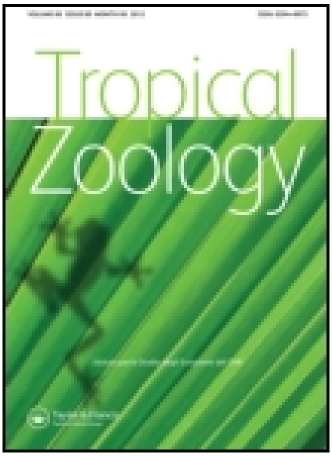

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Forest blocks and altitude as indicators of Myomys albipes (Rüppell 1842) (Mammalia Rodentia) distribution in Ethiopia

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Forest blocks and altitude as indicators of *Myomys albipes* (Rüppell 1842) (Mammalia Rodentia) distribution in Ethiopia

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Myomys albipes (Rüppel 1842) is an endemic rodent of the Ethiopian plateau. It occurs most commonly at altitudes between 1500 and 3300 m a.s.l. Its habitat varies from forest to scrub and the high altitude heathland. Information on altitude, vegetation, trap nights, trapping success and proportion of *M. albipes* in the catch were available for 26 localities throughout its distribution area. These were used to estimate the chances of finding the species at a given site. The species prefers the dense forests that are progressively shrinking, so perhaps it can be used as a reliable indicator of forest block reduction on an historical basis.

KEY WORDS: *Myomys albipes*, African rodents, Ethiopia.

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INTRODUCTION

The Ethiopian relief includes a range of altitudes from below sea level to 4620 m a.s.l., and 40% of the country consists of extensive highlands above 2500 m a.s.l. These extensive plateaus are bisected centrally by the Rift Valley. Although the highlands constitute less than 50% of the total area of the country, they harbour 74% of the human population.

Agriculture has been the main human activity during the past 4 millennia, and, through time, this has resulted in an extensive modification of the vegetation. The forests have been cleared for settlement and cultivation of crops and the recent rapid population increase has led to plundering of the natural forest at a faster rate. The dense forest, once estimated to encompass 40% of the country, has shrunk to less than 4% (EMA 1988). The disturbance to the vegetation is also likely to affect the diverse fauna of the country.

At present, 277 mammalian species have been recorded from Ethiopia (YALDEN & LARGEN 1992, HILLMAN 1993, YALDEN et al. 1996), 11% of these species are endemic, and the country is second only to Madagascar for mammalian endemism (WORLD CONSERVATION MONITORING CENTRE 1992). The small mammal fauna is particularly diverse. So far, 70 species of rodents have been recorded from Ethiopia, of which 21% are endemic. Among the nine families of rodents that occur in Ethiopia, the family Muridae comprises 57 species (84%) of the total and 93% of the total endemic rodents. About 50% of the Ethiopian endemic mammals are rodents.

One of these Ethiopian endemic rodent species is *Myomys albipes* (Rüppell 1842). This species is the most widespread of the Ethiopian endemics. It frequents forest habitats at altitudes mostly above 1500 m a.s.l. Its distribution was recorded from the literature and museum collections by YALDEN et al. (1976). More information on the distribution of the species has become available since then.

However, due to the destruction of many forest blocks in different regions of Ethiopia, it is anticipated that the widespread distribution of the species will shrink in time. Deforestation in Ethiopia was a serious issue even prior to the First World War (PANKHURST 1989). The recent civil unrest and temporary loss of law and order have greatly contributed to accelerating deforestation in Ethiopia. Localities famous for their faunal diversity like the Bale Mountains have also been affected recently (MIEHE & MIEHE 1994).

The present study is to assess the actual distribution of *M. albipes* in relation to its expected range basing upon published data. What are the chances of finding the species at a given site, using habitat and altitude as criteria? Is it possible to conclude that the distribution of the species is an indicator of forest habitat, past and present?

MATERIALS AND METHODS

Twenty-six localities were identified (Fig. 1 and Table 1) on the basis of data from previous research work carried out by RUPP (1980), YALDEN (1988) and AFEWORK BEKELE (1994, 1996). These localities, although they do not cover every habitat block where the species occurs, are a fair representation of the major regions. The available information on vegetation type was sorted according to coverage and tree height as follows: 1 = moorland, 2 = savannah woodland, 3 = heathland, 4 = scrub, 5 = forest scrub, and 6 = forest.

Each locality is represented by the number of rodent species, the total trap nights and the trap success, the number of rodents trapped and the proportion of *M. albipes* in the total catch (Table 1). The altitude considered in the present study ranges from 515 m to 3925 m a.s.l., localities below 1500 m being included for comparative purposes.

