Second RUFORUM Biennial Meeting 20 - 24 September 2010, Entebbe, Uganda

Research Application Summary

Spatial analysis of vegetation and small mammals' habitat for prediction of plague reservoirs and vectors in Lushoto District, Tanzania

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Abstract

Vegetation habitats mapping were studied in Mavumo area, Lushoto District, Tanzania using Arc view software in order to determine the distribution and abundance of plague reservoirs and vectors. The land cover took into account forest (natural and planted), cultivation, settlement, horticulture, rocky and bare land within different landforms and altitudes. Shrerman, wirecage and pitfall trap were used for trapping small mammals. Fleas and mites were counted. Most of the small mammals prefered forest but not herbaceous habitat. Trap success was negatively correlated to total cover and location while positively correlated to altitude and vegetation species. Altitude affected fleas abundance.

Key words: Fleas, plague, Tanzania, vegetation habitats

Résumé

La cartographie des habitats de végétation a été étudiée dans la région de Mavumo, district de Lushoto, en Tanzanie en utilisant le logiciel ArcView afin de déterminer la distribution et l'abondance de réservoirs et de vecteurs de peste. La couverture de terre a tenu compte de la forêt (naturelle et plantée), la plantation, la construction, l'horticulture, la terre rocheuse et la terre nue dans différentes formes de relief et d'altitudes. Le Shrerman, la cage de fer et le piège ont été employés pour attraper de petits mammifères. Des puces et les mites ont été comptées. La plupart des petits mammifères ont préféré la forêt mais pas l'habitat herbacé. Le succès de piège a été négativement corrélé à la couverture totale et à l'endroit tandis que franchement corrélé avec des espèces d'altitude et de végétation. L'altitude a affectée l'abondance de puces.

Mots clés: Puces, peste, Tanzanie, habitats de végétation

Background

Plague is among the three quarantined diseases declared as compulsory in the world (WHO, 2003). About 60% of the cases in Africa have been reported in Madagascar and Tanzania. More than 48 sub-villages of Lushoto, Tanzania had 7800 clinical plague cases and about 308 deaths during 1986 up to 1995 (Institut Pasteur de Madagascar, 2006). The ecology of the disease is still not well understood. Many reported outbreaks of plague in Tanzania have been associated with large mortalities of rodents (Kilonzo *et al.,* 2005). Vegetation cover can influence microclimate environmental conditions for development of the plague reservoir and vectors (Püttker *et al.,* 2008). The Tanzanian Government spends one million Euros per annum to combat the problem of plague (LEPUS, 2008). Therefore, this study was conducted to asses the influence of vegetation on small mammals and fleas as reservoirs and vectors respectively of plague disease so as contribute knowledge towards a broad investigation which is linking ecological factors with the distribution of plague disease and to provide information to the health and land use management programmes in Tanzania.

Literature Summary

Fleas and small mammal species are an indicator of predicting the occurrence of plague (Laudisoit *et al.,* 2009). Flea indices more than 1.0 were observed during plague outbreaks in Tanzania (Kilonzo *et al.,* 1992). Certain species of small mammals share the same type of fleas (Gage and Kosoy, 2005). Small mammal species have their habitat preference including vegetation in particular (Hackley *et al.,* 2010). However, only few studies have been undertaken to assess the influence of vegetation on plague occurrence with respect to reservoirs and vectors (Anisimov, 2002). For example, certain parameters including food, vegetation type, cover, vigour and vegetation communities, altitude, and landform have been reported in some cases to influence plague reservoirs and vectors differently (Elmhagen *et al.,* 2007). Pinzon *et al.* (2005) observed that spatial distribution of plague vectors and reservoirs was influenced by a combination of environmental factors including vegetation habitat. Therefore, studies that link vegetation and plague reservoirs and vectors particularly rodents and fleas are vital for prediction of plague occurrence in plague foci.

