

Dedication

*Verily, my prayer, my sacrifice, my living and
dying are for Allah, the Lord of the Worlds*

*To my beloved mother and to the memory of
my late father*

Son and daughters

To my Husband

*And all members of my family for support and
encouragements*

Fatima

ACKNOWLEDGEMENT

I thank the Almighty *God* for blessing me to complete this project without any hitch. Special thanks and appreciation go to my project supervisor, *Professor Ibrahim M .Hashim* for his patience, guidance, assistance and technical advice. His incisive comments and suggestions have added considerably to the clarity and organization of of this work.

My appreciation also goes to my Co-supervisor *Professor JörnsFickel* the Chair of Molecular Ecology and Evolution, Department Evolution, Institute for Biochemistry and Biology, Potsdam University, for their constructive criticism regarding the thesis synopsis as well as the invaluable support during data collection, and I am also grateful to all teaching staff, to *Miss Tania* the technical and laboratory assistant for her Laboratory help in Germany.

My sincere thanks and great appreciation are due to my third *supervisor Dr. FathiaKhogaly* for her kind help.

I express my thanks to *Professor Mohammed Tragedian* and *Professor AmelOmer* for their support to complete the field work. I am also indebted to *Dr. Omer A. Suliman* and all the staff of the Wildlife Conservation, General Administration for their contributions towards the success of this project.

My deep appreciation goes to *Dr. Franz Suchentrunk* for his help and for all the work of genetics,also comments and suggestions during his stay in Sudan.

Great thanks to my family for their support, my husband *Elwaleed*, son *Ahmed*, My daughters *Amel* and *Saria*. All my sincere thanks to my Mother *Asha* for her patience and kind help to carry out this work.*Dr. Sara Boshra* is highly appreciated. My deep thanks goes to all people whose names were not mentioned here.

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Abstract

This study was initiated with the aims to study the morphology and genetic characterization of hare (*Lepus capensis*) collected from three geographically separated regions, namely East of the Nile, West of the Nile and between the Blue Nile river and the White Nile river in 2012 and 2015. The study focused on morphometric, craniometric, morphological and dental shape and genetic characterization in order to classify the hares. In morphometric, a tape and digital balance with 0.05 mm accuracy was used, craniometric a digital Vernier with of 0.01 mm accuracy. For microsatellite loci, Markov chain method of GENEPOP program was adopted to test genotypic. The Fstat program was used to calculate mean locus-specific 'allelic richness' and a Kruskal-Wallis test as well as a Friedmann test were used to examine variations (AR) among the three regions the tests were lower significantly ($P < 0.011$ and $P < 0.016$) respectively. The GENETIX software was used to calculate pairwise Cavalli-Sforza Edwards chord (CSE) genetic distances between the three regions and to analyse the variation on individual composite genotypes between the regions while analyses of Molecular Variance (AMOVA) were used to test relative genetic variation in the samples from the three regions. STRUCTURE analysis and a Bayesian statistical method were used to identify number of population groupings (clusters) compatible with the observed genotypic distribution. When assuming different numbers of genetic clusters, a likelihood analysis to assign each individual hare to one of the three sample regions was used.

Morphometric (Tail length, height and the distance between eyes) were significantly different ($P < 0.05$) among the three geographic regions. As far as sex was concerned, females were heavier ($P < 0.05$) than males, indicating sexual dimorphism. Craniometric (sizes of skull bones) were

different ($P < 0.05$) among the three geographic regions. Tympanic bulla width (TBW) was larger ($P < 0.013$) in males compared with that of females, thereby supporting sexual dimorphism.

As for the genetic characterization of Cyt (b) and D-loop sequences and microsatellite revealed that there were no genetic differentiation between the three regions. Allelic richness values locus-by-locus were different ($P < 0.01$) in the three regions, across the three regions and frequencies of private alleles were generally low. Hares from the region between the two rivers recorded (7.56%) lower allelic richness (allelic diversity) than hares from the West (17.94%) and East (16.50%) regions.

STRUCTURE analysis suggested that there were two or three most likely genetic clusters (groupings/populations) that were underlying the composite data set, those two to three clusters coincided more or less nicely with the three discriminated regions.