Contour plots were used to visualise the proportion of *M. albipes*, vegetation and altitude. A contour plot is a projection of a three dimensional figure on to a two dimensional plane. The third dimension is given by the proportion of *M. albipes* in the catch, which is presented as a smoothed image of the raw data. The plane is divided into areas by isolines predicting where certain values of the third variable are expected to occur. We adopted the least squares smoothing procedure where the influence of individual points decreases with the horizontal distance from the respective point on the surface.

To estimate the chance of finding *M. albipes* at a given locality, we used multiple regression where the proportion of *M. albipes* trapped was the predicted variable; and altitude, vegetation type, number of species and the trapping success were the predictors. In order to avoid the effect of

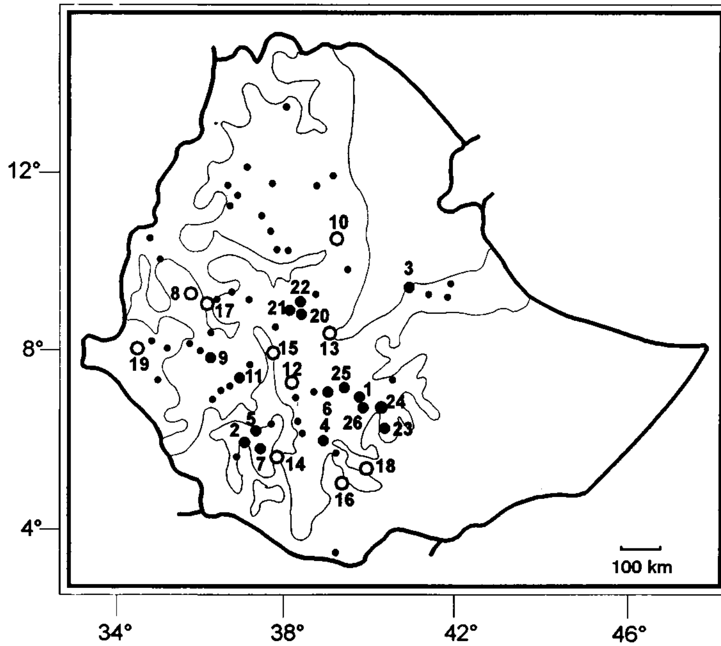

Fig. 1. — Map of Ethiopia showing the recorded distribution of *Myomys albipes* (solid circles). Large circles indicate localities analyzed, with absence (open circles) or presence of *M. albipes* (solid circles). Reference numbers identify localities as in Table 1 and the figure includes an approximate 1500 m a.s.l. contour line.

categorical and not ordinal vegetation scores from 1 to 6, each vegetation variable was broken into 5 two-state 0, 1 codes that give the same information.

Cook's D and R student were used to estimate the influence of each observation. Cook's D measures the change to the estimates that results from deleting each observation. R student is another measure of each observation's influence over the estimate; a cut-off larger than two indicates observations that need further investigation.

RESULTS

The proportion of *M. albipes* in the catch shows a positive correlation with altitude (0.428, $P < 0.03$). There is no correlation with the number of species or with trapping success. There is an obvious positive correlation between trapping success and the number of rodents collected, but this has no relation with the proportion of *M. albipes*, i.e. an increment of trap nights does not necessarily imply an increased chance of collecting the species in a given locality.

The contour plot with the predicted capture proportion of *M. albipes* plotted as a function of vegetation and altitude is shown in Fig. 2. It is clear that the highest proportions are found at higher altitudes in forest and forest scrub, although in

Table 1.
Localities, location, altitude, vegetation, trap night and trapping success, number of species and proportion of *M. albipes*.

