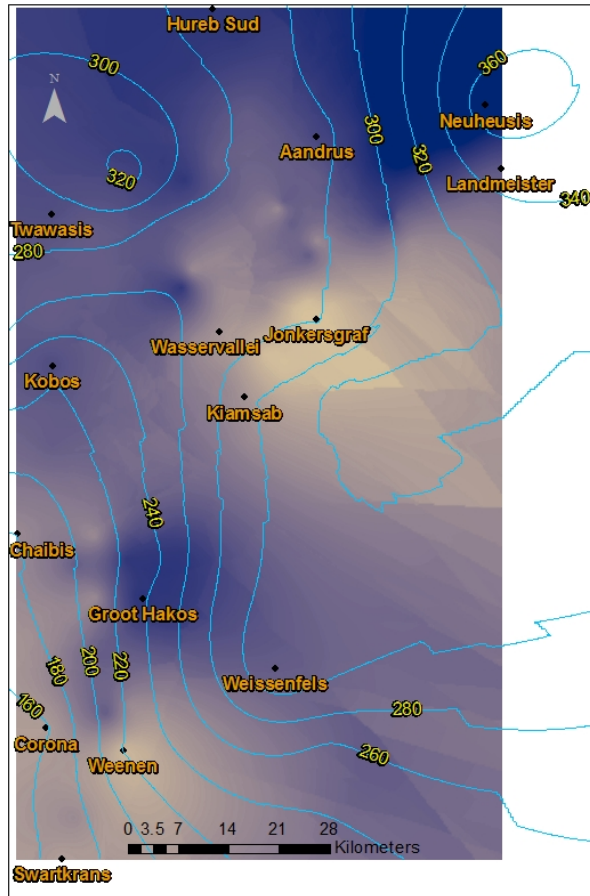
Week	Hureb Süd		Avis		Corona		Isabis		Neuheusis	
	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total	<i>Culicoides</i> species	Species total
Week 12										
21/09/2009			No data		No data		<i>bedfordi</i>	1	#94	2
	<i>exspectator</i>	752					<i>imicola</i>	40	accraensis group	1
	<i>herero</i>	752					<i>leucostictus</i>	7	<i>imicola</i>	15
	<i>imicola</i>	2869					<i>macintoshi</i>	1	<i>leucostictus</i>	4
	<i>leucostictus</i>	410					<i>nivosus</i>	1	<i>pycnostictus</i>	13
	<i>nivosus</i>	137					<i>pycnostictus</i>	57	<i>ravus</i>	74
	<i>pycnostictus</i>	274					<i>ravus</i>	240	<i>subschultzei</i>	11
	<i>ravus</i>	18574					<i>subschultzei</i>	7	<i>tropicalis</i>	1
	<i>subschultzei</i>	5805					<i>tropicalis</i>	3		
							<i>tutti frutti</i> (#30)	2		
	Sample total	29573					Sample total	359	Sample total	121
Week 13										
28/09/2009	No data		No data		<i>bedfordi</i>	19	No data		No data	
					<i>brucei</i>	13				
					<i>herero</i>	13				
					<i>imicola</i>	202				
					<i>leucostictus</i>	74				
					<i>macintoshi</i>	19				
					<i>pycnostictus</i>	25				
					<i>ravus</i>	483				
					<i>similis</i>	7				
					<i>subschultzei</i>	129				
					<i>tropicalis</i>	13				
					Sample total	997				

*No Data = No collections made. **null = No *Culicoides* caught in collection

APPENDIX 4: GRAPHICAL PRESENTATIONS OF ENVIRONMENTAL DATA AND THE OCCURRENCE OF HARTMANN'S MOUNTAIN ZEBRA (*E. Z. HARTMANNAE*) IN RELATION TO ENVIRONMENTAL DATA