The genetic characterization, dental analysis and external phenotype as well as the skull shape indicated that all the hares from the three geographic regions belong to *Lepus capensis* that is sexually dimorphic. Variations in morphometric and craniometric are attributed to variations in environmental factors within the three geographic regions; the overall genetic differentiation was low among the regions.

ملخص الدراسة

استندت هذه الدراسة على الأرناب البرية التي تم جمعها من ثلاث مناطق جغرافية هي شرق النيل وغرب النيل وبين نهري النيل الأزرق و النيل الأبيض في الفترة من 2012 الى 2015. ركزت الدراسة علىالصفات الخارجية ، قياس الجماجم ,اشكال الأسنان والصفات الوراثية وذلكلتصنيف الأرناب البرية . ولدراسة الصفات المورفولوجية تم استخدام شريط وميزان رقمي بدقة 0.05 جمو فيرنير(Vernier) بدقة (0.01)مم .ولدراسة مواقع المعلمات الوراثية استخدمت طريقة (Markov Chan Method)من سلسلة من برنامج GENEPOP Soft لاختبار النمط الوراثي .و تم استخدام برنامج Fstat لحسابتبايناتمتوسطات تكرارات الحزم الوراثية بواسطةالاختبارين(Kruskal-Wallis test وFriedmann test) وبفروقات معنوية منخفضة ($P < 0.011$ و $P < 0.016$) على التوالي. لمعرفة الاليل المميز لدراسة الاختلافات بين المناطق الثلاث.استخدمت كل من الزوج CSE (AMOVA) لاختبار التباين الوراثي النسبي لقياس مسافات الاختلافات بين المناطق الجغرافية المختلفة .استخدام طريقة التحليل الوصفي وطريقة و الطريقة إحصائية الافتراضية (Bayesian statistical method) لتحديد التجمعات السكانية (مجموعات) التي تتوافق مع التوزيع الوراثي النمطتم افتراض مجموعات مختلفة وراثيةلتحليل التشابه لتحديد توزيع كل فرد إلى واحدة من مناطق عينات الدراسة الثلاث.وجدت فروقات معنوية ($P < 0.05$) فى قياس طول الذيل ,الطول الكلى للحيوان والمسافة بين العينين) بين المناطق الجغرافية الثلاث. بالنسبةللجنس كان وزن الإناث ($P < 0.05$) اعلى من وزناذكور مما يشيرالى ظاهرة الاختلافات الشكلية باختلاف الجنس . هنالك اختلافات معنوية($P < 0.05$)فى جماجم الارانب البرية فى المناطق الجغرافية الثلاثة.عرض طبله الاذن(TBW) كان اكبرفى الذكورمقارنة بالاناث ($P < 0.013$) مما يدعم ظاهرة إزدواج الشكل الخارجى باختلاف الجنس.

بدراسة المعلمات الوراثية D-loop (microsatellite) , و سيتوكرومى(Cyt (b)لقيم التباينات الوراثية اوضحت الدراسة انه لا توجد اختلافات وراثية بين المناطق الجغرافية الثلاث. بينما وجدتاختلافاًمعنوية منخفضاً ($P < 0.01$)بين موضع أليلات المميزة فى تكرار الحزم الوراثية فى المناطق الجغرافيةالثلاث.من الواضح أن الأرناب البرية من منطقة بين النهريين سجلت(7. 56%) اقل تنوع فى الاليلات من الأرناب البرية فى المنطقتين الغربية(17.94%)والشرقية(16.50%).اوضح التحليل اوصفى أن هناك اثنين الى ثلاث مجموعاتوراثية هبالأكثر احتمالاً(جمعاتسكانية) من خلال تحليل البيانات التي تم

جمعها. اوضحت الصفات الوراثية، اشكال الأسنان و المظهر الخارجي وكذلك شكل عظام الجمجم أن جميع العينات من المناطق الجغرافية الثلاث تنتمي إلى نوع واحد هو (*Lepus capensis*) مع وجود اختلافات في الشكل الخارجوتعزى الاختلافات في الصفات المورفولوجية وقياس عظام الجمجم للاختلافات البيئية في المناطق الجغرافية الثلاث الا ان الاختلاف الجيني الكلى كان منخفضاً بينمناطق الدراسة الثلاث .