Population	Reference number	Location	Altitude	Vegetation	Trap nights and trapping success	Number of rodent species	Proportion of *M. albipes* (%)
Gambela [1]	19	08°15'N-39°35'E	515	savannah woodland	70 (18.6%)	3	0.0
Genale [1]	18	05°32'N-39°41'E	1000	savannah woodland	120 (3.3%)	2	0.0
Didessa [1]	17	09°04'N-36°10'E	1200	savannah woodland	230 (16.5%)	6	0.0
Neghele [1]	16	05°19'N-39°36'E	1400	savannah woodland	300 (0.0%)	0	0.0
Arba Minch [1]	14	06°03'N-37°38'E	1500	savannah woodland	607 (22.7%)	8	0.0
Omo-Tal [1]	15	08°13'N-37°40'E	1500	savannah woodland	100 (1.0%)	1	0.0
Maslo [3]	23	06°22'N-38°49'E	1510	scrub	90 (8.9%)	2	0.0
Koka [1]	13	08°27'N-39°06'E	1700	scrub	80 (13.8%)	4	0.0
Jimma [1]	11	07°38'N-36°45'E	1800	forest	670 (26.7%)	10	6.1
Shamana [1]	12	07°08'N-38°20'E	1800	scrub	50 (6.0%)	2	0.0
Harenna [3]	24	06°30'N-39°50'E	1975	forest	678 (18.6%)	6	47.6
Urumu [1]	9	08°15'N-36°10'E	2000	forest	520 (21.8%)	10	47.8
Majete [1]	10	10°25'N-39°45'E	2000	scrub	60 (20.0%)	4	0.0
Ghimbi [1]	8	09°10'N-35°50'E	2150	forest	80 (16.3%)	2	0.0
Menaghesha scrub [2]	20	08°56'N-38°31'E	2250	scrub	868 (9.4%)	6	50.0
Dorsey [1]	7	06°13'N-37°40'E	2400	forest/scrub	370 (18.6%)	5	11.6
Chenca [1]	5	06°16'N-37°40'E	2500	scrub	615 (28.3%)	9	49.4
Adaba [1]	6	07°03'N-39°33'E	2500	forest/scrub	60 (21.7%)	2	92.3
Menaghesha forest [2]	21	08°58'N-38°32'E	2550	forest	1712 (8.0%)	5	70.8
Kibre Mengist [1]	4	06°15'N-38°42'E	2700	forest	80 (5.0%)	2	75.0
Hirna [1]	3	09°15'N-41°14'E	2900	forest	60 (16.7%)	2	90.0
Bulto - Bonke [1]	2	06°05'N-37°23'E	2950	heathland	240 (40.8%)	5	56.0
Menaghesha heathland [2]	22	08°58'N-38°35'E	3050	heathland	604 (10.9%)	5	31.8
Dinshu [3]	25	07°06'N-39°48'E	3215	heathland	425 (14.1%)	6	23.3
Bale - Goba [1]	1	06°58'N-39°59'E	3300	heathland	220 (35.4%)	6	2.6
Sanetti [3]	26	06°52'N-39°57'E	3925	moorland	100 (24.0%)	7	0.0

[1] Rupp (1980); [2] Afework Bekele (1994); [3] Yalden (1988).

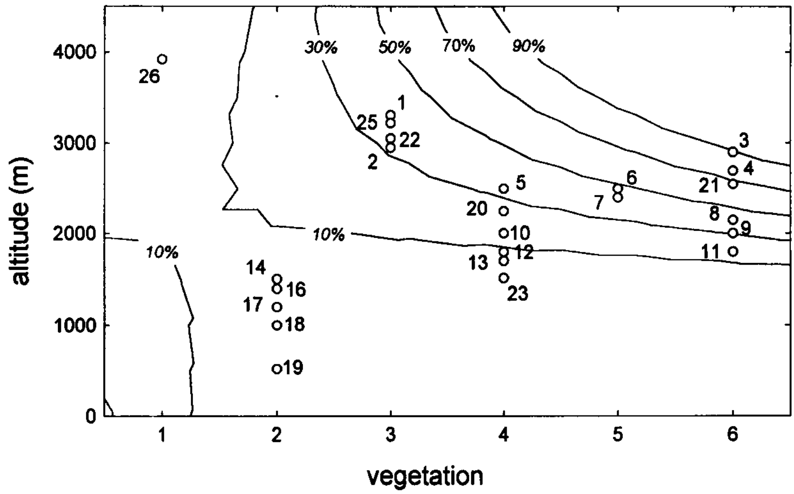

Fig. 2. — Contour plot of predicted variation in capture proportion of *Myomys albipes* with altitude and vegetation type. The capture proportion is indicated by isolines drawn at values of 10, 30, 50, 70 and 90%. Reference numbers of localities are as in Table 1, vegetation types are as defined in the text.

heathland at the greatest elevations the proportion begins to decline. The lowest occurrence of *M. albipes* recorded in this survey is in forest at 1800 m, although the species can be found in scrub at higher elevations.