Study Description

The study was conducted in Lushoto District, Tanzania at approximate geographic location between UTM coordinates 9479000 to 9490000 Northing and 0405000 to 0423000 Easting. Vegetation habitat and associated characteristics were assessed using remote sensing and GIS techniques coupled with field

survey and mapping. Geographic location in the field was done using Global Positioning System (GPS) and identification of vegetation types and communities was conducted following FAO guidelines (Di Gregorio, 2005) and General Habitat Classification (GHC) guidelines (Raunkiaer, 1934). Small mammals were trapped in the field based on mapped vegetation habitats. In total 41 habitats unit were mapped in which 3 or 4 sites were selected from each habitat for setting the traps. A minimum of 100 traps were used for each site. Sherman live trap, local wire cage and pit fall trap were used in order to increase the number of different species captured. The bait consisted of mixture of peanut butter, maize brand and small fish. The traps were placed five meters apart and left open during an average of two consecutive days. The trapped animals were counted, identified according to (Kingdon, 1997) and preserves initially in 10% formalin but transfered later into 70% ethanol. All prepared small mammals were deposited at the Sokoine University of Agriculture Pest Management Center for further study. Fleas were brushed from each animal, counted and paralyzed using ethanol 99.9%. The trapped small mammals and associated fleas data were compiled in excel spread sheet while the vegetation habitat data were spatially analyzed using ILWIS and ArcView GIS software. Statistical analyses were performed using SPSS, COSTAT, and Excel-Stat 2009. A stepwise multiple regression was accomplished using the Minitab 2004 software for developing model for reservoirs and vectors related to different vegetation habitat and some selected landscape characteristics (landform, altitude, and slope).

Research Application

Vegetation map at a scale of 1:20.000 was produced portraying more than 200 vegetation habitats. About 188 small mammals were trapped from the vegetation habitats and included 13 species. The general trap success for each habitat was around 3%. There was a significant difference ($P<0.001$) within the general habitats in terms of small mammal's trap success. Forest plantations attracted more small mammals followed by cultivation, shrub, natural forest, herbaceous and settlement compounds. The highest species diversity ("PiLn=0.81) was found within shrub followed by forest plantations (0.74). The observed small mammals' species in different habitat showed that *Mastomys natalensis* dominated in cultivations (80%) while *Praomys delectorum* was dominant in natural forest (60%). Six species were present within forest plantations including *Crocidura* spp., *Grammomys* spp., *Lophuromys flavopuntatus*, *M. natalensis*, *Mus minutoides* and *P.*

delectorum. *Rattus rattus* was found in settlement compounds. *Aethomys* spp. and *Grammomys* spp. were more common in herbaceous while *L. flavopuntatus* and *Grammomys* spp. were more common in shrub habitats (75%).

The results show further that the predictive model for trap success was given by the following relationship:

$$y_{Tsucc} = -0.327X_1 - 0.00189X_2 + 2.3X_3 + 0.48X_4 + 17973$$

Where Y_{Tsucc} was the trap success responses, X_1=Total vegetation cover, X_2=Easting Coordinate, X_3=Altitude and X_4=Species Number.

The mean number of fleas brushed from the small mammals was low (0.97) when compared to the total number of the trapped small mammals (188). No significant difference was found between fleas (P=0.3782) within vegetation habitats (n= 41). However, natural forest and herbaceous habitats had an average of two fleas while the rest of the habitats had less than one. The predictive model for fleas was explained by the following relationship:

$$y_{fleas} = -0.64X_1 + 2.64$$

Recommendation

The study demonstrated that forest plantations, cultivation and shrub habitats were important plague reservoirs in the study area. Fleas (plague vectors) were common in natural forest and herbaceous habitats. However, for these results to be applicable further research on vegetation habitat-plague reservoirs and vectors relationship are needed.

Acknowledgment

We thank SADC/ICART for sponsoring the research work. Special recognition is to the SUA-VLIR Own Initiative Project acronym 'Landscape-Ecological Clarification of Bubonic Plague Distribution and Outbreaks in the Western Usamabara Mountains, Tanzania (LEPUS)" which granted materials, training and logistics during field work.

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