

**THE STUDY OF DIVERSITY, DISTRIBUTION, RELATIVE ABUNDANCE AND  
HABITAT ASSOCIATION OF SMALL MAMMALS IN APNP, NORTH GONDAR  
ZONE, ANRS, N. ETHIOPIA.**

**A Thesis submitted to the School of Graduate Studies  
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**In partial Fulfillment of the Requirement for the Degree of Master  
of Science in Biology**

**By**

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**DEDICATION**

This work is dedicated to my wife Bizunesh Gaddisa, my son Gemechiis and daughter Si'ifan Tadesse for their patience.

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## Appendix I. List of the major vegetation species in APNP.

## A. Tree species

*Combretum spp.*

1. *Pterocarpus lucens*
2. *Terminalia laxiflora*
3. *Anogeissus leiocarpus*
4. *Acacia seyal*
5. *Acacia seberana*
6. *Lannea fruticosa*
7. *Balanites aegyptiaca*
8. *Allophylus macrobutrys*
9. *Oxytenanthera abyssinica*
10. *Combretum hartmannianum*
11. *Acacia polycantha*
12. *Combretum mole*
13. *Entada africana*
14. *Piliostigma thonningii*
15. *Ficus sicomorus*
16. *Ficus mochtteri*
17. *Ficus pamata*
18. *Ficus gnpalocarpa*
19. *Combretum collinum*
20. *Lonchocarpus laxiflora*
21. *Cordia ternitolia*
22. *Tamarindus indica*
23. *Xemenia americana*

24. *Hyphaene thebaica*
25. *Acacia nilotica*
26. *Grewia mollis*
27. *Boswellia papyrifera*
28. *Adansonia digitata*

b. Grass species

1. *Hyparrhenia cynescence*
2. *Rottboellia cochinchinensis*
3. *Hyparrhenia subplumosa*
4. *Sorghum sudanensis*
5. *Sorghum versicolor*
6. *Pennisetum unistem*
7. *Pennisetum schwinturthis*
8. *Andropogon gayanus*
9. *Echinochloa spp.*

## Appendix II. List of large mammals in APNP.

| Scientific name                   | Common name          |
|-----------------------------------|----------------------|
| <i>Civettictis civetta</i>        | African civet        |
| <i>Papio anubis</i>               | Anubis baboon        |
| <i>Conis adustus</i>              | Side striped Jakal   |
| <i>Orycteropus afer</i>           | Aardvark             |
| <i>Syncerus caffer</i>            | Buffalo              |
| <i>Tragelaphus scriptus</i>       | Bushbuck             |
| <i>Loxodonta africana</i>         | Elephant             |
| <i>Tragelaphus strepsiceros</i>   | Greater kudu         |
| <i>Sylvicapra girmmia</i>         | common duicker       |
| <i>Chlorocebus aethiops</i>       | Greavet monkey       |
| <i>Panthera pardus</i>            | Leopard              |
| <i>Ourebia ovrebi</i>             | Oribi                |
| <i>Mellivora capensis</i>         | Ratel (Honey badger) |
| <i>Crocuta crocuta</i>            | Spotted hyaena       |
| <i>Felis serval</i>               | Serval cat           |
| <i>Panthera leo</i>               | Lion                 |
| <i>Chlorocebus aethiops pygmy</i> | Vervet monkey        |
| <i>Phacochoerus aethiopicus</i>   | Warthog              |
| <i>Ourebia ourebi</i>             | Oribi                |

## Appendix III. List of major bird species in APNP.

| Scientific name                      | Common name                           |
|--------------------------------------|---------------------------------------|
| 1. <i>Leptoptilos crumeniferus</i>   | Marabou                               |
| 2. <i>Botrychia hagedash</i>         | Hadida                                |
| 3. <i>Alopchen aegyptiacus</i>       | Egyptian Goose                        |
| 4. <i>Milvus nigrans</i>             | Black kite                            |
| 5. <i>Francolinus clappertoni</i>    | Clappertons Francolin                 |
| 6. <i>Numida meleagris</i>           | Helmented Guinea fowl                 |
| 7. <i>Oena capensis</i>              | namaque Dove                          |
| 8. <i>Streptopelia dicipiens</i>     | Maurining Dove                        |
| 9. <i>Streptopelia senegalensis</i>  | Laughing Dove                         |
| 10. <i>Turtur abyssinicus</i>        | Black - billed wood Dove              |
| 11. <i>Clamator glandarius</i>       | Senegal coucal                        |
| 12. <i>Ceryle rudis</i>              | pie king fisher                       |
| 13. <i>Merops nubicus</i>            | Carrmine Bee-eater                    |
| 14. <i>Merops posillus</i>           | Little Bee-eater                      |
| 15. <i>Tochus nasutus</i>            | Grey Hornbill                         |
| 16. <i>Indicator indicator</i>       | Black-throated Honey guide            |
| 17. <i>Lanius nubicus</i>            | Nubian (masked) Shrike                |
| 18. <i>Lamprotornis chalybaeus</i>   | Blue-eared Glossy                     |
| 19. <i>Lamprotornis purpurpterus</i> | Ruppell's long tailed Glossy starling |
| 20. <i>Coracias abyssinicus</i>      | Abyssinian roller                     |
| 21. <i>Upopupa epops</i>             | African wood hoopoe                   |
| 22. <i>Laniarius erythrogaster</i>   | Black headed gonotek                  |
| 23. <i>Uraegnthus cyanocephalus</i>  | Blue capped corden blue               |

|                                      |                                  |
|--------------------------------------|----------------------------------|
| 24. <i>Turtur chaleospilos</i>       | <i>Emerald spotted wood dove</i> |
| 25. <i>Indicator minor</i>           | <i>Lesser hony guide</i>         |
| 26. <i>Ploceus lueolus</i>           | Black headed weaver              |
| 27. <i>Streptopetia senegalensis</i> | Laughing dove                    |
| 28. <i>Egretta alba</i>              | Great white egret                |
| 29. <i>Columba guina</i>             | Speckled pigion                  |
| 30. <i>Francollinus squamatus</i>    | Scally francolin                 |
| 31. <i>Lamprotornis puprputerus</i>  | Long tailed glossy starling      |
| 32. <i>Cisticola nana</i>            | Tiny cisticola                   |
| 33. <i>Aquila rapax</i>              | Towny eagle                      |
| 34. <i>Eplectes ater</i>             | Yellow crowned bishop            |
| 35. <i>Ciconia ciconia</i>           | White stork                      |
| 36. <i>Aegypticus occupitalis</i>    | White headed vulture             |
| 37. <i>Cisticola jundcidis</i>       | Zetting cisticola                |
| 38. <i>Cisticola njombe</i>          | Red-pate cisticola               |
| 39. <i>Pondion haliaetus</i>         | Osprey                           |
| 40. <i>Scopus umbretta</i>           | Hammer kop                       |
| 41. <i>Cercomlla familiaris</i>      | Familiar chat                    |
| 42. <i>Logonostica rubricata</i>     | African fire finch               |
| 43. <i>Dicrurus adsmilis</i>         | African drungo                   |
| 44. <i>Micraetus splinagaster</i>    | African hawk eagle               |
| 45. <i>Trudus pelios</i>             | African trush                    |
| 46. <i>Motacilla cinerea</i>         | Grey wagtail                     |
| 47. <i>Micomius gabar</i>            | Gabar Goshwak                    |
| 48. <i>Merops Orientalis</i>         | Little bee eater                 |

Source: Girma Mengesha, MSc Thesis, 2005 (in processing)

Appendix IV. Vernacular name (Gumuz) of the 26 species of fishes in Dinder River (scientific names not yet identified).

