

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Ministry of Animal Resources

Animal Resource Research Cooperation

Wildlife Research Center

**Collection of Research abstracts, References and Citation
Conducted in Dinder National Park during the Period of 1935 -
2015**

By:

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The Prospect of Wildlife Tourism in Dinder National Park

By:

Khalda M Osman Abuzaid

M.Sc. Thesis, Juba University, 1993

This study was conducted to assess the tourism industry in Dinder National Park (DNP), identify the problem and formulate recommendations that could promote the development of the tourism industry in the Park. The methodology used in this study is composed of field surveys which cover the general characteristics of the area of the study; in addition to that the facilities of the tourism industry, interviews, group discussions, and literature search and data analysis were also conducted.

The results showed that the tourism in the Park is under developed if it's compared with other countries. The number of the visitors was not considerable for generating income. The absence of the role of the government agencies (tourism agencies) and private sector are considered as the main factors that affected the process of the tourism development. The department authorities; wildlife Conservation Forces (WCF) and Tourism and Hotels Corporation (THCorp.) are suffering from insufficient finance for practicing their activities for developing the Park. The inadequate tourism facility inside the Park has led to discourage the tourists from visiting the Park. This study outlined the organization of Wildlife Conservation Forces, Wildlife Research Center (WRC) and Tourism and Hotels Corporation. Detailed were given about the general characteristics of the Park features (Fauna and Flora).

Recommendations were made for consideration by authorities concerned of proposal and plans for development of tourism industry inside the Park. Existence of private sector is considered as one of the important factors for promotion of tourism. Corporation between the different departments for assessing the development program and control of illegal activities through effective's laws is required. In order to preserve the Park values and for consideration to be given for a project to initiate economic development of the country's Wildlife Resources (wildlife tourism industry) and publicity and awareness programs are highly needed for tourism development.

**Distribution and measurement of small mammals in various
Ecosystems in Dinder National Park**

By

Khalda Suliman Mahgoub

M.Sc. thesis, Juba University 2004

This study was conducted in Dinder National park during the dry season From January to May 2002 .Objects of the study Were the Following: 1) to determine tree species richness, abundance and to assess herbaceous vegetation cover. 2) to determine the abundance and distribution of small mammals. 3) to determine the effect of fire on Maya, Riverine and Dehra ecosystems and on the small mammals.

Belt transects were used in the sampling of vegetation and small mammals, night surveys to determine the distribution of small mammals. Sixty six transects were sampled altogether in the three ecosystems. The study showed higher percentage of litter and bare soil in the Riverine ecosystem compared to the Maya and Dehra. About 38% of the park area was burnt in this year. Species richness was higher in the Riverine compared with Dehra and Maya. Density of trees was higher in Dehra than the Riverine but very low in Maya ecosystem.

Nineteen species of small mammals were identified in the park. These mammals were attracted to the Riverine more than the Dehra and Maya. The small mammals were not randomly dispersed in the park. Capture statistics showed that they preferred the unburned areas in Riverine and Dehra ecosystems. Standard body measurements were done for the captured animals.

**Basic information towards management of Guinea fowl in
Dinder Biosphere Reserve.**

By

Mubarak Ali Ibrahim

Msc Thesis, Sudan Academy of Science, 2009

This study was conducted in Dinder Biosphere Reserve, during the dry season of 2007 and 2008. Objectives of the study were to: estimate density and biomass of Guinea fowl in various ecosystems of the Reserve determine morph metric measurements of Guinea fowl, study the roosting ecology of the bird and to establish a certain annual harvest of Guinea fowl on sustainable basis.

Loop and nearest neighbor methods, were used for measuring vegetation attributes and tree density. Density of Guinea fowl was estimated by strip transect, which is 500- m long and 200- m wide; the number of the bird inside the strip was estimated by the double sampling procedure in which the number of bird was estimated first and then was counted directly. A predictive model was developed from the relationship between the counted and estimated numbers; subsequently the number of the bird was only estimated and predicted by the model. Biomass was estimated by capturing the bird, using local traps. A questionnaire was developed and distributed to the local community, aiming at evaluating the damages caused by Guinea fowl and to assess public attitude towards the bird. Density of birds was high around the Mayas, Rivers and waterholes. In 2007 density ranged 1800–5080 Bird/km² in Gererrisa and Ras Amir, respectively. In 2008 the density ranged 650-3250 Bird/km² in El abyad and Ras Amir.

Vegetation attributes surrounding the Maya-namely- litter, bare soil and burnt area were determined; the first one was high at Abdel Ghani, low in Ein Es shames. Bare soil was around 50 %. The burnt area showed low percentages, when compared with two other parameters. Trees showing high density included *Acacia seyal*, *Combretum sp*, *Balanites aegyptiaca*, *Ziziphus-spina Christi* and *Acacia polycantha*.

Morph metric measurements of guinea fowl in the park showed that the mean biomass of the female was 1.04 ± 0.087 kg and of the male was 1.056 ± 0.103 kg. The wing length was 35.194 ± 3.05 cm and 36.625 ± 1.591 cm for the female and male, respectively. The total biomass of Guinea fowl in the park was 93.76 kg/km², whereas the sustainable yield that must be cropped annually from the birds was 79.896 bird / year.

A questionnaire distributed to villages resulted in 111(55.5 %) respondents, their family sizes ranged 2-30, ages 20-80; Among these respondents, 64 % were farmers, other occupations (butchers, bakers, carpenters, drivers, free workers, merchants, officers, solders, students and workers), ranged only 5.4-0.9 %.

Guinea fowl appeared to cause some damage to the agricultural fields. This damage was tolerable because farmers do not complain much about it.

**Diversity, Flock Characteristic, Roosting Ecology and Seasonal Fluctuation
of Stork Numbers in Dinder National Park**

By:

Omer Mohammed Meina Mohammed

Msc. Thesis, Sudan Academy of Science, 2009

Storks were studied in Maya (meadow) ecosystem of Dinder National Park (DNP) during the dry season of 2009 and 2010. The objective of the study was to determine their diversity, flock characteristics, roosting ecology and fluctuation in numbers with annual climatic change.

The Storks were identified by directly observing them in the Mayas, using telescopes and binoculars. Their numbers were determined by the double sampling procedure in which the researcher was trained to estimate the number of storks in their flocks and then counted them directly. This was repeated until the estimated numbers were equal to or very close to the counted numbers. A regression model was then developed between the two variables. Subsequently, the researcher only estimated the number of storks from which the counts were predicted.

The roosting ecology was studied in Maya ecosystem where herbaceous vegetation cover was determined by the loop method, tree density by the nearest neighbor method. Crown diameters of trees were measured from which crown areas were calculated.

Results of the study showed that eight species of storks occurred in DNP including Abdim's (Ciconia abdimii), Yellow-billed (Mycteria ibis), Woolly-necked (Ciconia episcopus), African open bill (Anastomus lamelligerus), Saddle bill (Ephippiorhynchus sensgalensis), Marabou stork (Leptoptilos crumeniferus), the Black stork (Ciconia nigra), and the White stork (Ciconia Ciconia). Among these, the latter two species were Palearctic migrants whereas; Abdim's, Woolly-necked, African open bill and yellow-billed were locally migrants. The Marabou and Saddle billed were resident in the Park.

Three species of storks occurred in flocks. The largest flock was formed by the Marabou, the second in size by the Open bill and the least by the Yellow-billed. Juvenile/female ratio was

relatively high for the Open-bill (49%), but almost equal for the Yellow-billed (29%) and the Marabou (31%). Male/female ratio of Yellow-billed was 51% and unity for the remaining species, suggesting that the Yellow-billed is polygamous whereas, Open bill and Marabou are monogamous.

Numbers of storks reported in Maya ecosystem varied considerably between the two years. In 2009 the total numbers in respective summer and winter seasons were higher than in 2010, the decline in number was attributed to severe drought that struck the DNP in the latter year.

No relationship was found between the roosting ecology and vegetation attributes. Marabou, the only stork that roosted in DNP, showed affinity to a particular tree. Among the 10 species recorded in roosting sites, only *Balanites aegyptiaca* was selected by the bird for roosting.

Illegal and Patrolling Activities in Dinder National Park

By:

Ayoub Nor Eldin Elyas Mohammed

Msc. Thesis, Sudan Academy of Science, 2012

Poaching, livestock trespassing and resources collection were the illegal activities that have been going on since the establishment of Dinder National Park in 1936. The objectives of this study were to determine these activities, together with patrolling operations during the period from 1959 to 2010. Secondary data were completed from annual reports, proceedings, and dissertations and published materials about the park. Results of the study indicated that livestock trespassing and poaching consistently increased during the period of study. The resource collection was the highest activity, followed by poaching. Livestock and human trespassing comprised 51% and 20% of these activities respectively; respective Poaching and felling trees were 12% and 8%. The number of cattle trespassing into the park was unknown because it was reported in herds. Trespassing sheep comprised 80%, goats and sheep 13%. The livestock trespassing started in January and maximized in March. Patrolling operations did not coincide with peaks of illegal activities in March while the number of patrolling operations were a function of the number of sheep captured, they were not so for the number of cattle herds; it is concluded that no strategy is set to curb the illegal activities in the park. It is recommended that plans should be developed to guard critical areas in the park such as important Mayas and waterholes along the Dinder area prior to the inception of the illegal activities.

Morphometrics of Honeybee *Apis mellifera* L. Nesting Ecology and Honey

Production in Dinder Biosphere Reserve

By:

Lubna Mohammed Abd Allah Hassan

Msc. Thesis, Sudan Academy of Science, 2012

The objective of this study was to determine morphometrics, density and distribution of bee colonies and honey production in Dinder Biosphere Reserve as well as the impact of illegal honey collection on the reserve's biodiversity. Colonies of honeybees were counted in the Maya, the Riverine and the Dehara ecosystem along randomly selected line transects. Samples of honeybee workers were collected from honeycombs and boiled in water, preserved in a solution of ethanol, glycerin and distilled water(1:1:1 by volume) and then thoroughly washed in distilled water. The right wings were removed; the remaining parts were boiled in

10% potassium hydroxide. The samples were then cooled and washed thoroughly in distilled water. The proboscis, the right antenna, the right hind leg, stemite III and the third and fourth abdominal tergites were dissected, dehydrated in a series of alcohol solutions and their morphometric were determined.

The density of bee colonies was calculated as the total colonies counted in each transect divided by the area of the plot. Honeycombs were collected, weighed and pressed to extract honey. The honey was left in container for some time to settle and then weighed. Burnt and felled trees were counted in the same plots and their density was calculated as the number of burnt and felled trees divided by the area of the plots. Questionnaires were distributed to the local community to evaluate how they interacted with the biosphere reserve.

Morphometric of worker bees varied among the Maya, the Riverine and Dehara ecosystems, but they belonged to the same species *Apis mellifera*. Colonies of honeybees were closely associated with the two former ecosystems. Honeybees preferred *Habil*, *Combretum* sp., *Cuke*,

Acacia siebriana and *Higleig*, *Balanities aegyptica* for nesting and the degree of preference of each tree species varied between years. More bee colonies were encountered in 2009 than 2010;

also the active bee colonies were more in the former year. The honeycombs were more common in tree cavities than in the form of open-air comb (Dallou). In terms of honey production, it was high in Cuke followed by Higli and Habil. The latter two tree species were considerably damaged by illegal honey collectors either by burning or felling. The amount of honey collected was very small; it was sold in the local market to supplement the income of the local community which was mainly from cultivation. It is recommended that taxonomic studies through molecular genetics and strains as well as the constituents of honey from pollen of trees and grasses should be studied.

Vegetation Successions and its Effect on the Wildlife Herbivory in Mayas of Dinder National Park, Sudan

salwa M. Abdelhameedi Nadir M. Awadi Mutasim B. Nimiri Salah.

A. Hakim, El Gilay O. Ahmed and Ibrahim M. Hashim

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Cover in Mayas (meadows) of the Dinder National Park was determined in the dry seasons of 1972 - 1986. Mayas showing the highest percentage of cover were the most productive (young) Mayas. While non-productive (old) Mayas showed the lowest percentage of total grass cover. The percentages of both grass cover and bare ground were significantly different ($P < 0.50$) among the Mayas, but was similar ($P > 0.1$) in the Mayas.

Waterbuck, tiang, buffalo, giraffe, reedbuck, oribi, warthog were the prime users of the Mayas. Their pellet groups were counted and animal grazing load on the Mayas was calculated accordingly. The average biomass feeding of animals was significantly different ($P < 0.05$) among Mayas, but not among seasons ($P > 0.1$). There was no significant correlation between biomass feeding & grass cover at different Mayas ($r = 0.08$, $p > 0.1$), but was statistically significant at different seasons ($p = -0.7$, $p < 0.05$). There was direct relationship between biomass feeding and litter data in Mayas ($r = 0.48$, $p < 0.05$) and in seasons ($r = 0.53$, $p < 0.05$). Thus more trampling occurred by animals that lead to accumulation of more litter. The trend of annual grasses seems to increase in all Mayas towards 1986. That might reflect the gradual change in vegetation of Mayas towards drier conditions. The successional trend towards drier Mayas might greatly affect the food supply of the herbivores in the future.

Watershed management in the Dinder National Park, Sudan

By:

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A major objective of the study was to survey and map the drainage system of the park which is crucial to sound management and maintenance of the habitat. Landsat satellite data of multispectral scanner (MSS), thematic mapper (TM) and aerial photographs were the main sources of information. Visual image interpretation and field surveys were the methods employed to analyse and map the drainage patterns.