There is a wide area in the plot where the species does not occur, i.e. where the proportion is < 10%. This area comprises all altitudes below 1800 m, irrespective of vegetation type, and open moorland at the highest elevations. There is thus a clear trend for an increase of capture proportion as altitude decreases and vegetation changes from moorland to dense forest. There are two localities which apparently do not fit the model, i.e. Ghimbi (8) and Majete (10). They both have zero value for the capture proportion but they occur in areas with predicted values between 30-50% and 10-30% respectively. Although in Ghimbi no *M. albipes* was found, this is a forest locality at an altitude higher than other similar forest localities where the species does occur. The inclusion of Majete in the area with values > 10% is forced irrespective of the algorithm used (i.e. smoothing through linear, quadratic, negative exponential or spline).

Partial correlation and beta with the capture proportion of *M. albipes* is 0.676, for $P < 0.05$. The R^2 is 0.579 and the adjusted R^2 is 0.38. R^2 and adjusted R^2 for altitude and vegetation only are 0.574 and 0.499 respectively, suggesting that the capture proportion of *M. albipes* is mostly influenced by these two variables. Analysis of variance proved to be significant, with $F = 2.92$, $P = 0.03$.

Cook's D values range between 0.57 (Adaba and Dorsey) and 0.0001 (Didessa and Maslo) (mean = 0.11). These two latter localities are those for which residuals are the lowest and near to zero. Adaba, Dorsey, Bulto and Bale-Goba are the cases with the highest Cook's D values and therefore the highest influence over the estimate.

There are two localities presenting an R student value higher than two, i.e. Adaba and Ghimbi. They have the highest residuals, i.e. there is a very high proportion of *M. albipes* in Adaba and absence in Ghimbi (Table 1). Although there is no correlation between R student and the total number of trap nights (Table 1), still Ghimbi and Adaba are among the localities with the lowest number of trapnights and this may affect the findings.

DISCUSSION

This study concentrated on the recorded distribution of *M. albipes* from localities selected only because of the availability of data on the vegetation at these sites. Other localities, from different investigators who did not give information on vegetation, were not considered. Although the recorded distribution of the species is given in Fig. 1, this does not mean that an exhaustive survey throughout the country has been carried out and further range extension of the species is expected as more sites are surveyed.

Moreover, there is an indication that, due to habitat interference by human activities, the species has become commensal at some localities. This might be due to the effect of deforestation and as a result of introducing and protecting hedges with fences surrounding each house, as observed by MÜLLER (1977) in the Simien Mountains and from a preliminary survey at Entoto (near Addis Ababa) by the first author.

The records show that the species is also distributed outside the 1500 m limit in the western part of the Ethiopia (Fig. 1). This is not surprising, as the western part of the country receives high rainfall (DANIEL GAMACHU 1977). As a result, high humidity and extensive areas of broadleaf forest are frequent in these areas at low altitudes. In the southwestern part of Ethiopia, the record shows the occurrence of the species as low as 1285 m at Merab Abaya (DORST 1972) and 820 m at Godare (YALDEN et al. 1976). The other record outside the normal range is at the steep escarpment at the southern edge of the country. More information on the surrounding vegetation would reveal more about the ecology of the species at such places.

Multiple regression and the contour plot clearly indicate how the distribution of *M. albipes* is a function of altitude and vegetation (Fig. 2). The species does not occur in habitats where the vegetation cover is scarce as in the moorland of the Bale mountains (Sanetti) or in the savannah woodlands typical of lower altitudes. It does occur in scrub habitat but at altitudes above 2000 m a.s.l. To find the species at lower altitudes, the vegetation cover must be dense and rich, such as in the forests of Urumu and Jimma. Altitude does not seem to impose severe limits on distribution, since dense vegetation coverage allows the species to exist at surprisingly low elevations.

The same is true at altitudes higher than 3000 m. The species is abundant in montane forests such as those at Hirna and Kibre Mengist, and is still abundant in the heathland above 3000 m, although there is a very sharp decrease down to complete absence in the moorland. Multiple regression clearly suggests that forest blocks between 1800 and 3000 m are the most favourable habitat for the species, with the highest population densities.

Although *M. albipes* is the best recorded of the Ethiopian endemic rodents, more information on the distribution and association of the species with vegetation types will be obtained as further exploration is conducted. The distribution of any species is ultimately determined by many environmental factors, including rainfall, temperature, soil type, predators, food supply, etc., and only two components out of many have been used here. Future surveys should focus not only on the distribution of the species, but also upon the precise habitat and altitude at each collection site. If the occurrence of this species can be demonstrated as a reliable indicator of past and present forest distribution, it could provide a valuable mean of documenting historical changes in such habitats, and so contribute to conservation strategy. Continuing the study further by surveying more sites, including localities with different vegetation zones, is indispensable to test this hypothesis.

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