1. Aburda
2. Minsherb
3. Balego
4. Ensliw
5. Begeb
6. Alkewara
7. Tse'i
8. Edech-edech (Hedich-hedich)
9. Buru
10. Alwir
11. Besemir
12. Palolo
13. Hots
14. Aebubel
15. Yemencho
16. Tsepo
17. Zez
18. Boqorqur (Bokokur)
19. Agleb
20. Shelbay
21. Abtumbak
22. Ashmelbelet
23. Pess
24. Imgerputs
25. Suqir (Sukir)
26. Medi

## Appendix V. Geographic coordinates of the study grids in APNP

| <b>Grid</b> | <b>Location</b>   | <b>Habitat type</b> | <b>Local name of the area</b> |
|-------------|---|---------------------|-------------------------------|
| 4           | 12 <sup>0</sup> 19'-12 <sup>0</sup> 23'N<br>35 <sup>0</sup> 34'-35 <sup>0</sup> 37'E  | WGL                 | Dinar mountain                |
| 7           | 12 <sup>0</sup> 12'-12 <sup>0</sup> 13'N<br>35 <sup>0</sup> 30'-35 <sup>0</sup> 33'E  | RWL                 | No local name                 |
| 13          | 12 <sup>0</sup> 06'- 12 <sup>0</sup> 12'N<br>35 <sup>0</sup> 33'-35 <sup>0</sup> 39'E | WGL and<br>RWL      | Megenagna site                |
| 20          | 12 <sup>0</sup> 02'-12 <sup>0</sup> 07'N<br>35 <sup>0</sup> 34'-35 <sup>0</sup> -39'E | WGL                 | Demir Site                    |
| 26          | 11 <sup>0</sup> 55'-12 <sup>0</sup> 01'N<br>35 <sup>0</sup> 28'-35 <sup>0</sup> 33'E  | WL                  | Esub site                     |
| 33          | 11 <sup>0</sup> 53'-11 <sup>0</sup> 56'N<br>35 <sup>0</sup> 33'-35 <sup>0</sup> 37'E  | BWL                 | Ayibaza site                  |
| 37          | 11 <sup>0</sup> 48'-11 <sup>0</sup> 50'N<br>35 <sup>0</sup> 28'-35 <sup>0</sup> 32'E  | WGL                 | Abulta site                   |
| 29          | 11 <sup>0</sup> 50'-11 <sup>0</sup> 55'N<br>35 <sup>0</sup> 16'-35 <sup>0</sup> 22'E  | WGL                 | Omedla site                   |

## Appendix VI- Specific location of trap sites

| <b>Local name of the trap site</b> | <b>Trap location</b> |
|------------------------------------|----------------------|
| Ardeba (RWL)                       | 12°10'N, 35°36'E     |
| Megengagna (WGL)                   | 12°12'N, 35°40'E     |
| Grid 7 (RWL)                       | 12°12'N, 35°34'E     |
| Dinar Mt. (WGL)                    | 12°22'N, 35°37'E     |
| Demir (WGL)                        | 12°07'N, 35°36'E     |
| STS-1 (WGL)                        | 12°04'N, 35°37'E     |
| Esub (WL)                          | 12°01'N, 35°31'E     |
| Ayibaza (BWL)                      | 11°53'N, 35°35'E     |
| Abulta (WGL)                       | 11°49'N, 35°32'E     |
| Omedila (WGL)                      | 11°54'N, 35°20'E     |
| STS-2 (GL)                         | 11°57'N, 35°16'E     |
| H H-1 (commensal)                  | 11°56'N, 35°16'E     |
| HH-2 "                             | 12°17'N, 35°17'E     |
| HHH3 "                             | 12°12'N, 35°53'E     |

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## ABSTRACT

Species composition and ecological studies of small mammals were carried out in Alatish Proposed National Park, Quara Woreda, North Gondar Zone, Amhara National Regional State from August 2004 to March 2005. The four habitat types were grouped under wooded grassland, woodland, riverine woodland and mixed bamboo woodland. Nine representative trapping grids were randomly selected from the four habitats for live trapping. In addition, three special trap sites were also incorporated. These trapping sites yielded 29 species of small mammals as a new record for the area. These comprised, 370 small mammals that included 23 rodent and 6 insectivore species. Of these, three rodent species (Murid sp.A Murid sp. B and *Acomys* sp. A) and a shrew (Soricid sp. A) await for further taxonomic work to be considered as a new species. The trapped rodent species were *Arvicanthis dembeensis*, *Arvicanthis niloticus*, *Desmomys harringtoni*, *Mastomys natalensis*, *Mastomys erythroleucus*, *Myomys albipes*, *Acomys cahirinus*, *Acomys wilsoni*, *Acomys cineraceus*, *Mus musculus*, *Mus tenellus*, *Lemniscomys barbarus*, *Tatera robusta*, *Tatera valida*, *Tatera phillipsi*, *Euxerus erythropus*, and the yet to be identified rodents, Murid sp. A, Murid sp. B and *Acomys* sp. A. The trapped insectivore species were *Crocidura flavescens*, *Crocidura turba*, *Crocidura fumosa*, *Crocidura smithi*, *Atelerix albiventris* and the yet to be identified shrew, Soricid sp. A. In addition to these, four rodent species *Hystrix cristata*, *Paraxerus ochraceus*, *Heliosciurus gambianus* and *Xerus rutilus* were also observed. The endemic rodent species of the Ethiopian highland forest (*M. albipes* and *D. harringtoni*) were recorded in APNP outside their former altitudinal limits and geographical ranges. Similarly, the three highland dwelling shrews (*C. flavescens*, *C. turba*, and *C. fumosa*) were also recorded outside from their altitudinal limit and geographic range in the country. The occurrence of *M. albipes* and *D. harringtoni* from the Ethio-Sudan border trapping grids indicates the possibility of these species expanding their ranges to the neighbouring country.

Variation in species number between seasons was insignificant. However the dry season trap success was significantly high. Differences in the diversity of species among habitats were highly significant ( $X^2_3=19.5$ ,  $P < 0.001$ ). Wooded grassland habitats yielded more number of species than others. The number of species captured in different grids of each habitat showed great variation. Seasonal migration of small mammals among habitats was clearly observed. During the wet season, migration to the wooded grassland was common. These revert back to the other three habitats during the dry season. During the dry season forest fire, excessive grazing and lack of water and during the wet season flooding, humid and moist microhabitats were the major reasons for the seasonal movements. Breeding in most small mammalian species of APNP was seasonal and seemed to be associated with rainfall. 70% of the rodent species of APNP were important components of diets for the indigenous Gumuz people living surrounding the park area. 41% of the small mammals obtained in the APNP are pests. 31% of the total species move between villages and the park area. These were considered notorious pests. The high diversity of small mammals coupled with less number of settlers in the area should enhance the idea of proclaiming it as a conservation centre.

**Appendix VII**  
**Species diversity index (H') for the three major habitats & richness index for each sp.**

**For RWL**

| Species (S) | No. of ind. (I) | Proportion $P_i I/\Sigma I$ | $P_i^2$ | $p_i \ln p_i$                                     | Species richness $S-1/\ln(N)$ |
|-------------|-----------------|-----------------------------|---------|---|-------------------------------|
| An          | 10              | .25                         | 0.062   | -0.346  | 3.04                          |
| Ad          | 14              | 0.35                        | 0.123   | -0.367  | 2.66                          |
| Ac          | 2               | .05                         | .003    | -0.149  | 10.14                         |
| Mn          | 3               | 0.08                        | 0.006   | -0.202  | 6.42                          |
| Aco A       | 2               | 0.05                        | 0.030   | -0.149  | 10.14                         |
| Tv          | 2               | 0.05                        | 0.030   | -0.149  | 10.14                         |
| MsB         | 5               | 0.13                        | 0.016   | -0.265  | 4.34                          |
| Lb          | 2               | 0.05                        | 0.030   | -0.149  | 10.14                         |
|             | 40              | 01.01                       | 0.3     | $-\Sigma p_i \ln p_i =$<br>-1.776<br>$H' = 1.766$ |                               |