The drainage system of the park includes the rivers Dinder and Rahad, their tributaries and Mayas (wet meadows). Mayas are a special feature of the drainage system, straddling low-lying basins, river meanders and oxbow lakes. They are the major source of water and green fodder during the dry season (November-June). The spectrum runs from. Young productive wet Mayas to old non-productive dry ones. During the past 2 decades and due to the decrease in the amount of river discharge and rainfall, coupled with repeated fires, the catchment areas of Mayas have deteriorated drastically causing many of them to silt up to almost complete dryness. Perennial grasses, for example, have been substituted by annuals. The water and food supply available to wildlife has thll,S decreased greatly. The study assessed the present condition of Mayas and suggested possible means for improvement and restoring the natural storage capacities of some Mayas.

The role of some wild and domestic mammals in the transmission of *Leishmania donovani*

Sara Abdalla Khidir Saeed

Science, Zoology

Msc. Thesis, University of Khartoum, 2009

In view of the increasing needs to gain knowledge about the transmission and the risk factors of visceral leishmaniasis in an endemic area in eastern Sudan, this study was conducted to investigate the zoonotic transmission in some villages near the River Rahad and the Dinder National Park. The objectives of this study aimed at identifying probable reservoir hosts for visceral leishmaniasis among some wild mammals in addition to a number of domestic ones, to study the sandfly fauna attracted to the most abundant wild and domestic mammals in the area, and to determine the risk factors contributing to VL transmission indoor. Twelve villages along Rahad River and the Dinder National Park were selected to perform this investigation during 2006-2008. A total number of 101 wild and 124 domestic mammals were screened for the presence of *L. donovani*. Four PCR protocols were used for the detection of *L. donovani* DNA in tissue and blood samples from these animals. The direct agglutination test (DAT) was used for screening for the presence of anti-*Leishmania* antibodies. The responsibility of wild and domestic animals in disease transmission was also investigated using these animals as baited traps to know the ability they exert to pull vectors. Residents who live in close association to domestic animals were surveyed in 4 villages Tabldia, Umsalala, Umkakar, and Bello, using questionnaire forms. The Parasite DNA was evident in wild animals belonging to five species: Namely the Egyptian mongoose *Herpestes ichneumon*, the Spiny mice *Acomys albigena*, the Nile rat *Arvicanthis nilotus*, the Black rat *Rattus rattus*, and the African wild cat *Felis silvestris*. The peripheral blood samples obtained from the domestic mammals showed the presence of *L. donovani* DNA in 8 out of 32 cows (25%), 6 out of 31 donkeys (19.4%), and in 2 out of 30 goats (6.7%), but the sheep were negative for PCR. The animal-baited traps attracted a trustworthy number of two *Phlebotomus* and five *Sergentomyia* species. The domestic animals showed higher attractiveness to sandflies compared with the wild ones. The fed sandflies were isolated and subjected to PCR using 4 species specific primers for *L. donovani*. The presence of parasite DNA was documented in 11 out of 199 (5.5%) of *Phlebotomus orientalis* (the formerly known vector of

L. donovani in Sudan). The study reported the presence of parasite DNA in 7 out of 102 (6.9%) of *Sergentomyia clydie*, 9 out of 87 (10.3%) of *S. schwelzi*, and 2 out of 17 (11.8%) of *S. antennatus*. The primer targeting kinetoplast (mitochondrial) DNA (RV1-RV2) was found to be unparalleled in comparison to the other primers. The Direct agglutination test (DAT) was applied to pick out anti-*Leishmania* antibodies, the test verified positive titers (X05; 1/3200) in all the Egyptian mongooses tested, in 35% of spiny mice, in 33.3% of the black rats, and in 25% of the genets examined. Domestic animals showed positive DAT titers in 64.5% of the donkeys, 12.5% of the cows, 13.3% of the goats, and 9.7% of the sheep inspected. The present study showed a significant connection between keeping some of these domestic animals within houses to VL infection (χ^2 -test, P value <0.05). The existence of sheep showed significant values in the four selected villages in connection with the VL cases. The presence of goats and donkeys showed significant values in only two villages. On the other hand, cows, dogs, camels, and the domestic birds did not demonstrate association to VL infection. This study suggests the possibility of various among species of wild as well as domestic animals to harbor the parasite and hence play a central role in the transmission. Consequently, this may hinder our elucidation of disease dynamics. Moreover, the present study may propose the involvement of some domestic animals in the transmission of VL either directly by harboring the parasite, or in some way, by attracting added flies to the houses. Finding traces of parasite (DNA) for the first time in *Sergentomyia* should revolutionize the upcoming clarification of the transmission of VL in eastern Sudan.

Genetic diversity and population structure of *Phlebotomus orientalis* (Diptera: Psychodidae) from selected regions in Sudan

Mona Siddig Mohammed Numairy

M.Sc. Thesis, University of Khartoum, 2009

In Sudan, *Phlebotomus orientalis* is the principal vector of *Leishmania donovani* in the active foci of visceral leishmaniasis in eastern and southern Sudan. Therefore, the present study was carried out to investigate the genetic diversity of five natural populations of *P. orientalis* based on polymorphism analysis of RAPD-PCR loci. *Phlebotomus orientalis* were collected during 2006-2007 from Dinder National Park (DNP), Rahad River area (RH), Atbara River area (ATB), White Nile area (WN) and Surogia village (SR). The genomic DNA was extracted from each individual fly and then the DNA specimens were identified using specific primers. Also, females of *P. orientalis* from the five geographic regions were screened using RAPD-PCR. In this study, eleven sandfly species were recorded. All samples amplified using diagnostic-PCR were found to contain a band size 675 bp which specific for *P. orientalis*. Of 30 RAPD primers used in this study only four produced different banding pattern within and among the populations of different regions. Two common bands at 300 bp in all populations of *P. orientalis* were produced by two different RAPD primers. Population of DNP showed the highest number of genotypes (62) whereas WN population showed the lowest number (9). In contrast, the WN population produced the highest number of fragments (717) whereas ATB population produced the lowest number (112). The population of each site showed characteristic diagnostic bands by all RAPD primers; the exception was the population of RH. Moreover, populations *P. orientalis* showed different level of diversity at the RAPD loci ($P\% = 93\%-41\%$; $HE = 0.13-0.17$). Moreover, Dice coefficient showed high similarities between the populations of DNP, RH and SR whereas, the populations of WN and ATB showed low similarities to the other populations. Hierarchical clustering method for *P. orientalis* populations obtained by each RAPD primer and all RAPD primers showed clear clustering of these populations based on their geographic origin. Results obtained by Mantel test showed that no correlation between the genetic of the Populations and the geographic distance of collection sites in Sudan. The results obtained by AMOVA test on the genetic structure of *P. orientalis* showed a high proportion of variation between individuals of *P. orientalis* (95.7%) and moderate proportion of variation among groups

with populations (4.3%) and among populations (1.6%). The fixation index (F_{ST}) estimated by AMOVA test showed low genetic difference between the population of *P. orientalis*. Further work is needed to sequence the diagnostic DNA fragments of each *P. orientalis* populations obtained in this study which will give more information on the magnitude of the genetic variation among these populations.

**An Ecological Study of the Dinder National Park with Special Reference to Regeneration
Potential of *Acacia seyal* & *Balanites aegyptiaca***

By:

Gawahir Mohamed Dongola

M.Sc. Thesis, University of Khartoum, 1985

Abstract *Acacia seyal* and *Balanites aegyptiaca* constitute the major woody components of the natural vegetation in Dinder National Park. The objective of this work is to document some aspects of the ecology and regenerative potential of these two species. The study included treatments that simulate some factors that operate on seeds and influence their germination in the natural habitats. Mechanical scarification treatment which represents natural agencies of testa/pericarp decay gave the best responses in terms of percentage germination. Under field conditions, the seeds of *A. seyal* and drupes of *B. aegyptiaca* are exposed to periodical soaking in rain water, and to the effects of gastric acids when grazed by herbivores. Pre-soaking seeds in running water, stimulated high percentage germination. Promotion of germination through pretreatment with concentrated sulphuric acid produced results that are in agreement with earlier findings. Though not encountered in nature, some selected chemicals such as Gibberellic acid, thiourea, potassium nitrate solution, enhanced germination percentage by virtue of their corrosive action. The effects of frequent outbreaks of fire in the Dinder National Park upon germination have been tested in a number of experiments involving three arbitrary fire intensities : light, moderate and severe. The favourable responses to light/ moderate fire manifest on higher percentage germination. Excessively hot fires (above 330°C for *A. seyal* and 220°C. For *B. aegyptiaca*) presumably inflicted lethal damage on embryos and hence prohibit germination. Seasonal temperature appear to influence the rate of vegetative development of *A. seyal* seedling. Their performance in terms of shoot increment is best during summer time, autumn is average while winter imposes retarded growth. Seasonality does not seem to influence the rate of growth of *B. aegyptiaca* seedlings.

Studies on Sandflies, Transmission and Reservoir Host Of Visceral

Leishmaniasis in Eastern Sudan

By:

Mo'awia Mukhtar Hassan Abdalla

Msc. Thesis, University of Khartoum, 2004

The study described in this thesis has two components (1) Field work component conducted during June 1999 to July 2003 in Dinder National Park (DNP) and some villages along rivers Rahad and Atbara areas in eastern Sudan (2) Laboratory component performed at: Centre for Applied Parasitology and Entomology, Keele University, U.K, Faculty of Science and Institute of Endemic Diseases, University of Khartoum and National Malaria, Schistosomiasis and Leishmaniasis Administration, Federal Ministry of Health, Sudan. In this study entomological investigations and studies on the reservoir hosts of visceral leishmaniasis were conducted. The entomological investigations on the prevalence of *P. orientalis* in villages of river Rahad area and Atbara river area included transmission of the parasites and the infection rates of *Phlebotomus orientalis* with *Leishmania donovani* in villages and woodland of DNP. Sandflies were collected using light traps set at outdoors sites between 18:00-06:00 hrs. The results of this work indicated that the vector was prevalent in all villages investigated in the rivers Rahad area and Atbara. The infectivity of the vector was investigated using the Polymerase Chain Reaction (PCR). The study showed the presence of infected flies in villages in river Rahad area with an average infection rate of 1.6% of *L. donovani* in *P. orientalis*. However, infection rates of the parasites in the vector in woodland of the Dinder National Park (DNP) were done by both PCR and direct microscopy. The results showed an active focus of zoonotic transmission of *L. donovani* in the uninhabited site of DNP; this was demonstrated by finding the parasite in 3.4% (7 out of 184) and 3.2% (5 out of 157) of flies collected in March 1998 and May 1999, respectively. Attempt of establishment a functional colony of *P. orientalis* was conducted during June-September 2003. Females *P. orientalis* were collected from DNP using light traps and human bait techniques. The flies were transported to the insectary of the National Malaria, Schistosomiasis and Leishmaniasis Administration, Ministry of Health, Khartoum. The flies were maintained under the laboratory condition at temperature 25 oC and humidity of 75-90%.

Loss in different stages and their developmental time were investigated. Significantly, more loss was observed in the first instars larva than other stages (28.3 ± 5.66 ; $P < 001$). The whole life cycle of *P. orientalis* from oviposition to emergence of adult was found ranging between 48-60 days. Host preference study based on attraction of *P. orientalis* and other sandfly species to different animals was conducted in UmKura'a Warden Camp. Inverted light traps with bulb were hanged above animal cage between 18:00-06:00 hrs to collect sandflies attracted to different animal traps. The results showed clear preference of the *P. orientalis* to dogs (228.8 ± 53.5) compared to mongoose (*Herpestes ichneumon*) (63.88 ± 12.08), genet (*Genetta genetta*) (17.4 ± 3.72), and Nile rat (*A. niloticus*) (2.6 ± 0.56) ($P < 0.001$). However, all sandfly species collected were found attracted to the dog baited traps ($P < 0.001$) except *S. bdfordi* and *S. antennata*. Investigations for incrimination of a possible reservoir host (s) of *Leishmania* were conducted in two zoonotic foci of visceral leishmaniasis (1) Dinder National Park (DNP) and (2) Peri-domestic habitats of adjacent villages of eastern Sudan. The study included investigation of wild animals. Different traps were used for capturing animals including, animal cages, large spring traps (for carnivores), and multi-live trap, locally made faraneep (rats) and active chasing (for ground squirrels). Samples from spleen, liver and skin were taken from 250 and 254 during 1999 and 2000 respectively. Samples were kept in Isopropanosl for subsequent PCR and on glass slides for microscopy. Animals were captured, in March-November 1999 and April-June 2000 and examined for *L. donovani* infection using microscopy and two sensitive Polymerase Chain Reaction (PCR) systems. Infections of *L. donovani* were detected in 2 out of 14 Egyptian mongooses (*Herpestes ichneumon*), 1 out of 168 *Arvicanthis niloticus* and 1 out of 8 *Mastomys natalensis*. Samples from 68 other wild animals captured from the study area were all negative for *Leishmania* infection. The role of the domestic dogs (*Canis familiaris*) for the transmission of VL was investigated in the River Rahad area. Cross-sectional surveys were done during May 2002 to investigate the infection rates of *Leishmania* parasites in dog populations. A longitudinal survey was done to study the variation in the seroprevalence of VL infection among the dog populations in the area using the Direct Agglutination Test (DAT) during three different transmission seasons; November 2000, May 2001 and May 2002. For the infection rates study blood samples and lymph node aspirates were taken on filter papers Whattman No 3 for serology and subsequent PCR. Lymph node aspirates were prepared on glass slides for microscopy. The blood samples ($n = 87$) and lymph nodes ($n = 36$) collected during May 2002 were subjected to

PCR. However, blood samples collected during the May 2002 were subjected to both DAT and FAST tests. The presence of anti-Leishmania anti-body for the season May 2002 was tested by freeze-dried dog-DAT (KIT, Amsterdam). The seasonal seroprevalence were tested using DAT antigen prepared in Khartoum. The results revealed one positive blood samples out of 20 samples tested by PCR, whereas, lymph node aspirates samples showed negative results. The results of the serological investigations were found to be 6.9% for DAT and 51.7% for FAST test for the blood samples collected during May 2002. The results of the serology tests showed high exposure of the dogs to *L. donovani*. The microscopic examination showed no parasites in the lymph node aspirates. The seasonal seroprevalence studies revealed no significant differences in DAT positivity between the seasons of November 2000 (7.1%), May 2001(7.1%) and May 2002 (9.1%) ($\chi^2=0.259$; $P<0.878$). The result of a socio-economic questionnaire showed that the Masaleet people compared to other tribes mostly possessed dogs.