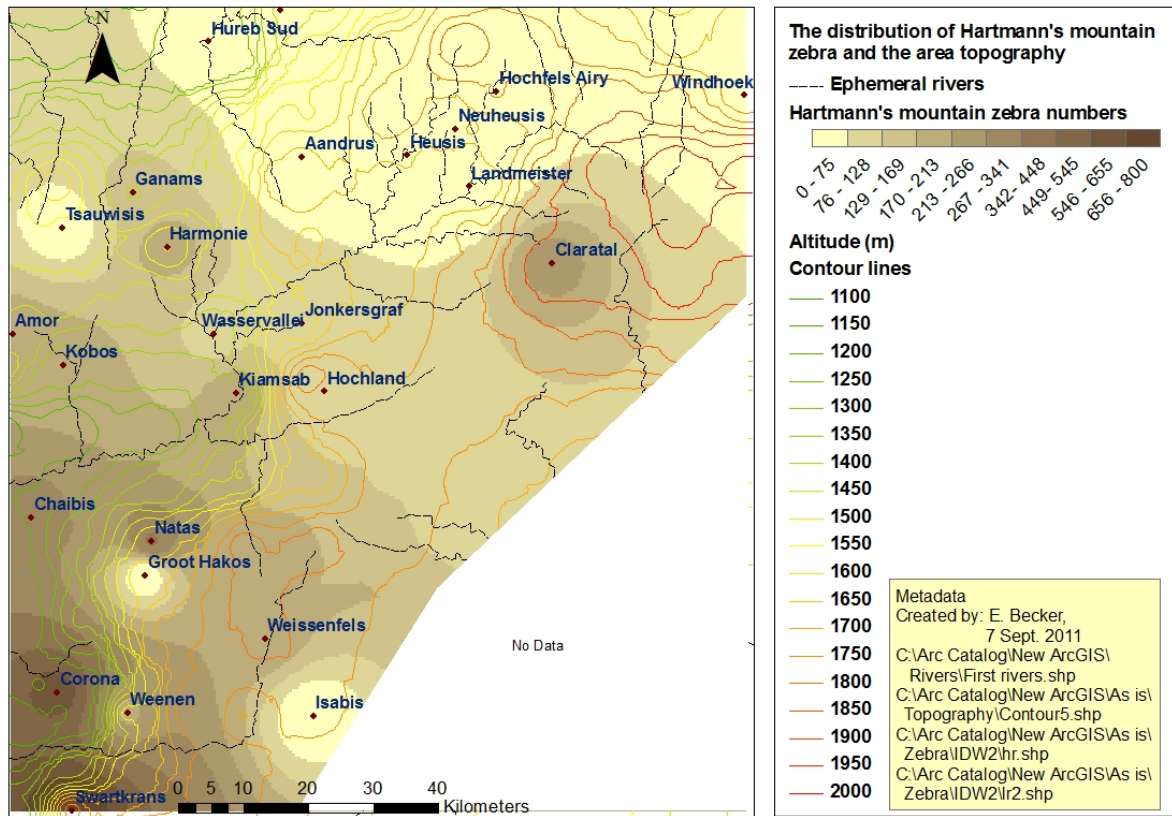


The distribution of mean annual rainfall in the context of the topography of the south-western Khomas Region.

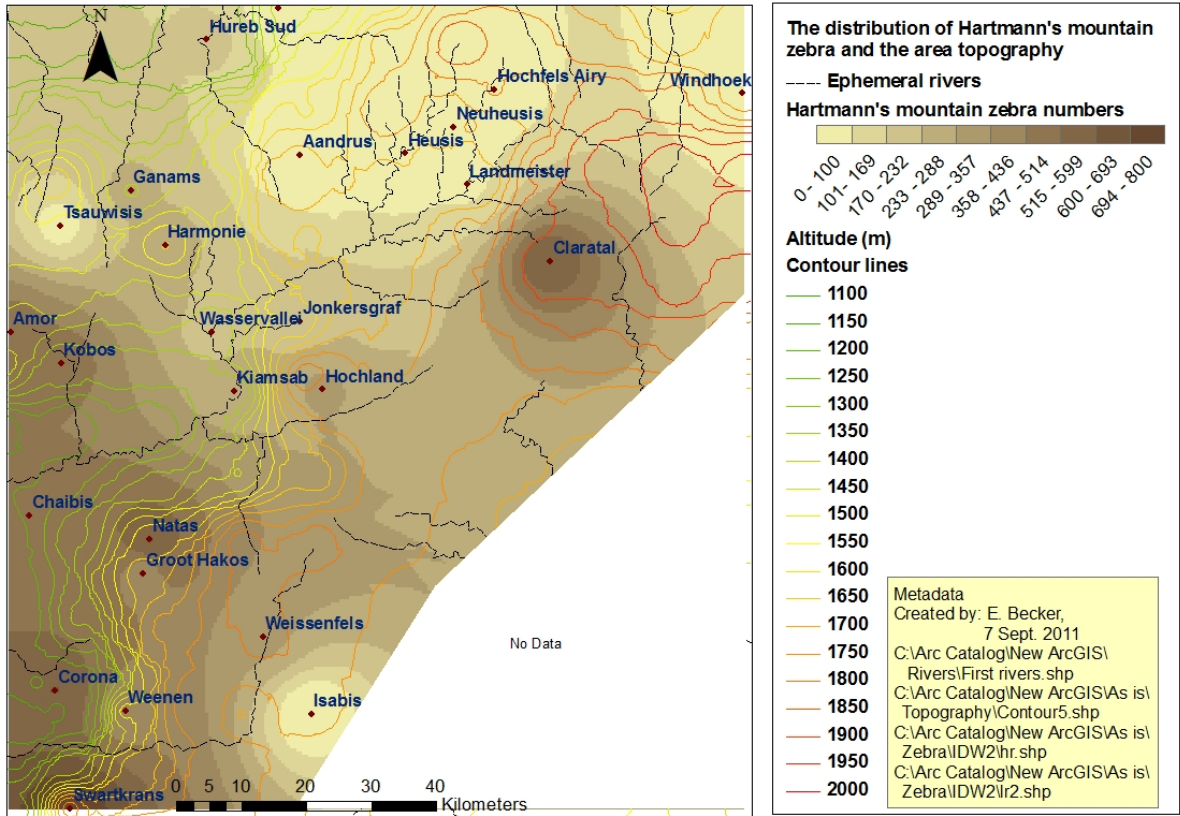


Metadata
 Created by: E. Becker, 11Aug 2011
 Google Earth TM
 F:\Rainfall\Rain 09,10.shp
 F:\Rainfall\Original.shp
 F:\Rainfall\Kriging\Rain seasons 2009/10 (Raster Dataset)
 F:\Rainfall\Original\Kriging\layrocontour.lyr

A comparison between the 2009/2010 rainfall distributions and the mean annual rainfall in the south-western Khomas Region.



The occurrence of *E. z. hartmannae* during wet periods in the context of the topography of the south-western Khomas Region.



The occurrence of *E. z. hartmannae* during dry periods in the context of the topography of the south-western Khomas Region.