**For BWL**

| Sp. | No. of individ (N) | Proportion of (Pi) $P_i/\Sigma N$ | $P_i^2$ | $P_i \ln p_i$ | $(S-1)/\ln(N)$ |
|-----|--------------------|-----------------------------------|---------|---------------|----------------|
| An  | 17                 | 0.27                              | 0.075   | -.353         | 1.77           |
| Ad  | 28                 | 0.45                              | 0.203   | -.359         | 1.50           |
| Dh  | 8                  | 0.13                              | 0.016   | -.265         | 4.63           |
| Mn  | 3                  | 0.05                              | 0.002   | -.149         | 2.41           |
| Ac  | 2                  | 0.03                              | 0.001   | -.0105        | 4.58           |
| As  | 4                  | 0.06                              | 0.004   | -.0168        | 7.24           |
|     | 62                 | 0.99                              | 0.301   | -1.399        |                |

$H' = 1.399$

## For WGL

| Sp.       | N   | Pi (Proportion) | Pi <sup>2</sup> | PiInpi | S-1 / in (N) |
|-----------|-----|-----------------|-----------------|--------|--------------|
| An        | 43  | 0.25            | 0.063           | -0.346 | 4.25         |
| Ad        | 49  | 0.28            | 0.082           | -0.356 | 4.11         |
| Dh        | 12  | 0.07            | 0.005           | 0.186  | 6.45         |
| Mn        | 10  | 0.06            | 0.003           | 0.168  | 6.95         |
| Ma        | 6   | 0.04            | 0.001           | -0.128 | 8.95         |
| Me        | 5   | 0.03            | 0.001           | 0.105  | 10.0         |
| Ac        | 10  | 0.06            | 0.003           | 0.168  | 6.95         |
| Aw        | 5   | 0.03            | 0.001           | 0.105  | 10           |
| AC        | 5   | 0.03            | 0.001           | 0.105  | 10           |
| Tr        | 2   | 0.01            | 0.0001          | 0.046  | 23           |
| Tv        | 2   | 0.01            | 0.0001          | 0.046  | 23           |
| Tphi      | 3   | 0.01            | 0.0001          | 0.046  | 14.6         |
| MsB       | 2   | 0.01            | 0.0001          | 0.046  | 23           |
| Aa        | 2   | 0.01            | 0.0001          | 0.046  | 23           |
| C.f       | 7   | 0.04            | 0.002           | 0.128  | 8.2          |
| C. fumosa | 4   | 0.02            | 0.001           | -0.078 | 11.59        |
| Cs        | 2   | 0.01            | 0.0001          | 0.046  | 23           |
|           | 171 |                 |                 | -2.195 |              |

$$H^2=2.195$$

An = *Arvicanthis niloticus*

Ad = *A. dembeensis*

Dh = *D. harringtoni*

Mn = *M. natalensis*

Ma = *M. albipes*

Me = *M. erythroleucus*

Ac = *A. cahirinus*

Aw = *A. wilsoni*

AC = *A. cineraceus*

Tr = *T. robusta*

Tv = *T. valida*

Tphi = *T. phillipsi*

MsB = Murid sp. B

Aa = *A. albirentis*

C.f = *Crocidura flavescens*

C.f = *C. fumosa*

Cs = *C. smithi*

Lb = *L. barbarus*

Asp A = *Acomys* sp.A

## **DECLARATION**

I, the undersigned, declared that this thesis is my work and all sources of Material used for the thesis have been duly acknowledged.

Name

TADESSE HABTAMU

Signature.....

Place and Date of Submission

Addis Ababa University

Addis Ababa

June 2005.

1969; Fiedler, 1994; Sillero-Zubiri, *et al.*, 1995) and behavioural adaptations for avoiding intense heat through nocturnal activity (staying in burrows during the day, and some others aestivating during the hottest time of the year) (Fiedler, 1994). Morphological adaptations such as long and tufted tail, longer hind legs, big eyes and ears are also manifested (Macdonald & Fenn, 1994).

Rodents are known to have economic, ecological, social and cultural values. Some rodent species (less than 5% ) are pests and cause significant losses to agricultural crops in many regions of the world (Singleton *et al.*, 2003). According to the World Food and Agricultural Organization (FAO) average annual estimate, rodent pests worldwide consume 42.5 million tonnes of food worth 30 billion US\$ (Stoddart, 1984). Rodents cause 5-10% preharvest and up to 20% post-harvest rice loss in Asia (Singlten, 2001). Singleton *et al.* (2003) reported that in Asia alone, the amount of rice eaten by rodents in rice fields each year would provide enough to feed 200 million Asians for a year. In 1999-2000-harvest season, rats in Australian cane fields destroyed approximately 825,000 tonnes of sugarcane valued at US \$ 50 million (Smith *et al.*, 2003).

Seventy-seven species of rodents in Africa and 35 species in Eastern Africa are known to damage field or stored crops (Fiedler, 1994). Eleven species of rodents consume or destroy up to 20% cereal crops in some years in Ethiopia (Afework Bekele & Leirs, 1997). Afework Bekele *et al.* (2003) have also estimated yield loss at harvesting stage of maize as 26.4% in Ziway farm, Ethiopia. Similarly, during the serious outbreaks of rodents, some areas in Kenya experiencing up to 90% maize harvest loss (Odhiambo & Oguge, 2003). Rodents are also involved in the transmission of more than 20 types of pathogens including plague, leptospirosis, boutonneus fever, marine typhus, brucellosis, Rift Valley fever, etc (Delany, 1972; Stoddart, 1984; Nowak, 1991; Fiedler, 1994).

Rodent outbreak is induced by extensive drought period, which was accompanied by a protracted rain to be responsible for most crop damages and spread of disease worldwide (Taylor, 1972; Fiedler, 1994; Leirs, 1995). Some larger species of rodents have been and still are, sought for food in many parts of the world (Stoddart, 1984). Some are considered very tasty and delicacy when available (e.g. Porcupines *Hystrix spp.* & *Arvicanthis spp.* in Gimuz natives, Ethiopia). Special efforts to capture from the wild include trapping, digging, smoking and flooding burrows.

However, only few such as the guinea pigs and dormice have been deliberately bred for food (Fiedler, 1994). Different species of rats and mice play an important role in different laboratories of the world for biological and medical research (Kingdon, 1974; Stoddart, 1984).

Ecologically, rodents serve as a prey base supporting a diversity of carnivores, raptors and snakes. Because of their rapid response to environmental changes, they serve as good indicators of environmental quality (Linzey & Kesner, 1997). Desert rodents viewed as model organisms for the study of ecological processes (Dickman, 2003). Monitoring of small mammals is a relatively quick and cheap method of indicating healthy or unhealthy ecosystem functioning (Avenant & Watson, 2002). In many instances, rodents provide a major benefit to the environment as bio-indicators (Singleton *et al.*, 2003). They are also of intrinsic interest being composed of a high proportion of little known members (Sillero- Zubiri *et al.*, 1995). Despite these contributions, due to the bad public image of the few pest species, rodents hold the dubious distinction of being one of the small numbers of vertebrate groups where the effort put into eradication and control vastly outweighs the conservation (Amori and Gippoliti, 2000). This situation is made less palatable by the fact that 384 species of rodents are currently classified as ‘vulnerable’, ‘endangered’ or ‘critically endangered (IUCN, 2000).

Over 1150 species of mammals are currently listed for Africa but more mammalian species, specially rodents, insectivores and bats await discovery (Kingdon, 1997). Rodents of East Africa account for about 28% of the total mammal fauna (Kingdon, 1974; Delany, 1986; Kingdon, 1989). Similarly, the African insectivore fauna is the most diverse in the world, and this is particularly true for the shrews (Soricidae) that have nearly 140 species (Hutterer & Yalden, 1990).