The Biology of the Reedbuck (*Redunca redunca* Pallay,1764) in Dinder National Park

By:

Mohammed Adam Mohammed Ahmed

Msc. Thesis, University of Khartoum, 2006

Field observations were made in the Dinder National Park to study the biology of reedbucks *Redunca redunca* and their interaction with other animals. Their feeding behaviour, breeding behaviour, sex ratio, group size, morphometric measurements, and other daily and seasonal activities were recorded. Observations were also made of the movements of the reedbuck and other species of animals, in the Park during the dry and rainy seasons of the year. In the dry season animals were found in the center of the park around water pools where green fodder and water were available. In the rainy season water and green fodder were available all over and outside the border of the Park and as a result animals tend to scatter to higher lying grounds. Animals made no regular migrations but they spread in all directions and in all localities within the Park and beyond. Ostriches seemed to be the only exception, because they migrated in large groups to the northern borders of the Park. Further study is needed to incorporate these observations.

On the Biology, Behavior and Taxonomy of some Sudanese Cyclops

(Craustacea: Copepoda)

By:

Gihan Mahmoud Edris Sharif

Msc. Thesis, University of Khartoum, 2002

In this survey, cyclopoid Copepods have been collected from six study sites: Dali, Mazmum, Wau zone, Western Sudan, Dinder National park and from various areas in Khartoum zone, during the period Feb 2001 -March 2002. Four of these areas namely Dali, Mazmum, Wau and western Sudan were endemic with Dracunculiasis. The aim of this research is to study the biology, behaviour and taxonomy (identification) of some cyclopoid Copepods of the Sudan. Almost 80 % of all Dracunculiasis cases have been reported from this country (at 2002). Seventeen genera and species of Cyclops were identified. The dominant genera found in Sudan were Mesocyclops and Thermocyclops. Mesocyclops aspericornis is the dominant species. It appears that Sudanese fresh water is very rich in cyclopoid Copepods. The life cycle of some Cyclops species was determined, besides studying many other phenomena, e. g. aestivation and parthenogenesis. Susceptibility tests were carried out to determine the LD 50 and LD 90 using the Cyclopicide "abate". These tests were complemented by using aquatic predators i. e. the Fish "Cyrinus carpio" and the dragonfly nymph *Crocothemis erythraea* as biological control agents. Three species and genera are suggested to act as vectors of Dracunculiasis in Sudan: Mesocyclops aspericornis, M. kieferi and species of the genus Cryptocyclops. This work is backed or supported by 4 appendices pertaining to the biology of Cyclops and guinea worm.

**Colonization, Biology and Insecticide Resistance of *Phlebotomus papatasi* (Scopali, 1786)
(Diptera: Psychodidae) in Some Areas in Sudan**

By:

Sally Osman Widaa Osman

Msc. Thesis, University of Khartoum, 2009

This research was carried out to study for the first time the colonization, the biology and to collect first baseline data on susceptibility status of *Phlebotomus papatasi* in Sudan. Samples of *P. papatasi* females were collected from Surogia village (Khartoum State, Sr), White Nile forest (White Nile State, WN) and Dinder National Park (Gedaref State, DNP) using both light and sticky oil traps. A colony of *P. papatasi* was established using standard protocols for rearing sandflies. The investigations on *P. papatasi* resistance to four insecticides (DDT, permethrin, malathion and propoxur) were carried out using WHO susceptibility test. Also a biochemical analysis was conducted to investigate the activities of four enzyme systems involved in insecticide resistance (acetylcholinesterase (AChE), non-specific esterases (EST), glutathione-S-transferases (GST) and cytochrome p450 monooxygenases (Oxy)). The total collection of sandflies by both light traps and sticky oil traps methods from Sr was 1373 flies. The species collected consisted of four *Phlebotomus* and seven of *Sergentomyia* species. Three species were formed the bulk of the total catch, *S. Clydei* (26.8%), *P. papatasi* (24.2%), and *S. antennatus* (17.7%). 3.1% of the specimens were identified as *P. orientalis* and (0.6%) as *P. rodhaini* and this is the first record of *P. orientalis* and *P. rodhaini* in northern Sudan. The observations on the colonized *P. papatasi* revealed that survival rates in immature stages increased in ascending order as the immature stages developed. The productivity of the wild *P. papatasi* females was 50.9. A total of 3001 eggs were produced by *P. papatasi* during seven generations (F1-F7), the minimum and maximum number of eggs were produced by F2 and F6, respectively. Significant difference was observed among the number of eggs laid by females, numbers of retained eggs and of the hatched eggs in the seven generations. The eggs hatching rates was at its highest rate in F3 and F6 and its lowest rate in F2. The mortality rates in the immature stages were found to decrease in a descending order from eggs to pupae. Result obtained on whole life cycle of *P. papatasi* showed that development time from oviposition to adult eclosion was found to be ranged

between 23-76 days. However, significant differences were observed in the pre-oviposition time, 1st larval instar, 2nd larval instar, 3rd larval instars, pupae and the whole life cycle durations of *P. papatasi* when compared for seven generations ($P = 0.000$). The average numbers of the eggs laid by a single female was between 10-85 eggs. The female *P. papatasi* was found to undergo only one gonotrophic cycle although it took a second blood meal but without laying eggs. The longest live of the females was found up 19 days in the oviposition vial under insectary conditions when they were supplied with a blood meal and sucrose solution. The results of the WHO susceptibility test showed that *P. papatasi* from WN and DNP were highly susceptible to the four insecticides (100% mortality after 24hr exposure). *Phlebotomus papatasi* from Sr was highly susceptible to DDT and Permethrin (100% mortality) but highly resistant to Propoxur and Malathion (1% and 7% mortality rates, respectively). The biochemical analysis for *P. papatasi* from Sr showed that no elevation in three enzymes systems (EST, GST and Oxy) with exceptions of only three samples. The statistical analysis revealed that there was no significant difference when they compared with susceptible population from DNP. An evidence for insensitive AChE as a first report of such resistances in sand flies in Sudan was observed in the Sr population. A significant difference was observed in the activities of AChE from Sr when it compared statistically with DNP. Also, 51% of *P. papatasi* from Sr was homogenous resistance allele (RR) with high frequency (0.88) which revealed that the sandflies resistance phenotype to Organophosphorus (OP) and/or carbamate insecticides.

**Study on some ecological aspects and parasites of bats in the area around
Khartoum and Dinder National Park**

By:

Mohammed Ali Omer Rahoum

M.Sc, Thesis, University of Khartoum, 1985

Twelve species of bats from the fourteen species obtained from the area around Khartoum and the Dinder National Park are reviewed. The species obtained include, *Epomophorus laviiformis*, *Ehinoroma microphyllum*, *R. hardwickei*, *Taphozous (Taphozous) perforatus*, *T. (Liponycteris) nudiventris*, *landerii*, *Lavia forns*, *Rhinolophus landeri*, *Asellia tridens*, *Chearephon) major* and *T. (Mops) Midas*. Sexual dimorphism and the geographic variation between the species the presented. An attempt has been made to study the breeding time of *T. (Lj. ponycteris) nudiventris*. The result of the helminthological examination of 134 bats belonging to 12 different species, *E. labiatus*, *R. microphyllum*, *R. hardwickei*, *T. (T.) perforatus*, *T. (L) Liponycteris*, *landerii*, *Q. variegata*, *Q. argentata*, *nigritas*, *T. (M.) major*, *(Lj.) midas*; are presented. And analysed. The revealed helminth parasites include trematodes of (*P.*) *Khqiili*, *Lecithodendrium clubosi*, *Paraieci*, *thodendrium* and *sanguineum*; a hymenolepidiid cestode, *Vampirolepis*, *E.* and nematodes of the order spiruredeae *Tiectulari*. *D.* ified specimens of the family *icuariidae*; a trichostrongyliid nematode *Capillaria* sp. are reviewed. The present studies also include the incidence and density of infection as well as the effect of the locality and host in the distribution of helminthes parasites.

**Ecological Studies on Phlebotomine Sandflies (Diptera, Psychodidae) of Surrugia Village
(Khartoum Province) and Dinder Park, (Blue Nile Province) Sudan**

By:

Sumaia Mohamed El Sayed

M.Sc, Thesis, University of Khartoum, 1990

An attempt was made in the present work to study some ecological aspects of Phlebotomine sand flies in Surrugia village/Khartoum Province and the Dinder National Park/Blue Nile Province. Sixteen species were recorded in the two areas of study, four *Phlebotomus*, and twelve *Sergentomyia*. A list of species in the two sites has been provided. A briefing of the biology, ecology and medical importance of the species encountered, was made. Encountered structural abnormalities in *P. papatasi*, *S. antennata* and *S. clydei* were described and illustrated. Updated distribution maps of the sand fly fauna of the Sudan have been given. Studies on distribution showed that the collected sandflies belonged to the species of the Ethiopian region and some of them with affinities to the Palaearctic region. Three species of *Sergentomyia* and one species of *Phlebotomus* were collected from Khartoum, with *P. papatasi* the most dominant. Some more ecological evidence has been added to incriminate *P. papatasi* as the probable vector transmitting cutaneous leishmaniasis in Khartoum Province. Twelve species of *Sergentomyia* and four species of *Phlebotomus* were collected from Dinder area, with *Sergentomyia* species the most dominant. *P. martini* has been incriminated on circumstantial and ecological, evidence as the probable vector visceral leishmaniasis in Dinder area . The prevalence of sandfly species has been discussed in association with prevailing climatic factors and vegetation. More species were found in Dinder area where the climate is Tropical and continental. Fewer numbers of species were found in Khartoum where the climate is semi-arid. Most of the sandfly species were found associated with termite mounds. These are probably the most important resting and breeding sites in Dinder area. Khartoum sand flies show two peaks of population densities, one in April - June and the other in September - November. *P. papatasi* and *S. clydei* were found to be "non- -seasonal species in Khartoum. *P. papatasi* in Khartoum bites man shortly after sunset, through the night, until few hours after dawn. Peak activity is during the first half of the night. The number of flies caught by oil traps outdoors were more than by other collection method, but most

of them were males. Trapped indoors yielded more females than males. , Host preference of *P. papatasi* has been determined by blood meal identification *P. papatasi* was found to prefer man, dog, mouse and the least preferred was the cat. Of the sand flies dissected none was found to be infected. Engorged females of *P. papatasi* were collected and made to initiate a laboratory colony and to cycle. Larvae from eggs laid in the laboratory reached the fourth instar and failed to pupate. Description of the egg to the fourth instar larva were made. Susceptibility test with the discriminating dose of DDT (4 %), Fenitrothion (1 %) and malathion (5 %) confirmed the susceptibility of *P. papatasi* to those insecticides. Acute toxicity test showed that the 24-hour LC50 of DDT against Adult *P. papatasi* was 1.04 %, the LT50 of 1 % Fenitrothion was 41 minutes, and LT50 of 5 P. *papatasi* was 16 minutes. Toxicity tests with DDT suggested that *P. papatasi* is very liable to develop resistance to DDT in the near future.

Study on some ecological aspects and parasites of bats in the area around

Khartoum and Dander National Park

By:

Mohammed Ali Omer Rahoum

M.Sc, Thesis, University of Khartoum, 1985

Twelve species of bats from the fourteen species obtained from the area around Khartoum and the Dinder National Park are reviewed. The species obtained include, *Epomoporus Laviaforms*, *Ehinoroma microphllum*, *R.hardwickei*, *Taphozous (Taphozous) perforatus*, *T. (lipenycteris) nudiventris*, *landerii*, *lavia forms*, *Rhinolophus landeri*, *Asellia tridens*, *Chearephon (major)* and *T. (Mops) Midas*. Sexual dimorphism and the geographic variation between the species the presented. An attempt has been made to study the breeding time of *T. (Lj.ponycteris) nudiventris*. The result of the helminthological examination of 134 bats belonging to 12 different species, *E. labiatuq*, *R. microphyllum*, *R. hardvlickei*, *T. (T.) perforatus*, *T- (L) Iip.dlyrentris*, *li. lcnderi*, *Q. variegata*, *Q. argent at, nigri. .tas. T. (M.) major, (li-) midas*; are prescnted. And analysed. The revealed helminth parasites include trematodes of (*P.*) *Khqiili*, *Lecithodendrium cluboj.si*, *Paraieci th- odendrium* and *sanguiheum*; a hymenolepidiid cestode, *Vampirolepis*. *E.* and nematodes of the order spiruredeaJ *TlectulariD. ified* specimens of the family *icuariidae*; a trichostronr *yliidnemcatode* *Capillaria* sp. are reviewed. The present studies also include the incidence and density of infection as well as the effect of the locality and host in the distribution of helminthes parasites.