Delany (1986) reviewed attempts in Africa over the past decades to survey the ecological distribution and geographical range of small mammals, most of which cover the western part of the continent. In the eastern part, there has been less study for example in Uganda, Kenya and Malawi (Bekele Tsgaye, 1999). The continued discoveries of several new species of small

mammals from Africa (Delany, 1986), however, indicates the need for further emphasis of continued efforts for similar ecological surveys particularly in remote areas.

Ethiopia's past geological history, unique topography and wide ranging climate have made the country home of diverse biological resources (Shibiru Tedla, 1995; Leykun Abune, 2000) with 284 species of mammals of which rodents and shrews account for 39.4% (Yalden & Largen, 1992; Hillman, 1993; Laverenchenko *et al.*, 1997). However, only little more than 17% of the total area, approximately 1.221 900 km<sup>2</sup> (Yalden & Largen, 1992) of the country is ecologically extensively surveyed for small mammals. There is need for further survey as more and more of the habitats are affected as a result of human interference in the ecosystem. Few of the ecological studies of small mammals of Ethiopia are those of Muller (1997), Rupp (1980), Shimelis Beyene (1986), Yalden (1988a, 1988b) Sillero-Zubiri *et al.* (1995), Afework Bekele (1996a, 1996b), Bekele Tsegaye (1999), Tilaye Wube (1999) and Alemu Fetene (2003) focusing on population ecology, habitat selection, habitat use, population dynamics of single species or on rodent community in an area, concentrating on the southwestern forest, south and south-eastern highlands, the Rift Valley areas, the Simen Mountains and few Central Ethiopian highlands and forest areas. The largest lowland areas of the country, more specifically the northwestern lowland ecosystems did not receive any attention as a result of the remoteness of the area. Besides lack of scientific information about the fauna of such areas, opportunities to collect such data are rapidly diminishing due to the ever-accelerating human demand for arable land.

Extended ecological studies in these remote, biologically rich, areas determining the diversity, spatial and temporal distribution, the relative abundance, habitat associations and possible threats of small mammals (rodents and insectivores) will provide a base line information vital for the selection, establishment, designing and implementing the management of conservation areas. This then, presents the results of an ecological study carried out in the Alatish Proposed National Park, North Gondar Zone, Amhara National Regional State, north-western Ethiopia.

The main objectives of this ecological study are to determine the diversity, spatial and temporal distribution, the relative abundance and habitat association and possible threats of the small mammalian fauna (rodents and insectivores) of the Alatish area and establish the importance of Alatish as a unique ecosystem and protected area for the conservation of mammalian species.

## **2.The study area and Method**

### **2.1 The study area**

The study area, Alatish Proposed National Park (APNP), is in Quara Woreda of North Gondar Zone, Amhara National Regional State (ANRS), Northwest Ethiopia (Fig. 1), located between 11<sup>0</sup>47' and 12<sup>0</sup>21'N latitude and 35<sup>0</sup>16' and 35<sup>0</sup>47'E longitude, and covers an area of approximately 2600 km<sup>2</sup> (Fig. 2). APNP is about 1123 km northwest of Addis Ababa, 534 km from Bahirdar (the capital of the ANRS), 324 km southwest of Gondar (the capital of North Gondar Zone) and 34 km northwest of Gelegu, the capital city of Quara Woreda.

APNP shares boundaries with eastern Sudan to the west, Dendir River to the south, Hyma River to the east (the upper part of River Dendir) and Mehadid Kebele to the north. Mehadid, Gelegu and Bambaho Kebeles of Quara Woreda to the north and northeastern Alatish, respectively are the three most important Kebeles adjacent to the proposed park. Similarly Arjamus, Ayibaza, Abulta, Kusli, Anishmish, Balaqur and Omedla Kebeles are also most important Rural Peasant Organizations (RPO's) engulfing the park to the eastern, southeastern and southern parts. All these are administrated under the Benshangul Gumuz National Regional State.

The altitude within the park varies between 528 m a.s.l. at Dendir River basin (most southern lowland) to 654 m a.s.l. at Esub site (the eastern part of central Alatish). In general, the lower central and eastern central parts of the park have a relatively higher elevation and certain peaks in these areas reach as high as 785 m a.s.l. (at Tsiqua Mt.). Alatish also has few isolated and yet very important hills. Among these are 'Yezihon' wuha mauntain (683 m a.s.l.), at the centre of Alatish. Tsiqua Mountain (785 m a.s.l) at the eastern Alatish. Mountain Omedila, at the extreme southwest of Alatish. Mountain Almetani, 11.4 km north of Omedla Mountain has an elevation of 650 m a.s.l. At the northwestern part of Alatish is Mt. Amdog. The smaller peak located at the northern boundary area of Alatis is Mt. Dinar. Mountains Amdog in the northwest, Almetani in the west and Omedla in the southwest part of Alatish comprise a natural border for Ethiopia and Sudan, and hence its western boundaries.

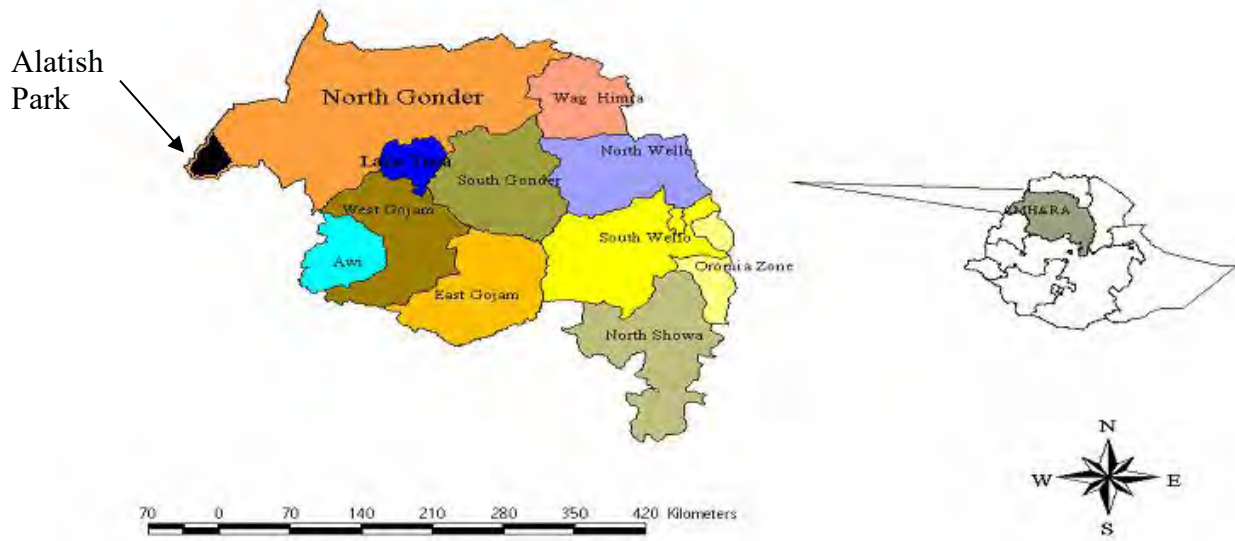


Figure 1. Map of Ethiopia showing the location of the study area, North Gondar Zone.