Vegetation Dynamics in the Major Mayas of the Dinder National Park (Sudan)

By:

Abdel Karim Sabir Ali

M.Sc, Thesis, University of Khartoum, 1986

The Dinder National Park consists of a large number of: Mayas (grassy meadows) which provide essential fodder for the game that inhabits the Reserve. The herbaceous vegetation of eleven different productive Mayas and two degenerate Mayas (gudahas) has been studied in the present work. The results showed that the zonal pattern of vegetation is dominated by particular plant species whose soil moisture affinities are met within particular rings. The responses of these species to availability of moisture reflect upon their ecological behavior in terms of several aspects of vegetative performance. Sufficient moisture stimulates best indices while low soil moisture poses problems indicative of poor performances. The crucial role of soil moisture in the development and vigour of vegetation has been emphasized and. the beneficial impact of supplementing moisture has been verified. Several recommendations have been put forward for the benefit of management of this National Reserve.

Phlebotomine Sandflies (Diptera: Psychodidae) and their Role in Transmission of Visceral Leishmaniasis (Kala-Azar) in an Endemic Focus in Eastern Sudan

By:

Hassan Kamal El Din Hassan

M.Sc, Thesis, University of Khartoum, 1996

A field and laboratory study was carried out at Umsalala village (Galabat Province) and Dinder National Park (Dinder Province) during the period November 1993-August 1995, to investigate some ecological aspects of the sandflies and their relation to the transmission of visceral leishmaniasis in the area. The sandfly species found at Umsalala village were *Sergentomyia schwetzi*, *S. clvdei*, *S. antennata*, *S. africanus*, *S. quamipleuri*, *S. phlebotomus*, *S. orientalis*, *P. papatasi*, *P. rodhaini* and *P. saevus*. With the exception of *P. saevus*, all these flies were found in the Dinder area. Whereas *Sergentomyia* sandflies were abundant in most habitat investigated, phlebotomine sandflies were more or less restricted to specific locations, with *P. orientalis* and *P. rodhaini* being prevalent in the forest of the Dinder area and *P. papatasi* and *P. saevus* found in the village.

The species of sand flies found biting man in the area were *P. orientalis*, *P. papatasi* and *P. saevus* comparing the abundance of sandflies in different vegetation. *P. orientalis* showed high association with the *Acacia* sycal vegetation comparing to other types of ecosystems characterized by the presence of *Balanites aegyptica*, *Combritllm* cardamom trees and the riverine vegetation. Tennite mounds were the only resting site detected for this species in the area, other sandflies were found rested mainly at indoor sites, soil cracks, chicken coop and tree holes. *Phlebotomus orientalis* reached its maximum number at the end of the dry season and the beginning of the rainy season, other sandflies were either seasonal or non-seasonal ones. Although *P. orientalis* was generally active at mid night, its biting activity was at its maximum immediately after sunset. For the first time, using the enthrone test, *P. orientalis* was detected to feed on fructose-sugar in the Dinder wood-land with similar frequency at different geomorphic stages of the females and age of the males and different time interval of the night investigated. Trails to isolate the parasite from the flies were hampered by fungal and bacterial contamination of culture and insusceptibility of Siwss albino mice. The Lmet-2 DNA probe showed that general

infection rate of *Leishmania donovani* in *P. orientalis* in Dinder area was 4.9%. The rate fluctuated at different seasons. In the dry season the infection rate was at its maximum, 6.9%. This rate dropped at the beginning of the rainy season to 3.5%

**A Study on Sandflies, Transmission and Control of Visceral Leishmaniasis
in Eastern Sudan**

By:

Moawia Mukhtar Hassan

M.Sc, Thesis, University of Khartoum, 1998

A field study was carried out, during the period June 1997-March 1998, in the Dinder National Park (D.N.P., Dinder Province) and the adjacent village's of Bellow, Ein-Elgamel and Umsalala (Galabat Province, Gedarif State, eastern Sudan) to investigate the ecology of transmission of visceral leishmaniasis (VL, kala-azar) and evaluate the effects of a pilot bednet project in control of the disease. In a preliminary investigation, work was done to compare efficiency of CDC light traps equipped by different light filters and sticky paper traps coated by different oils in collection of sandflies. The sandflies found in the area were *Phlebotomus orientalis*, *P. rodhaini*, *P. papatasi*, *P. bergeroti*, *P. duboscqi*, *Sergentomyia bedfordi*, *S. schwetzi*, *S. clydei*, *S. africana*, *S. squamiplueris* and *S. antennata*. Resting sites of different sandfly species were determined using sticky paper traps placed on soil crack, termite mounds and exits of animal burrows. Colour and intensity of light was found to affect the sandfly yield of height traps. The most attractive lights to sandflies were the white (Norma) and the yellow light (450nm wavelength) as compared with the sky, blue (670 nm), the sunset red (750 nm), the blue-green (720 nm), the green (670 nm), and the orange (530 nm) colours and negative control (no light). It was also observed that light traps placed at 1/2 metre above the ground collected more sandflies than light traps placed at elevations of 1 and 2 metres. Comparing collections made by sticky paper traps coated with different oils it was noticeable that castor oil is more attractive to sandflies than sesame and petroleum. From human -Landing collections and dissection of sandflies further evidence was obtained that the only vector of VL in the area is *P. orientalis*. This sandfly species was found to be more abundant in the D.N.P woodlands than in the villages. A high infection rate of promastigotes (3.68%) was observed by dissection and Phase Contrast Microscope examination of *P. orientalis* collected from DNP in March 1998. No similar infections were seen in females of the vector collected from the villages in the same month. However, in earlier attempts made in July 1997, a heavy infection of *L. donovani* in a female *P.*

orientalis collected from Umsalala village was confirmed by microscopy and DNA techniques (Polymerase Chain reaction, PCR). A socio-economic questionnaire format was used to investigate some of the risk factors of acquiring kalazar. As the susceptible populations (children) were found spending most of the evening time in the villages, it was inferred that although the risk of infection is higher in the surrounding woodlands, most of the cases of the disease are acquired within the villages. Results of a follow up of an ongoing insecticide-impregnated bednet project in Bellow and Ein Elgamel villages indicated that this method may provide an efficient method for control of the disease. Significantly less proportions of cases with VL were observed in these villages as compared to Umsalala village in which no insecticide-impregnated bednets were used. Interestingly, higher proportions of sub-clinical infections of *L. donovani* in the villages using the bednets, indicating that the method reduces the morbidity of the disease, rather than the general incidence of infection.

**The Polymerase Chain Reaction as Tool of Molecular Diagnosis of
Leishmania Infection in the Sudan**

By:

Amna Osman Yousif Hashim

M.Sc, Thesis, University of Khartoum, 1997

Leishmaniasis, manifesting on its different clinical forms is endemic in different regions of the Sudan. Diagnosis of the disease in the Sudan is usually done by simple methods such as microscopically examination of slit smears, histological sec and cultures. Serological diagnosis using enzyme linked immunosorbent assay, (ELISA)- and direct agglutination test (DAT) is sometimes used as more sensitive methods. The use of the polymerase chain reaction (PCR) as a molecular diagnostic tool has thrown light on the epidemiology of the disease in the Sudan. This study was conducted on 126 subjects to identify the parasites-causing different clinical manifestations, to determine the genetic diversity of different isolates of Leishmania and to detect parasites in the peripheral blood of subjects from the endemic foci. The study population consisted of 7 with suspected VL, 12 suspected ML, 14 with suspected PKDL, 2 with suspected sporotrichoid CL and 89 healthy game wardens and army soldiers from highly endemic foci. Parasites were cultured in biphasic medium and subcultured in liquid medium until mass production was stabilized. Extraction of DNA was done using methods which were phenol/chloroform / isoamylalcohol, K buffer and protein, as well as lysing of the parasite with distilled water The KDNA was amplified using species namely AJS1 and DeB8. The products were analyzed on 1.5% agarose gel-and were visualized and photographed with 1 transilluminator and camera. Characteristic bands of 700 and 800 b .p corresponding to the full length of minicircle of L. major and L. donovani respectively were obtained on amplification of KDNA from patients with VL and CL. In some cases lower bands of 400 and 50 were obtained for amplified VL and CL KDNA. Double bands of 800 and 600 b PKDL and multiple bands for sporotrichoid CL. Leishmania DNA was detected the conjunctiva of the eye of a patient with PKDL. The genetic diversity of Leishmania parasite was determined by digesting product from PKDL, sporotrichoid CL and VL patients. Different patterns produced for each digesting product. This result indicates that there is heterogeneity among isolates producing products of 800

bp. The data from the Dinder National Park showed that Leishmanin skin and K39 dipstick may be useful as endemicity marker in these areas. PCR detect, *L. donovani* on patients peripheral blood who displayed a wide clinical spectrum including healthy individual of both Leishmanin negative and positive, active Kala-azar cases as well as previous Kala-azar patients. The study has shown that different isolates of *Leishmania* cause the different clinical forms and there is an indication of heterogeneity among isolates causing PKDL and spotrichoid CL.

**On the Biology, Behaviour and Taxonomy of Some Sudanese Cyclops (Crustacea:
Copepoda)**

By:

Gihan Mahmoud Idris Sharif

M.Sc, Thesis, University of Khartoum, 2002

In this survey, cyclopoid copepods have been collected from six study sites: Dali, Mazmum, Wau zone, Western Sudan, Dinder National Park and from various areas in Khartoum zone, during the period February 2001 - March 2002. Four of these areas namely Dali, Mazmum, Wau and western Sudan was endemic with Dracunculiasis. The aim of this research is to study the biology, behaviour and taxonomy (identification) of some cyclopoid Copepods of the Sudan. Almost 80 % of all Dracunculiasis cases have been reported from the country at 2002. Seventeen genera and species of Cyclops were identified. The dominant genera found in Sudan were Mesocyclops and Thermocyclops. Mesocyclops aspericornis is the dominant species. It appears that Sudanese fresh water is very rich in cyclopoid Copepods. The life cycle of some Cyclops species was determined, besides studying many other phenomena, e.g. aestivation and parthenogenesis. Susceptibility tests were carried out to determine the LD50 and LD90 using the Cyclopicide "abate". These tests were complemented by using aquatic predator's i. e. the Fish *Cyprinus carpio* and the dragonfly nymph *Crocothemis erythraea* as biological control agents. Three species and genera are suggested to act as vectors of Dracunculiasis in Sudan: *Mesocyclops aspericornis*, *M. kiefert* and species of the genus *Cryptocyclops*.

Monitoring of Anti Leishmania Antibody Responses for Early Diagnosis and Prognosis of Visceral Leishmaniasis in Dinder National Park

By:

Husam Abdulrhman Mahmoud Noraldaim

M.Sc, Thesis, University of Khartoum, 2012

Introduction: Visceral leishmaniasis is a serious health problem endemic in many regions of Sudan .The outcome of leishmania infection depends on the infecting leishmania species and the host immune response .It is known that the majority of leishmania infected hosts remain asymptomatic. There is a little information available on the seroconversion and the outcome.

Materials and methods: A longitudinal prospective study was conducted for 12 months in Dinder National Park in central Sudan. The area is known to be highly endemic for VL.Wild Animal Guards in the Park were consented and recruited to the study. A total of 110 guards were tested in two surveys for detection of anti leishmania antibodies IgG, IgM, IgG1, IgG2, IgG3 and IgG4 were measured in serum sample collected from the participants using DAT and ELISA. Attempts to detect circulating leishmania DNA were done using PCR amplification of leishmania kDNA. Paired sample were obtained from 31 participants. Results: Forty- six guards were IgG positive during the period of the study using DAT while eighty-five were positive using ELISA. Two guards had antileishmania IgM detected by ELISA. Of the participants who were positive in IgG had dominate IgG subclasses sixteen had IgG1 ELISA, 38 had IgG2 ELISA, 12 had IgG3 and 3 had IgG4 ELISA

Conclusion: The majority of individuals exposed to leishmania infection develop asymptomatic infection. The infection induces IgM and IgG antibody responses. The role of the induced humoral response in protection and susceptibility against leishmania is not well defined. Further studies needed to investigate the evolution of antibody responses in leishmania.

دور الإدارات الحكومية ومنظمات المجتمع المدني في حماية البيئة

(دراسة حالة محمية الدندر القومية – محلية الرهد)

منى أحمد البشير علي

M.Sc, Thesis, University of Khartoum, 2007

This research aims to study the biological diversity and to discover the role played by the government and non-government organizations in the environmental protection of Dinder National park. This role is of special significance as the area is expected to be of great socio-economic value depending on its recreational resource potentialities. The hypotheses are suggested, and the study adopts the inductive together with the descriptive analytical methods. Field work data has been collected by such tools as direct observation, personal interviews and questioner. The work is presented in Chapters covering a theoretical from work on the concepts, principles,. And theories related to environmental organization and administration. The physical and human features of Dinder area are reviewed. The research has arrived at the main conclusion that some mal-practices have led to changes and transformations resulting in the deterioration of the biological diversity: the people, the government, and non-government organization are not doing enough in this respect. The study offers the following recommendations: To adopt the model to conserve and develop, To increase peoples environmental perception which helps achieving conservation and sustained development, To lie a plan for better administration and utilization of the wet lands in Dinder and To develop the recreational potential resources in order to a chive the high socio-economic gains promised by the Dinder National park. This research can lead us to the different development and put some aims in order to preserve the Kindness biological diversity the act.