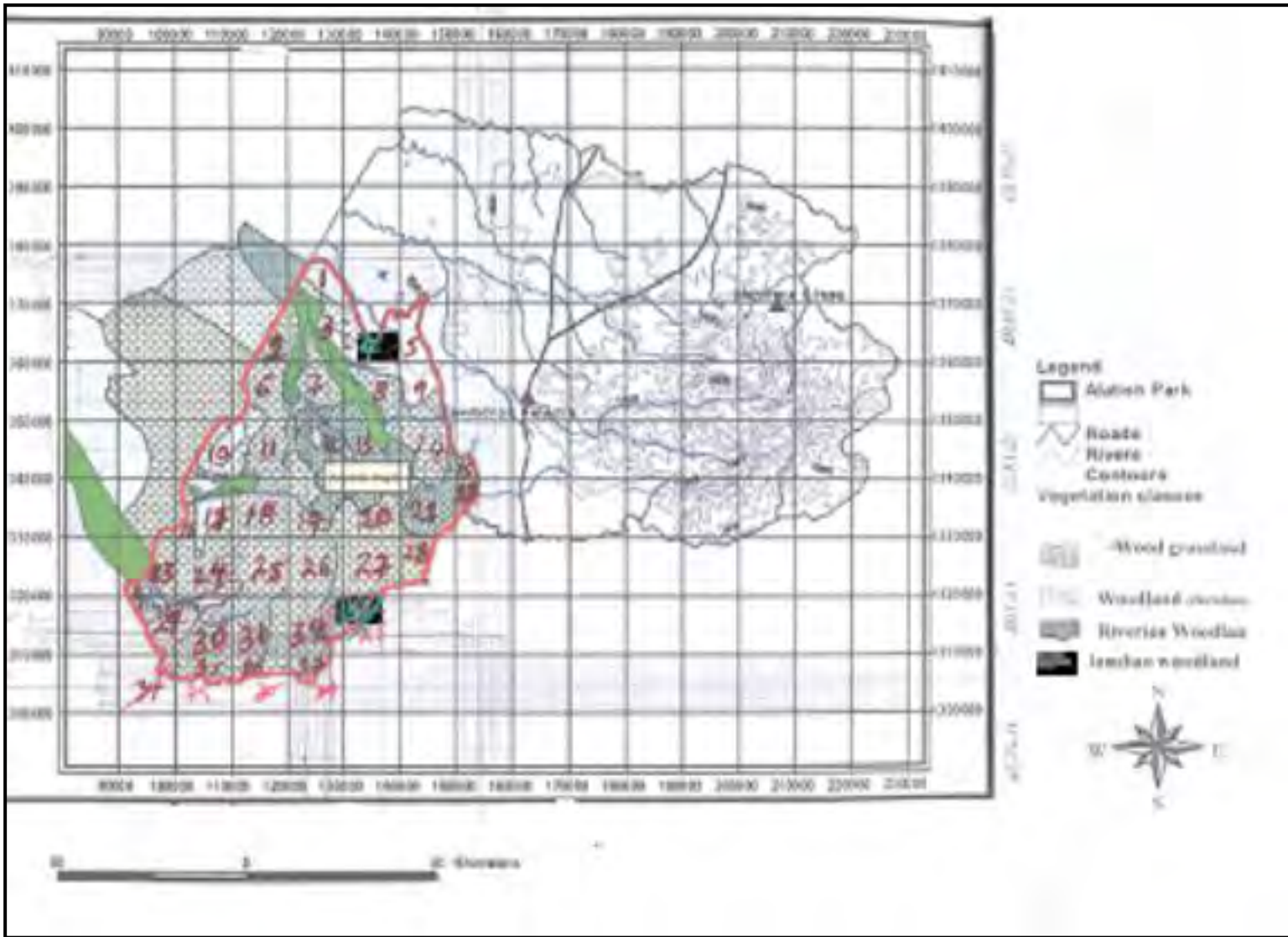


Figure 2. Quara Woreda and the location of Alatish Park.

These hills have geographic importance for the local Gumuz people who by climbing or locating them from far distances determine the direction and estimate the distance of their destination. From the altitudinal gradient, it is estimated that 95% of the Alatis area is flat plain.

### **2.1.1 Geology**

The geological processes that divided the whole Ethiopia into four major physiognomic regions place Alatis area under the northwestern highlands and the associated lowlands (Mesfin Wolde Marriam, 1972).

### **2.1.2. Physical features**

During the Pre-Cambrian Era, Ethiopia was covered with gigantic mountains of oldest igneous and metamorphic rocks, which were folded and faulted by the internal forces from the west and east (Mohr, 1971; Mesfin Wolde Mariam, 1972). During the Paleozoic Era, the Pre-Cambrian surface was intensely subjected to persistent denudation, which lowered and leveled the surface. At the beginning of Mesozoic Era, the peneplained pre-Cambrian surface slowly sunk, and as a result the seas invaded the land. The advancing seas deposited a layer of sandstone along the edge and a layer of limestone that covered the pre-Cambrian rocks. At the end of the Mesozoic Era, the process of sinking gradually stopped and the opposite process, uplifting started and the land slowly emerged out of the sea. The land that emerged out of the seas also had three layer Mesozoic marine sediments namely, the Addigrat Sandstone (the oldest), the Antalo Limestone, and the Upper Sandstone (the youngest). These lie horizontally over the Pre-Cambrian basement complex (Mohr, 1971; Mesfin Wolde Mariam, 1972). At the beginning of the Tertiary period, the Ethiopian land was uplifted by strong internal force. The force was so strong and broke the basement complex and the overlying Mesozoic sediments. It was during these breaks that fluid basaltic lava poured out in immense quantities (Mesfin Wolde Mariam, 1972). The great height of Ethiopian plateau is then the result of this intrusion of lava in the Tertiary period. This thick layer of basalt reaches up to 3000 m deep in the Simen Massifs.

The land that was low at the end of Mesozoic Era rose to thousands of metres above seas level (Mesfin Wolde Mariam, 1972; Yalden & Largen, 1992). But, the northwestern associated

lowlands, where the study area is located, may have remained lowland probably because they may not have experienced uplifting of land mass of the Tertiary period or may not have received the Oligocene and Miocene lava overflows of the area where we now find the Ethiopian plateau. This phenomena made these two altitudinally quite different areas to develop their characteristic climate, flora and fauna. Besides, the Gundo mountain chains that starts at Chilga (2000 m a.s.l.) (Yalden & Largen, 1992) remain the most important barrier for the flora and fauna of these two regions to mix their gene pool. Due to morphological reasons, this is particularly true in the case of small mammals. This is a starting point to predict the existence of unique small mammalian fauna in these areas.

### **2.1.3. Soil**

Two types of soils are identified in the Alatish area (BOA, LUPT, 1999). Most of the plain areas of Alatish are dominated by reddish sandy soil (Euric vertisol). In some patchy area, such as along river basins, eastern and southern wooded grassland, central and east central woodland areas, northern and western meadow areas have black cottony soil (Rigosol). These black soils are extremely sticky during wet season, and crack deeply during the dry season. Because of this, these soils are some times called "self-ploughing" soil. Holsworth (1968) and Dasmann (1972) gave similar description of soil for Dendir National Park of the Sudan that occurred immediately adjacent to Alatish Proposed National Park.

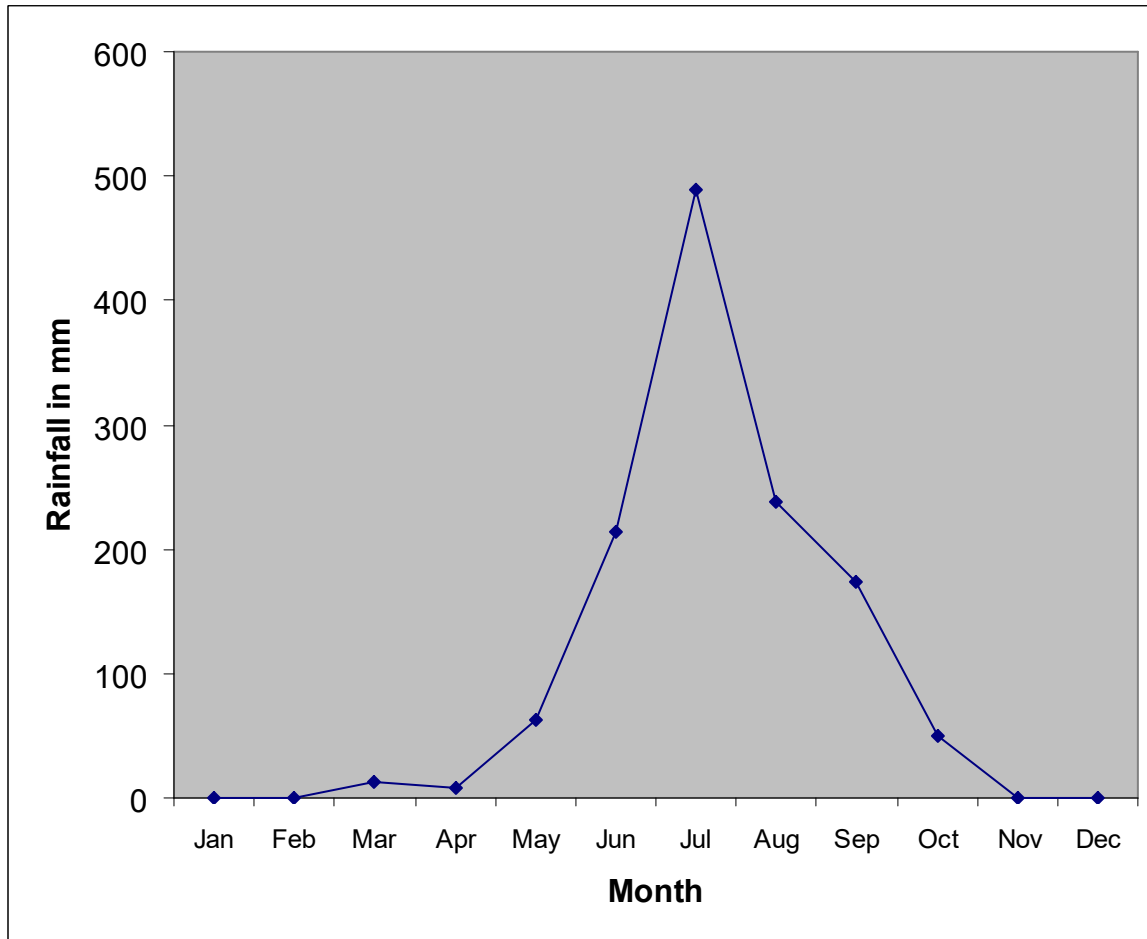
### **2.1.4. Source of Water**

Alatish has no permanent river or stream. But the two important water sources are Alatish and Dendir Rivers both of which drain parts of the northern Ethiopian massifs. These two rivers show seasonal character and they start surging in June and reach peak around the middle of August. However, both cease flowing in November. Alatish River flows south through the centre of APNP dividing the park into two equal halves and joins Dendir River at Omedla. This river has no surface water starting from early November through the dry season. However, people who use the area for grazing, hunting or gathering get to access water by digging the sandy river beds

at any point along its course. Dinder (also called Hyma at the upper part of its course) flows southwest. It forms a natural boundary of the park at the eastern, southeastern and southern part. After joining at Omedl, the Alatish and Dendir Rivers flow out to Sudan. Dinder River is larger, has greater channel and more volume of water than Alatish and its surface flow continues up to late November. When surface water flow ceases, the sandy riverbed, thereafter, is left with numerous pools all along its course. Some of these pools retain much water throughout the dry season. Dinder is the only river with access surface water for wildlife and the surrounding inhabitants. Some of the pools (in deep ditch areas) harbour several fish species. There are several intermittent rivers that are there probably to direct the intense mid-summer desert flood to either of the big rivers. In most of them, there was no sign of water, even under the sand or deep pools. This was observed during the late wet season. The small dry riverbeds include Berenta River, located 9.8 km south of Megenagna (the main park outpost site). Demir River is relatively larger and contains water in one of its big pools located at 12°07'N and 35°36'E, 11.4 km south of Megenagna. Its water last up to late December. Abumelah is also a seasonal river, 10 km south of Demir camp site that has water at a point, 12°04'N and 35°31'E, during late wet season. Esub River is found at 12 km south of Demir, towards the centre of Alatish. This river has very little water in its muddy pool (12°01'N and 35°31'E) during the wet season. At the eastern side of Demir River is River Albashom, which is relatively larger and contained ground water where "Fellatas" extract water for their herds from borehole (12°07'N and 35°40'E). The three small summer brooks originating from Mt. Tsiqua are called Tsiqua Gorge Rivers. The special feature of these brooks is the presence of several large beautiful and shiny igneous rocks all along their beds. In a few eastern areas, these rivers contain water during the wet season under big rocks but not easily accessed. The location of these water points is at 11°59'N and 35°29'E. All these summer intermittent rivers are located between Alatish and Dendir Rivers. All water sources of Alatish, whatever it might be, occur entirely towards the eastern block of the park whereas the western parts lack water. This makes survey of the area towards the western block very hard. The other very few source of water is from the few wetlands (locally called Sambrews) of the northern and western Alatish. These areas accumulate water from rain or sheet flows and retain it up to mid-November, in northern Alatish. But in western Alatish, these areas loss water early.

### **2.1.5 Climate**

The climate of Metema-Quara lowland where Alatish occurs is classified as the "Tropical Semi-arid" and is characterized by the summer rain. According to the rainfall regime classification (Daniel Gemechu, 1972), the Alatish area (as part of northwestern Ethiopia) is characterized by one rainy season having five rainy months (May to September) with highest concentration in July and August. There is only one long dry season and no other rainy season in between. Alatish area lacks long-term climatic records and the climatic data records of the nearest Meteorological station at Shehedi (Metema) were used to estimate for Alatish. Accordingly, the mean annual rainfall is estimated to be between 600 and 1000 mm (Fig. 3). The mean monthly temperature minima ranges between 13.6 and 19.2°C, and that of maxima is between 34.0 and 41.1°C. The lowest minimum temperature was 9.8°C, registered in July 2001. The maximum temperature was 41.1°C registered in April 2003 (Fig. 4). The hottest month of the year is usually March and the relatively coldest is August.