هدفت هذه الدراسة إلى التعرف على التنوع الإحيائي بالمنطقة والى التعرف على الكيفية التي تتعامل بها الحكومة ومنظمات المجتمع المدني مع المشاكل البيئية في المنطقة ودورهم في تطوير العلاقة بين المحمية والمواطن وذلك لأهمية محمية الدندر وما يمكن أن تلعبه في المجال الاقتصادي والسياحي. ووضعت عدة فرضيات للتحقق من ذلك، ولإثبات صحتها أتبعته الدراسة بعض المناهج الجغرافية مثل المنهج الاستقرائي والمنهج الوصفي التحليلي، مستعينة في ذلك بعدة وسائل: أهمها الاستبانة والمقابلات الشخصية والملاحظة. وحسب متطلبات البحث اشتملت فصوله على إطار نظري يتطرق للمفاهيم والأسس والنظريات ذات الصلة بالمجتمع المدني والبيئة والمحيط الحيوي، ومن ثم توضيح الظواهر الطبيعية والبشرية في المنطقة، وكذلك التعرف على التباين الحيوي بالمحمية ومعرفة التغيرات والتحويلات التي طرأت عليها والإدارات الحكومية والمدنية

والمحلية العاملة في ذلك المجال وكيفية معالجتها للمشاكل المختلفة التي تتعرض لها سواء كانت طبيعية أو بشرية. ثم خلصت الدراسة الي نتائج مختلفة هي أن:- التدهور في التنوع الإحيائي بالمنطقة يعود لأسباب طبيعية وبشرية، ودور الإدارات الحكومية والمنظمات في معالجة هذا التدهور محدود ولا يمكن أن يحافظ عليها أو يطورها إلا إذا أعيد النظر في السياسات والخطط المنفذة. والخاتمة قدم البحث بنموذج مقترح لمعالجة المشكلة ووضع توصيات من أجل المحافظة علي التنوع الإحيائي بالمنطقة.

Human Impact on Wildlife Resources in Dinder National Park

By:

James Modi Kenye

Msc. University of Juba, 2001

Intricate villages' problems in Dinder National Park (DNP) still remain. There are eleven (11) villages with population of 3,255 people involving twenty-two (22) different tribes. Exact location of villages determined by Global Positioning System (GPS) instrument. Umkora village has largest population of all villages in the park. Masalit, Tagali, Fallata, Hosah and Gumus in descending order are numerous tribes in villages in the park. These tribes grow many food crops. Chief (Sultan) and Leader of Youth (Raisi Lajna) of each village provided data information to set of questionnaires. MEDECINS SAN FRONTIERES hospital in Umkora town helps citizen in villages in and outside park in treatment of Leishmaniasis (kalazar) and other diseases. Ten (10) Equatoria State Game Scouts serving in this park died due to this disease.

Animal count done by road transect count and numerous mammalian species in the park being baboon *Papio anubis*, reedbuck *Redunca redunca*, patas *Erythrocebus patas*, vervet *Cercopithecus aethiops* and buffalo *Syncerus caffer*. Human encroachment and settlement caused extinction of nine (9) wildlife species in DNP. More than 80 different avian species occur in studied Mayas and more bird species occur in Ras Amir, Grerisa and El Dabkora Mayas. These Mayas show high prominence value (PV) as have more order and family of birds. Nine hundred and eighty-five (985) livestock cases were attended in Dinder town court from 1985 - 1999 involving trespassing of man *Homo sapiens* and his livestock camel *Camelus dromedarius*, cattle *Bos indicus*, sheep *Ovis aries* and goat *Capra hircus*. Future existence of Dinder National Park is at mercy of villages and ill Mechanized Agricultural Schemes (MAS). The park will take its place if all villages are resettled outside elsewhere and MAS not involved in poaching. In wet season, poachers enter the park as most Game Scouts moved out of most Game posts due to stickiness of the soil being cotton-clay type and biting sandfly *Phlebotomus* sp. The park still has abundance and diversity in wildlife species. Patrols using camels and tractors advocated. Illegal livestock entrance in the park and poaching are major Wildlife Laws violation resulting from abolition of Rahad Game Reserve (RGR) and extension of the park engulfing ten

(10) villages along River Rahad. Livestock driven to Rahad and Butana in wet season and to Mayas in dry season and illicit fires caused by many factors.

Managerial problems in Dinder National Park include presence of villages, poaching, destruction of vegetation, illicit fires and vectors causing diseases. In my research period in the park, only a bushbuck *Tragelaphus scriptus* was preyed by a python *Python sebae* and cut bundle leaves of Dom Palm tree *H} phaene thebaica* were carried and thrown down by 3 intruders on camels near road to Grerisa Maya.

**The effect of competition between wildlife and domestic livestock
in natural range land of the Dinder national park**

By:

Sanad Suliman Bin Suliman

M.Sc, Thesis, University of Khartoum, 1987

This study was conducted during the period 1984 – 1987 at the Dinder national park, Sudan

The main objectives of the research work was to evaluate the impact of competition between wildlife and domestic livestock animals in natural range land during the dry season. The study was conducted on two groups of Mayas. The grouping was carried out considering the intensity of the grazing by domestic livestock during the dry season.

Group (A) includes Mayas which were protected against domestic livestock grazing during the dry season by enforcement of game scots around.

Group (B) component of Mayas which were heavily grazed by livestock during the dry season due to absence of game scout stations.

The study was designed to include determination of frequency percentage, plant density, cover percentage, age, productivity, available forage, estimate of number of wild animals, current yearly production, and animal preference.

Heavy grazing of domestic animals in some Mayas resulted in replacement of perennial grasses by annual species such as Sorghum. Mayas with high density of sorghum species attracted less Reedbuck. Availability of drinking water, absence of domestic livestock, less illegal human activities and high density of *Echinochloa stagnina* in Mayas increased the average utilization of these Mayas. Illegal human activities increased more during the last ten years especially in areas heavily grazed by domestic animals. Numbers of wildlife animals in Mayas heavily grazed by domestic animals were found to be the same.

Wildlife animals concentrated in Mayas protected by game scouts due to presence of domestic livestock and illegal human activities in other Mayas. This resulted in decreasing the number of wildlife animals due to shrinkage of their habitats.

*Seasonal Abundance and Diversity of Waterbirds at Eleven Mayas
in Dinder National Park, Sudan*

By

Esmat Elfaki ElHassan

M.Sc, Thesis, Sudan Academy of Science, 2003

This study was conducted in the Dinder National Park (DNP) during the dry season of 2009 and 2010. The study area was eleven mayas (wetlands) that were covered each year in the winter and summer. The objectives were to determine seasonal waterbird abundance, diversity and the effect of disturbance on these parameters.

Waterbirds were observed and directly counted in mayas with the help of telescope and binoculars.

The numbers and diversity of waterbirds fluctuated widely between years and seasons. The largest assemblage of waterbirds was observed in 2009, particularly in winter in which time palearctic migrants comprised most of the species richness recorded. Also some species moved locally between mayas.

Waterbird numbers were high in 2009, low in 2010. Furthermore, the numbers of waterbirds at each maya fluctuated from year to year depending on ecological conditions. More species richness and numbers of waterbirds were recorded in the shallow mayas compared with deep mayas. The highest concentration of waterbirds was seen in Ein Elshams in 2009 and in Ras Amir in 2010.

Disturbance factors such as grazing by domestic livestock, fishing activities and drought on mayas affect waterbird diversity. Less disturbed and undisturbed mayas had higher waterbird diversity than the disturbed ones. In 2010, all mayas were disturbed due to the drought. Mayas in the western side were more than those in the eastern side of the Dinder River, resulting in a considerable decrease in numbers and richness of waterbirds.

*The Distribution Abundance and Habitat Assessment of Reptiles
in Dinder National Park*

By:

Ismail ElSadig Sulieman Ahmed

M.Sc, Thesis, University of Juba, 2009

Reptiles were studied in Riverine, Dahara and Maya ecosystems of Dinder National Park during the dry season of 2003 and 2004. Objectives of the study were to determine: the ground cover, abundance of trees, reptile richness and some morphometric measurements.

Using line transects in each ecosystem, herbaceous vegetation cover was determined by the 10-points frame procedure, tree and reptile density as well as reptile frequency were ascertained in large plots. In addition, the reptile frequency was determined in waterholes along the banks of Dinder River. Morphometric measurements of some reptiles were also determined.

Percentage of the herbaceous vegetation cover was high in the Maya ecosystem, but was almost negligible in the Riverine and Dahara ecosystems. High percentage of litter and bare soil were found in the Riverine ecosystem, which attract reptiles for concealment and basking respectively. Live and dead trees are important reptilian microhabitat particularly in the Riverine and Maya ecosystems. The density of the former microhabitat was high in the Dahara; the density of the latter was high in the Riverine but very low in the Maya ecosystem.

Nineteen Reptile species were identified in Dinder National Park, including the snakes, eight lizards, one crocodile and one tortoise. Their percentage frequencies were relatively high in the Riverine, followed by Dahra and lastly the Maya ecosystem. The distribution of the most common reptiles was as follows: Ground agama occurred in the Dahara ecosystem in the Northern part of the park; The Nile monitor and Python mostly occurred in the Riverine and Maya ecosystems. The reptiles were associated with four microhabitats: terrestrial (bare soil), arboreal (trees), aquatic and rocky.

*Some Aspects of Waterbuck (Kobus ellipsiprymnus Defassa) Ecology in Abdal Gani Maya
Dinder National Park*

By

Tahani Ali Hassan ElHaj

Msc. Thesis, University of Juba, 2009

In this study, the population characteristics, diurnal activities and habitat of waterbuck (*Kobus ellipsiprymnus Defassa*) were investigated, in Dinder National Park during the dry season from January to April 2007 and from January to February 2008.

Numbers of waterbucks were estimated by the out-bound approach method, abundance of trees by the nearest neighbor method.

Nitrogen content of seed pods was determined by the standard Kjeldhal nitrogen procedure.

The diurnal activities were studied by the scan sampling method. Abundance of fecal droppings was determined by line transect procedure.

The population size was found to be 1338 in 2007 and 950 in 2008; Biomass was 1519/km² and 961/ km² respectively. The overall density was 8 animal / km².

Waterbuck preferred seed pods of *Acacia seibriana* and *Acacia nilotica*. Percentage of crude protein in these seed pods was 9.5 and 8.8 respectively which is well above the critical level (5%). There was no significant differences in the use of the riverine, woodland and grassland whether it is burned or not burned.

Study of diurnal activity showed that males spent more time resting than females whereas, females spent more time walking and feeding compared with males.

Myiasis Caused by *Strobiloestrus* spp in Reedbuck in El Dinder National Park, Sudan

By:

Abubakar Ahmed Saaid Mohamed

Msc. Thesis, Sudan Academy of Sciences, 2015

A survey of myiasis in Reedbuck was conducted at the Dinder National Park (DNP) during the period 2010-2013. General health and clinical condition were observed.

Clinical chemical parameters were determined in six weaned. 2 adult males (8-10 years) and 2 adult female (4-5 years) reedbuck *Reduncu reduncu* from the Park which were captured using net capturing and gun anesthesia. Approximately 20-30 nodules were present in the skin of six infested weaned reedbucks and 1-2 in two infested female reedbucks and no infestation on two male reedbucks. A single second stage larva was removed through an opening in the center of each nodule.

About 20-30 larvae were recovered from each skin of 10 dead animals inspected in DNP. The colour of the second instar larvae was white-ivory. The body length was 7-12 mm. The third instar was yellowish-white and the body length was 18-22 mm. The Cephalopharyngeal skeleton in the third instar larva showed mouth hook. Intermediate sclerite and pharyngeal sclerite. The anterior parts of third instar larva have hook and antenna with sensory papillae. Blood parameters including Hb. PCV. WBCs. RBCs. count were also studied. The values of total protein (45±1.73), glucose (6.72±4.4) and albumin (24.2±0.65) of weaned reedbuck were determined.

The prevalence of the larvae in the live weaned reedbucks (33%) was higher than adult females (11%). No larvae were detected in adult males. From the collected skins of dead animal (56%) were infected with myiasis larvae, while higher prevalence of myiasis was recorded in weaned reedbucks.

Conclusively, this study determined the susceptibility of the reedbuck to act as the host of *Strobiloestrus* larvae. The observation showed that the larvae remain about ten months in subcutaneous tissues of the host and the animals were free of larvae in February (late winter). The high prevalence of infestation with myiasis appeared soon after winter.

Meadow Use by Wild Ungulates in the Dinder National Park, Sudan

By:

Ibrahim Mohammed Hashim

Phd, Thesis, 1984

Meadows are important in supporting wild ungulates in the Dinder National Park during the dry season. Objectives of this study were to (1) quantify diet composition of six wild ungulates utilizing the meadows, including buffalo (*Syncerus caffer*), waterbuck (*Kobus defassa*), roan antelope (*Hippotragus equinus*), tiang (*Damaliscus korrigum*), reedbuck (*Redunca redunca*), and oribi (*Ourebia ourebi*) (2) evaluate the nutritional status of the forage plants on the meadows during the dry season, (3) evaluate the nutritional status of the six wild ungulates on the meadows by analyzing their feces during the dry season;--(4) relate plant diversity and available forage in meadows to their use by the six wild ungulates, and (5) relate meadow use by the six wild ungulates to their masses of fecal pellet-groups./ Meadow age was found to affect the amount of green forage available and its utilization by the wild ungulates. Meadows showing simple plant communities had more available forage and were intensively used by the wild ungulates. Conversely, meadows showing diverse plant communities had less available forage and were seldom used by the wild ungulates.

Fecal analyses showed that key plants in meadows, viz., *Echinochloa* spp., were more common in feces of buffalo, waterbuck, tiang, and reedbuck compared to roan antelope and oribi. Chemical analyses showed that nitrogen, phosphorus and calcium were abundant in animal feces and in plant species selected by animals in meadows. Relationships were established between biomass of forage consumed and masses of fecal pellet-groups voided by ungulates at various meadows.