**Figure 3.** Mean monthly rainfall of APNP and the surrounding areas (n=7)

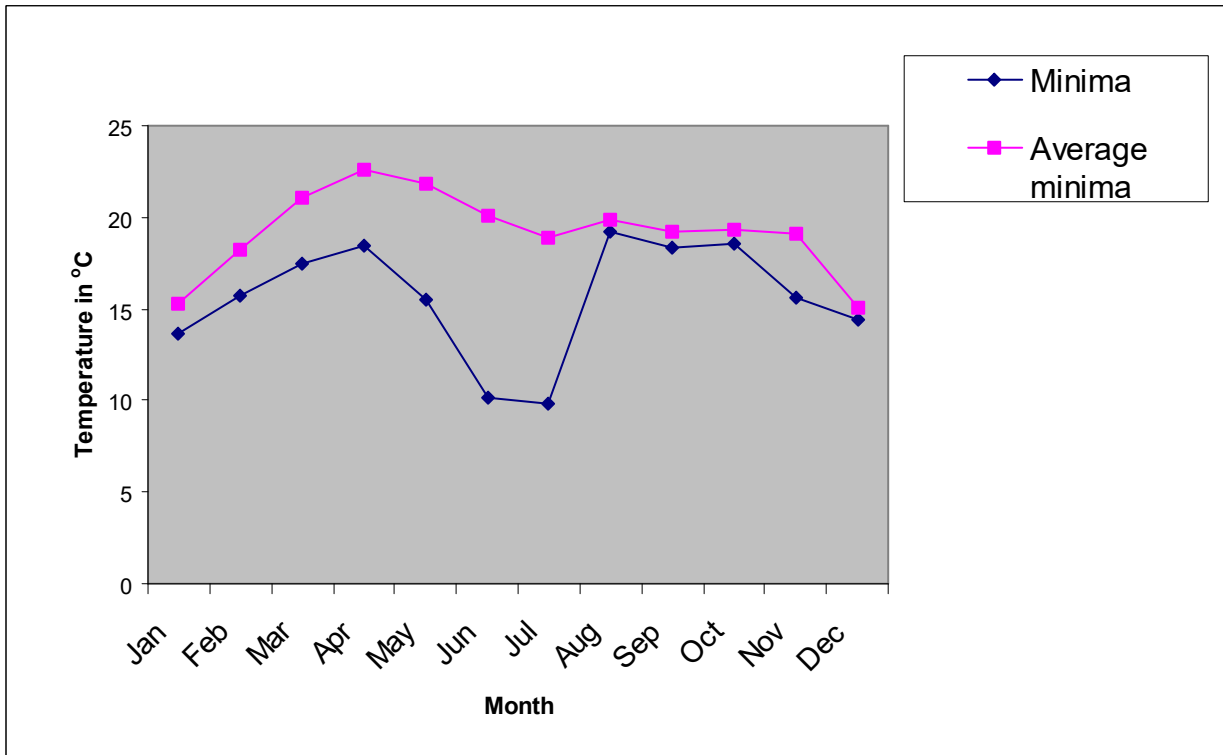
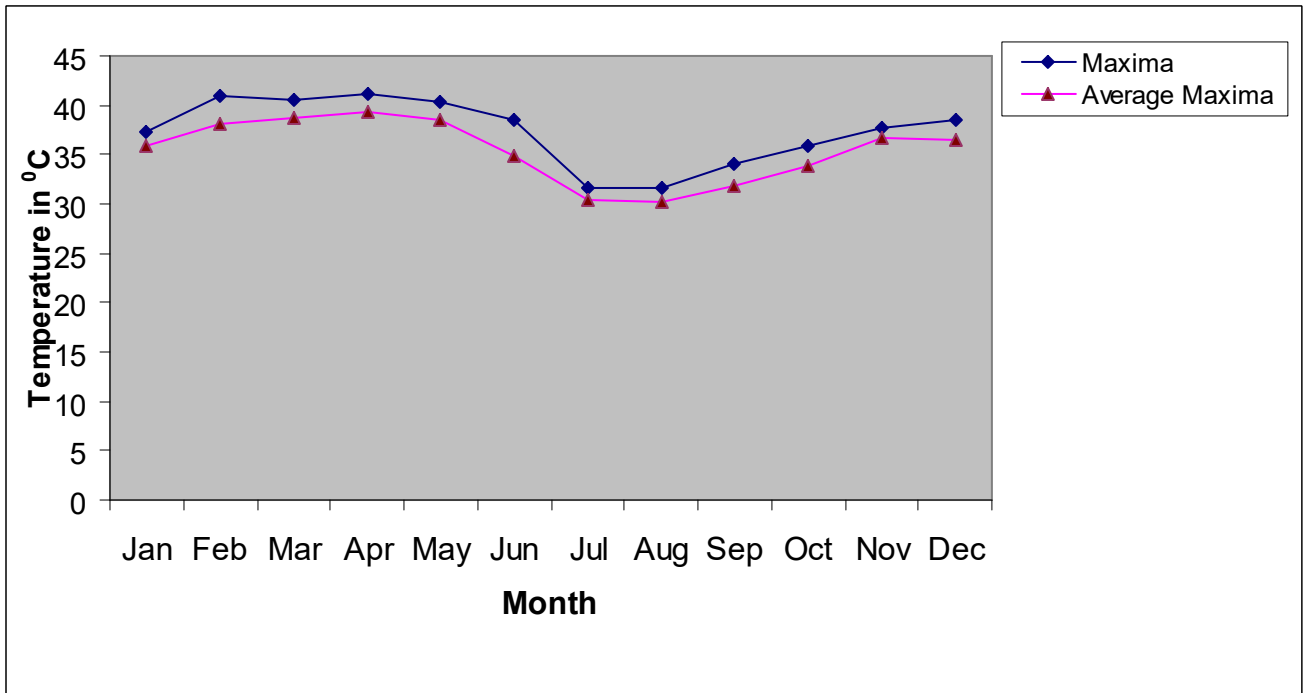


Figure 4 a) Monthly Temperature Minima and Average Minima (n=7)



4 b) Monthly Temperature Maxima and Average Maxima of the APNP and the surrounding areas (n=7)

### 2.1.6 People

Alatish Proposed National Park is referred to as part of the hot to warm - moist plain agro-ecological zone (BOA - ANRS, 1999). In terms of Agricultural development and other extensive year round development activities, Alatish is a self-protected area. The predominating sandy nature of the soil, the high temperature, the relatively low annual rainfall and high prevalence of malaria make it unsuitable for permanent settlement and arable crop production. However, there are native Gumuz indigeneous people living in different Kebeles bordering the park area. The settlement pattern of the Gumuz, generally follow the water catchment areas of the two important seasonal rivers, Dendir and Gelegu. The northern and northeastern settlement (in Mehadid and Gelegu Kebeles) follow the Gelegu River. This important river is located far in the north and flows west without bordering Alatish. Villages such as Bambaho, Bemur, Arjamus, Ayichich, Ayibaza, Abulta, Kusli, Anishmish, Balqur and Omedla are established along the catchment area of Dendir River. All the villages except Bambaho and Bemur are administered under the Benshangul Gumuz National Regional State. Settlement toward the western part of Alatish during the present study was not observed. The residents of these settlement areas, except Gelegu and Bambaho, are all Gumuz indigeneous people. Gelegu and Bambaho harbour largely Amhara and few Agew and Gumuz people. The newly established Bermil Kebele following the re-settlement policy of the region has recently settled thousands of people from the highlands of the ANRS. This settlement may be a potential threat for the APNP. The indigenous Gumuz Nilotic people are known to live in the lowland region of Benshangual Gumuz Regional State and the neighboring Quara Woreda of the ANRS (BOA/RD/LUPT, 1997). Hover (1998) has also stated that the Gumuz tribes were known to live in the Sudan bordering Dendir National Park since 1912.

The Gumuz Nilotic People lived partly on subsistence rain fed farming (on small fertile areas near the rivers) in their unique hoe-mixed with plough culture of farming. The products are sorghum (Wedakir), maize, groundnut and beans for household consumption. They also produce sesam and cotton as cash crops. Dairy farming activity (goats and poultry) is also practiced in some of the households. Goats are mainly raised for cash return while poultry is for consumption,

cultural festivals and cash return. Most farming is performed by women who are well known for shifting cultivation. The effect on the environment was insignificant as a result of low population. The most important and most practiced activities throughout the dry season are hunting, fishing and gathering. The activities are undertaken individually or in groups. They hunt all sorts of wildlife, both terrestrial and aquatic. Any accessible large mammals (e.g. warthog, oribi, bushbuck, roan antelope, buffalo, patas monkey; grivet monkey, etc.) are hunted. Among the small mammals, porcupines, hedgehogs, ground and tree squirrels and a variety of small rodents are killed and consumed. Ground nesting birds and waterfowls are also hunted.

The Gumuz use weapons ranging between old outdated firearm and modern Klashnikov for hunting. They also use traditional weapons as spears, bow and arrows and locally produced snares. Other activities like smoking burrows and excavating animals from burrows are also common. Fishing is carried out by single hook or stretching several hooks over the length of the river or in pools. Locally produced personal or group nets are also used. Poisoning of pools is commonly practiced to harvest the aquatic fauna. The bark of *Balanites aegyptiaca* (Lalo) is the most frequently used plant for poisoning (Plate 1). Birds are trapped using the locally produced snares or killed by shooting. The Gumuz also gather and use various edible fruits, seeds, tubers and gums of *Acacia* spp.

Except for the Mehadid Kebele Ggumuz, others still retain the tradition of holding guns starting from teenage stage. People of all Kebele use resources of Alatish in one or another form. Inhabitants of Gelegu, Bemur and Bambaho areas use the northern and northeastern part of Alatish for seasonal grazing and as a source of construction and firewood. Gumuz indigenous people of all villages entirely depend on Alatish resources, particularly the northern, and northeastern blocks. They use the area for wildlife hunting, collecting wild honey and edible plants, grazing and browsing purposes (Plate 2). They also use most areas for traditional beehive hanging. The Agew tribe, from the northern and western Benshangul Gumuz Regional State is very specialized in hanging traditional beehives. Hence, these people use most central and eastern parts of Alatish for this activity and for wildlife hunting (Plate 3).