Regression equations were fairly useful for buffalo ($r^2 = 0.41$, $P < 0.06$), tiang and waterbuck ($R^2 = 0.35$, $P < 0.05$) and waterbuck and buffalo ($R = 0.93$, $P < 0.001$) in predicting the biomass of forage consumed in individual meadows. Tiang and waterbuck accounted for the variability associated with the regression model ($R = 0.37$, $P < 0.004$) when variables were correlated across

all meadows of the park. Slopes of regression lines were significant for buffalo and waterbuck, suggesting that herbivory in the meadows primarily resulted from these animals.

**Food Habits of Giraffe, Roan antelope, Oribi and Camel
in Dinder National Park, Sudan**

By:

Nadir Mohammed Awad

Phd. Thesis, Colorado State University, 1985

This study was designed to determine the food habits of giraffe, roan antelope, oribi and camel in Dinder National Park, Sudan. Food habits were determined using the fecal analysis technique for two dry seasons. Vegetation was quantified using frequency measurements simultaneously with fecal pellet collection. Dietary overlap of herbivores was measured by Kulczinski's Similarity Index. Discriminant Analysis was used to test the variations in diets of each herbivore species between the different sites and between years. Pearson's correlation coefficients were computed to test the relationship between the botanical composition of herbivores diets and available forage.

Giraffes and camels were mainly browsers. The most important plant species in diets of giraffe and camel were *Acacia* spp., *Ziziphus spina-ahristi*, *Sesbania* sp., *Capparis tomentosa* and *Cassia mimosoides*. Roan antelope and oribi were mixed feeders, but roan antelope preferred grasses and woody plants, while oribi preferred forbs and grasses. The major forage species preferred by roan antelope and oribi were *Eragrostis* sp., *Pennisetum pedicellatum*, *Cassia mimosoides* and *Indigofera* sp.

There was considerable diet overlap between camel and giraffe but both had little food in common with either roan antelope or oribi. Discriminant analysis showed significant differences between the diets of giraffe and camel and between those of roan antelope and oribi. Each herbivore species generally displayed a high to moderate diet similarity and ate the same forage plants in nearly the same order of preference in both years. The diets of each herbivore were not significantly different between the two dry seasons. Discriminant analysis showed that the diets of each herbivore species were significantly different between the four sites. The herbivore diets were influenced by the vegetation composition of the range, even though strong feeding preferences were expressed.

Trophic diversity indexes showed that all herbivores were able to feed on a wide spectrum of forage plants. By accepting a wide range of forage plants, the diets of herbivores were mostly non- duplicative with a uniform use of forage plants on their natural habitats.

Nadir M. Awad

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Fall 1985

**Dietary Overlaps of Tiang, Buffalo, Reedbuck, Waterbuck and Sheep
in Dinder National Park, Sudan**

By:

Salwa M. Abdel Hameed

Phd. Thesis, Colorado State University, 1985

Tiang, buffalo, reedbuck and waterbuck are the dominant herbivores using the Mayas (meadows) of Dinder National Park. In the dry season, sheep trespass the park and share the available resources with the wild herbivores. There is a need for reliable diet information on the five herbivores to help in better management of the park.

The study was conducted to determine the botanical composition, diet similarity and/or variation and to test selectivity of the five herbivores to the available forage. Diet composition was estimated by microhistological analysis of fecal samples. Availability of forage was determined through frequency measurement of vegetation. Vegetation data were collected simultaneously with collection of fecal pellets from four Mayas in the dry seasons of 1981 and 1983. Kulczyński's similarity index and Spearman's rank order correlation coefficients were used to measure the dietary overlap. Herbivores' dietary variation between the four mayas and the two years was determined by Discriminant Analysis. Pearson's correlation coefficient was used to test the animal selectivity to the available forage plants in the Mayas.

A wide spectrum of plant species (60) were selected by the five herbivores. Tiang foraged on 29 plant species. Buffalo ate 32 plant species, reedbuck 28, waterbuck 32 and sheep 43 plant species. Grasses and grass-like made the largest proportion of the herbivores' diets. Forbs accounted for smaller amounts of total diets of the wild herbivores. Sheep diets contained an appreciable proportion of forbs and browse. The major food items selected by the herbivores were *Echinochloa* sp., *Echinochloa stagnina*, *Cynodon dactylon*, *Brachiaria* sp., *Rottboellia exaltata*, *Schoenofieldia gracilis*, *Panicum* sp. and *Ipomoea aquatica*.

Trophic diversity was fairly high for all herbivores. All herbivores are wide spectrum feeders but they expressed strong feeding preferences towards certain plants. They consumed the preferred

forages as encountered in the Mayas. However, reedbuck was a more selective herbivore than the others.

There was a significant variation in the composition of diets selected from the four Mayas for tiang, buffalo and reedbuck, but not for waterbuck and sheep. The diets of all wildlife species varied between the two years. Sheep diets showed insignificant variation.

The highest similarity in the diet selection process occurred during the end of the dry season and in Abdel Ghani Maya. Tiang versus reedbuck (73.3%) showed the highest dietary overlap in 1983 and waterbuck versus reedbuck (71.5%) in- 1981. The highest dietary overlap between sheep and the wildlife species were found between tiang and sheep (70.0%) and between sheep and buffalo (66.0%). Tiang versus reedbuck had the highest similarity in the order of selecting the most important food items. However, a lot of variation exists in the order each herbivore selected its diets from different Mayas throughout the season.

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Fall 1985

**Towards Community's Involvement in Integrated Management
in Dinder Biosphere Reserve. Sudan**

By:

Abdalbagi Abdalla Elmekki

Phd. University of Khartoum, 2008

The research study is planned to address this problem by means of exploring the relationship between the local community and the natural resources in the study area. The main objective is to adopt a management approach following the biosphere reserve concept.

The methodology used for the research included:

- 1) Social Survey: using questionnaires, P R A, and secondary data.
- 2) Inventory Survey: using survey lines extended 4.8 KM running from river bank to, Dhahra. land locating., 12 sample plots (each 2 hectares) along each survey line for vegetation measurement.
- 3) Related Literature Review.

According to the analysis of compiled data it is clear that local people in the study area completely rely on natural resources of the park. The distance covered for collection of wood increases yearly and now community members have to go 5-7 kilometers to collect the suitable trees for construction purposes .Also distance of 2-4 kilometers should be covered to collect fuel wood. Regarding the tree stocking in the study area it is clear that there is considerable variation between sector I (Near the villages) which average about 4000 tree per sector compared to that far away (sector 3)which average about 6/000 trees per sector .

Acacia seyal (97%), Balanite aegyptiaca (74. 2%) and Compretum species (74.2%) are the most preferable trees to the community and they are highly consumed in the study area.

Most of the settlers tend to rear animals mainly to support their food security and to guarantee diversification of diets . For wildlife, the majority of respondent (81,8%) indicated the decreasing

of the wildlife population mainly due to human activities (66.7%), and due to the same reason, 95.4% assure that the range land condition was much better in the past. Shifting cultivation is the only applicable method of cultivation adopted by the settlers (100%). 77.3% of the respondents stated that they follow crop rotation and no fallow period which means intensive cultivation method some high palatable grasses has been mentioned by respondents as declined or disappeared species and some new unpalatable species colonized the study area

The main factor threatening the existence of the local communities are the lack of education (71.2%), lack of health services (50%) addition to lack of adequate drinking water (36,4%).

However, settlement with it's Negative impact in th e study, area was became a reality and accordingly, the main recommendation of this study is the managing of the study area on participatory manner, to involve different stake holders with an immediate objective to revise the policy adopted now and to adopt an active a n d practiced community based natural resources management, in order to promote conservation of the park and sustainable use of the natura] resources in the study area.

Application of Remote Sensing in Monitoring Ecological

Changes in Dinder National Park

By:

Ibrahim Osman Kanno

Phd. Thesis, University of Juba, 2004

Dinder National Park was established in 1935. It lies 550km southeast Khartoum at the Sudan - Ethiopian border. It occupies an area of 1 0126.6 km². It is rich of fauna and flora. River Dinder and so many tributaries traverse the park. It has been characterized by so many depressions locally named Mayas. They vary in size and the period of storing water. They provide drinking water and green grasses for grazing wildlife species in the dry season as well as fishes for fish-eating species. It has been listed as biosphere reserve in 1979.

Remote sensing is a technique and art of identifying objects through electromagnetic waves from a distance without being physically in contact with it. So many methods are used for that purpose e.g. Balloons, aircraft or Satellite. The obtained pictures or photos can be visually or digitally interpreted using computers and software. e.g. ILWIS. Satellite images provide valuable and temporal data where by a person can detect, follow-up or monitor any ecological changes occurred in a particular period and place. Thus, the method is used for detecting changes occurred in Dinder National Park within the period 1972- 2000.

The study revealed that changes have occurred in the following areas:

1. Vegetation of the park.
2. Land use around the park.
3. Mayas ecosystem.
4. Wildlife population trend.

With respect to the vegetation of the park, the areas of open grassland decreased from 28.8% in 1972 to 18.9% of the area of the park in 2000. The area of Riverine forest also decreased from 8.8% in 1972 to 6.1 % of the area of the park in 2000. The area of wooded grassland increased from, 62.4% in 1972 to 75.0% of the area of the park in 2000.

The study also showed that human activities around the park have been intensified especially mechanized agricultural schemes and grazing of domestic livestock to the extent seriously affected the park resources.

There were also great changes in Maya's ecosystems. Some of them were faded, others on the way and most of them have been invaded by unpalatable plant species especially *Sorghum* spp. The blockage of their feeding channels led to reduction in their water storing capacity and depositions of silt and debris resulted in elevation of their beds.

The ground survey (road and pool counts) showed great reduction in wildlife population in the park - with exception of Guinea fowls and Baboons which increased tremendously. Ostrich also started rebuilding their population. Some wildlife species have disappeared from the park e.g. Giraffe, elephants, leopards, crocodiles, Tora hartebeest, rhino etc. The area of the annual burning has increased from 67.5% in 1972 to 71.2% of the total area of the park in 2000. Thus, annual burning gave chance to fire-resistant tree species and unpalatable plants to grow at the account of the open grassland. Factors contributed to the deterioration of the park are:

1. Physical factors e.g. dry spells.
2. Human interference. e.g. poaching, trespass of domestic livestock to the park led to overgrazing and transmission of diseases and diffusion of seeds of unpalatable plant species in the park and Mayas in particular e.g. *Sorghum* spp., cutting grasses for thatching, felling trees, making charcoal, collecting honey and Dom palm leaves, fishing and cultivation.

The ecological changes of the park have seriously affected the habitat of wildlife species in the park and hence led to their disappearance, migration and/or reduction in populations.

**Changes in Vegetation Cover and Impacts of Human
Population in Dinder National Park, Sudan
During the Period from 1972 to 2013**

By:

Ameer Awad Mohammed

Phd, Thesis, Sudan Academy of Science, 2014

Dinder National Park (DNP) is considered as one of the most important wildlife areas in north Sudan and Arab region, because it is one of the nearest protected areas locations to the Middle East and Europe. It is located in North-East Sudan, with an area of 10290 square kilometers. DNP supports a large population of a variety of African wildlife species.

DNP composed of three main ecosystems; the riparian, meadows (known locally as Mayas) and the woodland. Each ecosystem has its own flora and fauna. Most of the people who settled in the Dinder region depends on DNP plants for nutrition and treatment in addition to their heritage, cultures and beliefs.

Human settlement in the Dinder region dates as far back as the pre-nineteenth century, intensified in the early 1960s, with increasing number in 1980s, through immigration from western Sudan and West Africa countries. It is noticed that the human settlement was influenced by many factors.

DNP ecosystems are exposed to many ecological changes, which are usually the result of climate change or as a result of various human activities.

The monitoring of these environmental changes of the most important cyclical processes are very necessary to ensure the preservation and conservation of biodiversity. The overall objective of this study is to monitor the changes in the vegetation cover within the different ecosystems in DNP throughout the period from 1972 to 2013. Geographic Information System (GIS) and Remote Sensing technologies were used for monitoring the ecological changes in the park.

Digital image-processing software Erdas imagine 8.5 was used for the processing, analysis and integration of spatial data to reach the objectives of the study.

Post-classification comparison (change detection) of the imagery was applied to determine the changes in land cover that had occurred over time in DNP. The satellite images which covered the area for the years 1972 - 1984 - 1999 and 2013 had been analyzed to access those changes.

The change in vegetation is considered as one of the important factors for the specific natural environments with a close relationship with the changes that have occurred in the types and numbers of wild animals in DNP. Some wildlife species had disappeared such as giraffes, elephants, leopards, which are believed that they had migrated to the Ethiopian plateau. Others are declining in numbers, such as roan antelope and larger and lesser kudo while some species continues to increase, such as monkeys, Quinoa fowl, ostriches and waterbuck. To determine the relationship between human activities and the changes in the vegetation cover a questionnaires were distributed to 200 to the target groups living in the villages in the Dinder area. For the socio-economic study, the villagers are divided into four groups as follows: River Rahad villages group inside the park, River Rahad villages group outside the park, Kadallo villages group inside the park, Kadallo villages group outside the park. The family size ranged between one and 27 individual.

The study showed that there are significant changes in the vegetation cover of the riverine ecosystem from 17.50% in 1972 to 20.47% in 1984 to 13.27% in 1999 to 14.63% in the year 2013. While there are a gradual increasing in the percentage of wood land ecosystem from 37.07% of the total area of the park in 1972 to 42.26 % in 1984 to 53.03 % in 1999 to 65.07 % in 2013.

It is also noted that the percentage of open grass land decreased during the study period between 29.3%, 25.02%, 23.70% and 13.01% for the years 1972, 1984, 1999, and 2013, respectively.

The percentage of bare soil decreased from 16.07% in 1972, to 12.25% in 1984, to 10% in 1999 and then to 7.29% in 2013. The Damazine meteorological station was selected as a station located far south and Gedarif station as a station located far north to the DNP and Singa metrological station in the north west DNP, to estimate the amount of annual rainfall, considering that the amount of the rainfall will increase as we head south. Generally, the results

showed that the amount of annual rainfall in Gedarif and Damazine stations fluctuated with decreasing rate.

The results of socioeconomic data reveal that 93.81% of the local community in Dinder area are practicing agriculture as a source of income, 40.21 % are working as laborers in agriculture, either in small-scale or large rain fed schemes. While 26.29% of the population are working in the field of animal husbandry. 21.13% are running small trading business. 13.40% using wood forest product or non-wood forest product as a source of income, few of them (5.15%) are working in government jobs and 1.03% are working in the field of fishing.

It was found that there are close relationship between the different village groups with different human activities and various types of conflict and disputes between the residents and the park authority. The villages group inside the park has significant conflict rather than the village outside the park. It is clear that this conflict happened as result of their dependence on DNP resources.

The study recommended the need to activate the role of the local population in the preservation of the park through the application of the biosphere reserves concept. Establishment of a Monitoring unit inside the park is necessary for continuous monitoring and follows up of the various changes. The study also recommended the need for developing horticulture in the West Bank of River Rahad inside the park as a sort of an additional income generation which would reduce the entrance of humans and their livestock into the park.

Studies on Some Weaver Birds and Their Helminth Parasites in the Sudan

Mohamed Ahmed Idris

Phd, Thesis, University of Khartoum, 1979

The helminths of three weaver birds, *Qualea qualea aethiopica*, *Ploceus badius badius* and *P. cucullatus abyssinicus* have been studied in the fung area in the central of the Blue Nile province in the Sudan. This area is characterised by its arid climate and seasonal rainfall of about 400-940 mm. annually, between May- October. The soil is heavy and composed of dark, alkaline, cracking caly and can be divided ecologically into (i) Bushiland (ii) Woodland (iii) Grassland (iv) Forest, Gerif and Karrab. This area supports a large population of arthropods during the rainy period and a lesser number, mainly near water, during the dry season. The area is also rich with different and numerous species of vertebrates, especially in the Dinder National park for helminth recovery and study. The three species were mainly collected from around Karkoj and Ed Damazin. In addition to two species of blood microfilariae, twenty- five species of helminths have been recovered, six of which are new to science. These are studied, described and drawn in detail. All of these helminths except *Anomotaenia qualea*, *Anonchaenia globata*, *Echinocotyle dolosa*, *Mediorhynchus wardi* and *Oxyspirura (oxyspirura) nigerica* are new to Africa. With the exception of *A. qualea* which was reported before from *Q. Guelea* in Northern Rhodesia, each of these helminth species provides one two or three new hosts records. Apart from *splendidoflora grelittat* which was reported in Madagascar (Malogoty) Island, this is the first record of the genus *Splendid* of *ilaria* and of *tonaisia* and *cartrema* in Africa. The generic diagnosis of *cartrema* and of *pseudochanotaenia* is amended *Diplatriaene ozaxi* has been synonymized with *D. ozaxi*. *Olsoxio (oxvspirure) strep ova*. *O. (oxvspirura) lalages* and *O. (oxvspiraure) lalages* and *O. (oxvspivure) vehi*, on their present descriptions cannot be distinguished from *O. (oxvspivura) pepingensis*. The highest overall prevalence of these various helminths is from Damazin, 69% infected compared to 50% from Karkoj. Generally *P. cucullatus* shows the highest percentage of infection (80) followed by *P. badius* (76) and then *Q. qualea* (37). *Q. qualea* and *P. badius* females from both sites reveal a higher percentage of infection than males, whereas in the case of *P. cucullatus* males show a slighter, infection than the females. From both sites and in each host, nematodes have the highest prevalence of infection, followed by cestodes, trematodes and lastly by aconthocephala the three hosts from two localities have been shown to harbour 25

helminth species and two species of blood microfilarias to 16 Geneva. Thirteen of 17 helminth species found in *O. Ouelea* occur in both localities. 3 species have been recorded only from Krakoj and a single species recorded only from Domazin. Fifteen of 19 helminth species found in *P. badius* occurred in both localities and 2 species in each locality. Thirteen of 19 helminth species found in *P. oucellatus* occurred in both localities, and 3 species in each locality. Helminth species which occurred in high incidences and in densities have all been figured. They all occur in high percentages at low specimen numbers and are of slightly higher incidence in female than male hosts from both localities. It has also been found that infection with a single species of helminth is commonest while multiple infection with four or five species is the least encountered. Also species of relatively large size occur most frequently in low numbers in individual host, and species of very small size are frequently present in large numbers. Two species of blood microfilariae have been detected in *P. badius* and *P. cucullatus* from both localities but not in *Q. quelea*. One of these is identified as the microfilaria of *S. plocell* n. sp. but the other does not conform to any known species of avian filaria and its adults have been recovered. Microfilariae of *S. plicei* n. exhibit a marked nocturnal periodicity, and although insects fed on the infected birds have not been found to harbour microfilaria when subsequently examined, epizootological evidences suggest *Culicoides* as a possible vector of *P. Plocei* n. sp.

**Feeding Habits and Behavior of Waterbuck (*Kobus ellipsiprymnus defassa*)
in Dinder National Park, Sudan**

By:

Tahani Ali Hassan ElHaj

Phd. Thesis, University of Juba, 2013

This study was conducted in Dinder National Park (DNP) (Lat- long) during the year 2010 – 2011 with the aim to investigate the feeding habits of the (*Kobus ellipsiprymnus defassa*). The study selected Abd el Ghani Maya where waterbuck constituted the most density population .The ecological aspects of the area included plant abundance, composition and density. Diurnal activities and feeding behaviour were monitor with 15 minutes interval for 12 hr 3 days a week. Chemical analysis included both plant species and waterbuck feces . Results showed that densities of waterbuck were found to be 5.6 and 7.6 per hectare inside and outside Abd el Ghani Maya respectively. Generally the fecal density of waterbuck was consistently high than the fecal density of the other animal species utilizing the Maya . Respective densities of *Acacia seibriana* and *Acacia seyal* were 160 trees/ hectare and 1394 tree/ hectare while the density of *Acacia nilotica* was 750 trees/ hectare. Waterbuck was active in the morning and in the evening during 7:00 am and 10:00 am and during 4:00 and 6:00 pm, but rested in the middle of the day at 01:00 to 3:00 pm and the peak of resting activity occurred around 12:00 o'clock. During the day, more time was devoted to feeding, followed by walking and resting.

In this study 21 plant species were identified in the feces of waterbuck in 2010, and 19 plant species in 2011. These plant species comprised grasses, forbs and woody trees. The grass were *Echinochloa* sp, *Cyprus* sp, *kylinga* sp, *sorghum arundinaceum* forbs were *Corchorus depressus*, *Ipomoea equatica* and *Polygonum* sp and the trees and shrubs were *Acacia seibriana*, *Balanites aegyptiaca*, *Ziziphus spina-christi* and *Crativa adonsonii*. During the early dry season grasses and forbs comprised 80% of the diet and trees and shrubs 20%. During the late dry season however grasses and forbs comprised about 40% of the diet whereas trees and shrubs constitute 60%. Among food plants *Cyprus* sp and *Acacias* sp had the height nitrogen and phosphorus concentrations. Food niche breadth and Shannon

diversity index indicated that the diet of waterbuck was more diverse in the late dry season than the early dry season. It could be conclude that waterbuck preferred grasses when they are fresh and plentiful of nutrient during the early dry season and leaves of woody trees during the late dry season to supplement their requirements.

Msc and Phd Thesis:

1. Abakar, O. G. 1986. Effect of Burning on Soil & Vegetation in Dinder National Park. Msc. Thesis, Faculty of agri. Univ. of Khartoum, Sudan.
2. Abd Alla, L. M, 2011. Morphometrics of honeybee *Apis Mellifera* L., nesting ecology and honey production in Dinder Biosphere Reserve, Sudan. Msc. Thesis. Sudan Academy of science. Sudan.
3. Abdel Hameed, S. M. 1985. Dietary overlap of Tiang, Buffalo, Reedbuck, Waterbuck and sheep in Dinder National Park, Sudan. Phd. Thesis, CSU. USA. 124p.
4. Abdel Hameed, S. M., (1983). Vegetation of Mayas in Dinder National Park, Sudan. Msc. Thesis Colorado State Univ. USA. 93 P.
5. Abdel Salam, M. Y. 1985. A Population Study of Some of the Larger Mammalian Species in Dinder National Park, Sudan. Msc. Thesis, Faculty of agri. Univ. of Khartoum, Sudan.
6. Adam, H. A. 2000. Livestock Trespassing and its Effect on the Wildlife of the Dinder National Park. Msc. Thesis, envi. Studies, Univ. of Khartoum. Sudan.
7. Ali, A. S. 1986. Vegetation Dynamics in the Major Mayas of the Dinder National Park (Sudan). Msc. Thesis. Faculty of science, zoology. Univ. of Khartoum.
8. Awad, N. M. 1982. Keys to identification of plant fragments from Dinder National Park Sudan. Msc. Thesis CSU, USA. 99p.
9. Awad, N. M. 1985. Food Habits OF Giraffe, Roan antelope Oribi and Camel in Dinder National Park, Sudan, Phd. Thesis CSU, USA.
10. Bin Suliman, S. S. 1987. The effect of competition between wildlife and domestic livestock in natural range land of the Dinder national park. Msc. Thesis, Faculty of agri. of Univ. of Khartoum. Sudan.
11. Dai, A. H. 1982. Base-Line Information on Some Mayas of the Dinder National Park: Some Hydrological and Siltation Aspects. Msc. Thesis, Faculty of agri. Univ. of Khartoum, Sudan.
12. Dongola, G. M. 1985. An Ecological Study of the Dinder National Park with Special Reference to Regeneration Potential of *Acacia seyal* & *Balanites aegyptiaca*. Msc. Thesis. Faculty of science, Botany. Univ. of Khartoum.

13. Duruku, B. T. 1997. Baseline Ecology and Management of Olive Baboon (*Papio Anubis*) in Dinder National Park. Msc. Thesis, envi. Studies, Univ. of Khartoum. Sudan.
14. Edris, G. M. 2002. On the Biology, Behavior and Taxonomy of some Sudanese Cyclops (Craustacea: Copepoda). Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
15. El Bashir, M. A. 2007. (دراسة حالة دور الإدارات الحكومية ومنظمات المجتمع المدني في حماية البيئة) محمية الدندر القومية – محلية الرهد Faculty of Geography. Univ. of Khartoum.
16. El Makki, A. A. 2009. Towards Community's Involvement in Integrated Management in Dinder Biosphere Reserve, Sudan. Phd Thesis, Faculty of Forestry, Univ. of Khartoum. Sudan
17. El Sayed, S. M. 1990. Ecological Studies on Phlebotomine Sandflies (Diptera, Psychodidae) of Surrogia Village (Khartoum Province) and Dinder Park, (Blue Nile Province) Sudan. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
18. ElHassan, E. E. 2011. Seasonal Abundance and Diversity of Waterbirds at Eleven Mayas in Dinder National Park, Sudan. Msc. Thesis. Sudan Academy of science. Sudan.
19. Elyas, A. N. (2012). Illegal and patrolling activities in Dinder National Park. Msc. Thesis Sudan Academy of science. Sudan.
20. Fadul, A. S. 1983. Ecological Studies on Acacia Seyal and Balanites Aegyptiaca in Dinder National Park. Msc. Thesis, Faculty of agri. Univ. of Khartoum, Sudan.
21. Hamid, R. A. 1992. Soci-Economic and Environmental Impacts of Displaced People : The Case of Dinder Area Council. Msc. Thesis, envi. Studies, Univ. of Khartoum. Sudan.
22. Hashim, I. M. 1984. Meadow use by wild ungulates in Dinder National Park. Sudan Phd. Thesis NMSU, USA.
23. Hassan, H. K. 1996. Phlebotomine Sandflies (Diptera: Psychodidae) and their Role in Transmission of Visceral Leishmaniasis (Kala-Azar)in an Endemic Focus in Eastern Sudan. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
24. Hassan, M, M. 2004. Studies on Shadflies, Transmission And Reservoir Host Of Visceral Leishmaniasis In Eastern Sudan. Msc. Thesis, Faculty of Animal production. Univ. of Khartoum.

25. Hassan, M. M. 1998. A Study on Sandflies, Transmission and Control of Visceral Leishmaniasis in Eastern Sudan. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
26. Hassan. T. A. 2009. Some Aspects of Waterbuck (*Kobus ellipsiprymnus* Defassa) Ecology in Abdal Gani Maya Dinder National Park. Msc. Thesis, Univ. of Juba. Sudan.
27. Hassan. T. A. 2013. Feeding Habits and Behavior of Waterbuck (*Kobus ellipsiprymnus* defassa) in Dinder National Park, Sudan. Phd. Thesis, Univ. of Juba. Sudan.
28. Ibrahim, M. A. 2011. Basic information towards management of Guinea fowl in Dinder Biosphere Reserve. Msc. Thesis. Sudan Academy of science. Sudan.
29. Idris, G. M. 2002. On the Biology, Behavior and Taxonomy of Some Sudanese Cyclops (Crustacea: Copepoda). Msc. Thesis faculty of science, Zoology. Univ. of Khartoum. Sudan.
30. Idris, M. A. 1979. Studies on Some Weaver Birds And Their Helminth Parasites in the Sudan. Phd. Thesis, Faculty of science, zoology. Univ. of Khartoum.
31. Kanno, I. O. 2004. Application of remote sensing in monitoring ecological changes in Dinder National Park. Phd. Thesis. Univ. of Juba, Sudan.
32. Kenye, J. M. 2001. Human Impact on Wildlife Resources in Dinder National Park. Msc. Thesis, Univ. of Juba. Sudan.
33. Khidir, S. A. 2009. The role of some wild and domestic mammals in the transmission of Leishmania. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
34. Mahgoub, K. S. 2004. Distribution and measurement, of Ismall Mammals in various ecosvstems in Dinder National park. Msc. Thesis. Univ. of Juba. Sudan
35. Mahmoud, H. A. 2012. Monitoring of Anti Leishmania Antibody Responses for Early Diagnosis and Prognosis of Visceral Leishmaniasis in Dinder National Park. Msc. Thesis. Faculty of Med. Univ. of Khartoum.
36. Meina, O. M. 2011. Diversity Flock characteristics, roosting ecology and seasonal fluctuation of storck numbers in Dinder National Park. Msc. Thesis Sudan Academy of science . Khartoum Sudan.
37. Mergani, D. A. 2008. Flood Frequency Analysis for the Eastern Nile: A Case Study of Blue Nile, Atbara, Dinder and Rahad Rivers. Msc. Thesis, Faculty of engine. Univ. of Khartoum. Sudan.

38. Mohammed, A. A. 2014. Changes in vegetation Cover and impacts of human population in Dinder National Park, Sudan during the period from 1972 to 2013. Phd. Thesis. Sudan Academy of science. Sudan.
39. Mohammed, M. A. 2006. The Biology of the Reedbuck (*Redunca redunca* Pallay,1764) in Dinder National Park. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
40. Mohammed, M. S. 2009. Genetic diversity and population structure of *Phlebotomus orientalis* (*Diptera: Psychodidae*) from selected regions in Sudan. Msc. Thesis. Faculty of science, zoology. Univ. of Khartoum.
41. Omer, M. A. 1985. Study on some ecological aspects and parasites of bats in the area around Khartoum and Dander National Park. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
42. Peter, M. L. 2001. The Ecology of *Hyphaene thebaica* (Dom) in Dinder National Park - Sudan. . Msc. Thesis, envi. Studies, Univ. of Khartoum. Sudan.
43. Sulieman. I. E. 2009. The Distribution Abundance and Habitat Assessment of Reptiles in Dinder National Park. Msc. Thesis, Univ. of Juba. Sudan.
44. Suliman, O. A. 1998. Studies on the Conservation and Breeding of the Ostrich in the Dinder National Park Sudan. Msc. Thesis, envi. Studies, Univ. of Khartoum. Sudan.
45. Suliman, S. S., 1987. The Effect of Competition between Wildlife and Domestic Livestock in Natural Rangeland of the Dinder National Park. Msc. Thesis, Faculty of agri. Univ. of Khartoum, Sudan.
46. Widaa, S. O. 2009. Colonization, Biology and Insecticide Resistance of *Phlebotomus papatasi* (Scopali, 1786) (*Diptera: Psychodidae*) in Some Areas in Sudan. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
47. Yousif, M. O. 1997. The Polymerase Chain Reaction as Tool of Molecular Diagnosis of Leishmania Infection in the Sudan. Msc. Thesis, Faculty of science, zoology. Univ. of Khartoum.
48. Osman, K. M. 1993. The prospect of wildlife tourism in Dinder National Park. Msc. Thesis, Univ. of Juba. Sudan.
49. Ali, M. E. 2006. Ecology of Wild Stork (*Cyconia cyconia*). Msc. Thesis, Univ. of Khartoum.

50. Saaid, A. A. 2015. Myiasis Caused by *Strobiloestrus* spp in Reedbuck in El Dinder National Park, Sudan. Msc. Thesis Sudan Academy of Science.
51. Mohaned, M. Elt. (2010). Use of remote sensing and Geographical information System to build a historical background of Wild land fire Regime in Al Dinder National Park. Msc. Thesis Sudan Academy of Science.
- 52.

Students' Dissertations

1. Abakar, A. A. Effect of Overgrazing of Domestic Livestock on Dinder National Park in the Period Between 1998 - 2001. Bsc. (Honour) Dissertation Univ. of Juba.
2. Abdel Alatif, A. 1996. A study on some aspects of feeding ecology of olive Baboon (*Papio anubis*) in Dinder National Park Bsc. (Honour) Dissertation Univ. of Juba.
3. Abdu AlGauran, W. M. Mayas of Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba.
4. Abdullah, W. M. 2008. The use of Encounter as Method of Estimating Birds Species richness and Abundance in Maya Mousa and Maya Abdalgani. Dinder national Park. Bsc. Dissertation Univ. of Juba.
5. Aborma, J. 1993. Impact of the proposed Rahad Canal on Dinder National Park). Bsc. (Honour) Dissertation Univ. of Juba.
6. Adam, H. 2001. Effect of Overgrazing of Umbroro Cattle on Dinder National Park. Bsc. Dissertation Univ. of Juba.
7. Adam, M. 2001. Buffalo in Dinder National Park.(in Arabic) Bsc. Dissertation Univ. of Sennar.
8. Al Degeir, M. T. 2000. Impacts of Human Settelement on Dinder National Park. (in Arabic). Bsc. Dissertation Univ. of Sennar.
9. Alaa, A. A. 1994. Management Recornnendation for Dinder National Park. Bsc. (Honour) Dissertation Univ. Of Juba.
10. Awad AlKarim, F. 2001.Trees and Shrubs Components in Wild Animal's Diets in Dinder National Park. Bsc. Dissertation Univ. of Juba.
11. Ayull Chan , A.E. 2000. Wildlife Based Tourism in the Sudan; A Case Study ; Dinder National Park. Bsc. Dissertation Univ. of Juba 36 p.
12. Dirdiri, S. Daily Activity of Water buck in Dinder National Park. Bsc. (Honour). Dissertation Univ. of Juba.
13. Eliaba, J. A. 2000. Road Counts in Dinder National Park. Bsc. Dissertation Univ. of Juba. 37p.
14. Fadul Elmula, D. A. 1994. Management Recommendation for Dinder National Park. Bsc. Dissertation Univ. of Juba. 41p.

15. Gaffar, A.0.2001. Ecological Study of Termites (White ant) in Dinder National Park.(in Arabic). Bsc. Dissertation Univ. of Sennar.
16. George, J. I. 1993. Evaluation of the Development Aspects of Dinder National Park. Bsc. Dissertation Univ. of Juba. 34p.
17. Hamed, A. A. 2000. Influence of Fire and Tree-cutting on non-breeding bird communities in Dinder National Park. Bsc. Dissertation Univ. of Juba. 29p.
18. Hamuda, A. Problems that threaten Dinder National Park. (in Arabic) Bsc. Dissertation Univ. of Sennar.
19. Haroun, T. 2000. Overpopulation and its Effect on Dinder National Park. (in Arabic). Bsc. Dissertation Univ. of Sennar.
20. Hassan, A. D.2001 .Tree Cover of Woodland (Dahara) of Dinder National Park. Bsc. Dissertation Univ. of Juba.
21. Ibrahim,T. 2001. Kinds of Direct Resources Offered to the People around the Dinder National Park. (in Arabic). Bsc. Dissertation Univ. of Sennar.
22. Ikang, J. 1994. Evolution of development aspects of Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba.
23. Jumma, A. G. 2001. The Use of Camel for Patrolling in Dinder National Park. (in Arabic) Bsc. Dissertation Univ. of Sennar.
24. Kara, E. 2001. International Conventions and their Effect on Wildlife Legislations. (in Arabic) Bsc. Dissertation Univ. of Sennar
25. Kenneth, J. S. 1993. The Effects of Mechanized Farming and Livestok Grazing in Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba.48p.
26. Kimly, M. 2000 Behaviour, Density and Distribution of Baboon (*Papio anubis*) in Dinder National Park. Bsc. Dissertation Univ. of Juba.
27. Koul, D. M. 1994 Road Counts in Dinder National Park. Bsc. (Honour). Dissertation Univ. of Juba. 50p.
28. Kpoor, N. A. 1996. The Dominant Tree Species of Riverine Forests of Dinder National Park and their inter-relationship with some wildlife species. Bsc. (Honour). Dissertation Univ. of Juba. 20p.
29. Lako, S. M. 2005. Population trend of Orabi (*Ourebia ourebia*) and its habitat preference around Galagu camp in Dinder national park. Bsc. Dissertation Univ. of Juba.

30. Langa, E. J. 1993. Road and Pool counts at Galegu Area and management Recommendations for Dinder National Park. Bsc. (Honour). Dissertation Univ. of Juba.
31. Mahjoub, M. 2001. Personnel in Dinder National Park. (in Arabic) Bsc. (Honour). Dissertation Univ. of Sennar.
32. Mamli, M. M. 2000. Acute Toxicity of the Venoms of *Echis carinatus*, *Pyramidum* and *Naja nigricollis pallida* Against the Albino Rat (*Rattus norvegicus*) and the and the Common African Toad (*Bufo rigularis*). Bsc. (Honour). Dissertation Univ. of Juba. 37p.
33. Mardish, B. D. 2001. Law Violations in Dinder Nationak Park. (in Arabic) Bsc. Dissertation Univ. of Sennar.
34. Mohamed, N. S. 2001. Population Estimate and Age Structure of Warthog in Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba. 25p.
35. Mohammed, A. B. 2004. Corpological survey for endoparasite infection in Dinder national park. Bsc. Dissertation Univ. of Juba.
36. Mohammed, H. A. 2007 Endoparasite of waterbuck (*Kobus deffassa*) and warthog (*Phacochoerus aethiopicus*) in Dinder national park. Bsc. Dissertation Univ. of Juba.
37. Musa, S. A. 2000. Evaluation of Pellet-group Surveys for Estimating Population Trend in Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba. 29p.
38. Mustafa, A. M. 2012. Ecological study of tree species in Dinder national park Bsc. Dissertation Univ. of Bahri.
39. Orner, E. E. 1990. Road and Pool Counts of Galego Area and Management Recommendation for Dinder National Park. Bsc. (Honour) . Dissertation Univ. of Juba. 92 p.
40. Orner, F.A. Sustainable Development in Dinder National Park.(in Arabic) Bsc. Dissertation Univ. of Sennar.
41. Osman, E. A. 2000. Comparative Study of Overstory Attributes at Three Mayas ; AbdelGani, Ras Amir and Grerrisa in Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba. 59 p.
42. Osman, N. M. 2001. Dome Trees in Dinder National Park. (in Arabic) Bsc. Dissertation Univ. of Sennar.
43. Otwel, B. P. 1996. Distribution of *Struthio camelus* in Dinder National Park. Bsc. (Honour) Dissertation Univ. of Juba.

44. Rahamtalla, T.2000. Daily Activity of Marabou Stork in Dinder National Park. (in Arabic) Bsc. Dissertation Univ. of Sennar.
45. Ramadan, R. O. 2006. Riverrine forests birds diversity around Galagu camp in Dinder national park. Bsc. Dissertation Univ. of Juba.
46. Students of Forestry Department, University of Khartoum. 1984. Dinder National Park ; Problems, Present and Future. 9p.
47. Suleiman, K. 1994. Feasibility study of development of Tourism in Dinder National Park 1994. Bsc. (Honour) Dissertation Univ. of Juba.
48. Yassin, A. S. 2001. Status of the Reed buck (Redunca redunca) in Dinder National Park between 1971- 1998. (in Arabic) Bsc. Dissertation Univ. of Sennar.
49. Yousif, M.2001. Tourism in Dinder National Park, and its Role in Socio- economic Development. (in Arabic) Bsc. Dissertation Univ. of Sennar.

Reports and conference papers:

1. Abdel Rahman, S., (2012). Baseline survey on Apicultural Activities in Dinder Biosphere Reserve (DBR) – Sudan. Eastern Nile Watershed Management Project. Sudan Component. Report. Part 1.
2. Abdelhameed, S. M. Awad, N. M., ElMoghraby, A. I., Hamid, A. A., Hamid, S H., Osman, A. O., Watershed management in the Dinder National Park, Sudan
3. Abdelhameed, S. M. Awad, N. M., Nimir, M. B., Hashim, I. M., Hakim, S., Ahmed, E. Vegetation Successions and its Effect on the Wildlife Herbivory in Mayas of Dinder National Park, Sudan. Wildlife research center. Report.
4. El Medani, K., Balla, A., Suliman, I., Jamal, F., El Amin, F. M., (2012), Social Assessment Study of the Communities in and outside of Dinder National Park. Eastern Nile Watershed Management Project. Sudan Component. Report.
5. Elobied, A. O., (2012). Baseline survey on Aqua-cultural Activities in Dinder Biosphere Reserve (DBR) – Sudan. Eastern Nile Watershed Management Project. Sudan Component. Report. Part 2.
6. HCENR and WCGA Higher Council for Environment and Natural Resources (HCENR), Wildlife Conservation General Administration (WCGA), (2004). Management plan for Dinder national park. UNDP/GEF project SUD/98/G41 and SUD 00/o14. Khartoum. Sudan.
7. مشروع الإدارة الشعبية للأحواض المائية- وحدة الدندر التنفيذية بالتعاون مع مكتب الاحصاء ولاية القضارف. (2013)، المسح الإجتماعى والإقتصادي للقرى العشرة داخل محمية الدندر الإتحادية. تقرير باللغة العربية.