The Gumuz people generally live in harmony with the environment. Hunting and gathering activities are only for household consumptions (Plate 4). Cattle from Gelegu and Bambaho area that use Alatish for grazing are few in number and cause no harm to the vegetation and the wildlife. The natives state that groups of armed hunters from the Sudan cross the Ethio-Sudan border during the dry season and hunt wildlife in Alatish Park. Python, monitor lizard, warthog, porcupine, patas monkey, grivet monkey and any accessible large game are their targets. They are also observed poisoning large pools harbouring fish. Such activities are mainly for commercial purpose. Above all, the nomadic pastoralists "Fellata" tribes and their cattle move from the Sudan and settle and use Alatish area as a seasonal grazing ground from November to June. These nomads use water from the pools of Dendir River. When they use the central area of Alatish, they construct boreholes all along the sandy Riverbeds of Alatish River and extract water for their livestock (Plate 5). The largest destruction is the result of the activities of "Fellata" and their cattle. The early dry season fire largely set by Fellatas, normally clears the undergrowth and the remaining is picked up by the large number of livestock that out competes the wild fauna of the area. Fellatas normally set fire for two purposes: to control wild ticks and to chase large carnivores away from their cattle. This activity also affects the slow moving small mammals, reptiles and ground nesting birds. In addition, the few evergreen trees such as *Balanites* spp. and *Lannea* spp., whose branches are not within the reach of goats, sheep and camel, are cut down. Fellatas are also known to hunt large games for consumption and commercial purposes. These all affect the resident large and small mammals, birds and reptiles of the area and those that use the area as a seasonal range. As the central and western Alatish area are devoid of water during the dry season, the Fellatas do not use these areas for grazing and hence the large wild herbivores get refuge.

Few illegal farmers also encroach into the park area of the northern corner and cultivate sesame. The demand for more untouched fertile arable land for sesame and cotton cultivation (the most valuable cash crops of the area) may increase the threat on the northern and northwestern areas, which are relatively fertile.

### **2.1.7 Land-use**

The land, as in others part of Ethiopia, is under public ownership. The ANRS has planned to set aside the Alatish area as a key ecosystem conservation area under three levels - as a national park, Alatish Wildlife Reserve and Alatish Controlled Hunting Areas (BOA-FAP, 1999). Recently, the boundaries have been demarcated and the concerned authorities are in preparation for gazetting Alatish as a National Park. In addition to its resident wildlife resources, it may also serve as an important habitat for animal species that migrate from Dendir National Park (DNP) of Sudan, adjacent to the Sudan side (Kefyalew sime *et al.*, 1996, Assefa Mebrate, 2004). It is also known as a "green guard" because of its protective function against desert encroachment from the adjoining Sudan and the Sahel region (Crabtree, 1997). APNP has also global significance because of its geo-physical location. Alatish area lies along the transition ecotone between two floristic regions, the Ethiopian highlands plateau and the arid Saharan Sudanian biome. The presence of Dendir River and the few northern meadows create suitable temporary ground for north-south migratory birds (as observed during the study). Its core and the western areas are the only available area to refuge large herbivores like elephant, euffalo that are reported to be missing from DNP (Hoven, 1998). Pools of Dendir River are very important watering areas for the resident species of the area as well as for seasonal migratory species.

The newly established regional office, the ANRS, Parks Development and Protection Authority (PDPA), among its other mandates is to carry out studies of wilderness areas and evaluate their ecological, scientific, educational and recreational values and plan for their conservation strategies. As a result, priority is given to finalize the baseline information and to gazette Alatish as a National Park. The Zonal and Woreda Administrative bodies, the whole society of Gelegu, the surrounding Gumuz villagers and the neighboring Woredas have great desire for the protection of the unique Alatish ecosystem and are eagerly awaiting for the realization of the area to the park status. This is generally approved from the feedback of the questionnaire dispatched to gather information about the attitude of the society towards the establishment of the park (Girma Mengaesha, in preparation).

### 2.1.8 Vegetation

According to the aspects of climate and water budget in Ethiopia (Daniel Gemechu, 1977), Alatish area is categorized as Bereha (desert, less than 800 m a.s.l.). The vegetation in Alatish generally shows low diversity. The sandy natures of the soil and the very low annual rainfall (between 600 and 1000 mm) have contributed to the existence of such a low diversity of natural vegetation (BOA-RD/LUPT, 1997). Generally the ecosystem is undifferentiated. The few species of deciduous trees (*Combretum* sp. and *Terminalia* sp. and few tall grasses (*Sorghum* spp.) dominate the whole area of Alatish. These few species of plants alternate dominancy within few metres interval.

The common tree species in Alatish include *Combretum* sp., *Pterocarpus lucens*, *Terminalia laxiflora*, *Anogeissus leiocarpus*, *Acacia seyal*, *Acacia sebrana*, *Lannea fruiticosa*, *Balanites aegyptiaca*, *Allophylus macrobutry*, and *Oxytenanthera abyssinica* (Appendix I). The understory of the whole habitat is composed of few species of tall (2-3 m high) annual grass such as *Hyparrhenia cyanescence*, *Rottboellia Cochinchinensis*, *Hyparrhenia subplumosa*, *Sorghum sudanensis* and *Sorghum versicolor*. These tall grasses form a dense thicket during the wet season so that passing through becomes very hard and in some places (in riparian and meadow area), practically impossible (Plate 6). During the wet season, the dense green leaves of the trees and the tall grasses form a thicket that is hard for large and medium-sized mammal to pass through or to live inside. The cosmopolitan tree species that occur in varied abundance in all the four habitat types of Alatish are *Pterocarpus lucens*, *Combretum* sp., *Terminalia laxiflora* and *A. leiocarpus*. Similarly, the grass species are *H. cyanescence* (more in relatively open and reddish sandy soil areas), *H. subplumosa* (in dense trees and relatively black soil) and *R. cochinchinensis*, *S. sudanensis* and *S. versicolor* (mostly near riverine and wetter areas). Dominancy of grass species also alternate at few metres interval. All the tree species are deciduous and most of them shed their leaves before December while *Pterocarpus lucens* shed earlier. As a result, no green leaf is observed in the Alatish area during the dry season except for

*Balanites aegyptiaca*. All the grass species are perennial and they are swept by forest fire before December (Plate 7).

The size and densities of trees and grasses follow the characteristics of the soil. In black cottony soil areas, trees are relatively dense and have larger stem diameter and height. In this soil type, the vegetation and the leaves greenness persist for longer period. The undergrowth in this soil type is dominated by two species of grasses, *H. subplumosa* and *R. cochinchinensis*. In lighter or reddish sandy soil area, the size and length of the trees are medium, have less dense foliage and shed leaves earlier. The dominant grass species in such areas are *H. cyanescence* and to a lesser extent is *P. unistem*. In the western part of Alatish, towards the Ethio-Sudan border, *Acacia seiberana* and *A. seyal* alternate dominancy for a considerable distance and are usually continuous and dense. This dominancy sometimes is taken over by *P. lucens* and *Combretum* spp. *Boswellia papyrifera* dominates the hilly area of the northeastern edge of Alatish, between Gelegu and Bambaho kebeles. In parts of gorgy, rocky areas, hillsides and few dry river side pocket areas, lowland bamboo (*Oxytenanthera abyssinica*) occurs interspersed between other trees and grasses. In the foothill areas of Mt. Dinar and in certain drier parts of the northwestern Alatish, the tree species including *Combretum* spp. and *Petrocarpus lucens*, grow shorter than their characteristic size so that the area is mistakenly characterized as bushland. Except grasses, there is generally no significant herbaceous plant cover was observed over the larger area of Alatish during both seasons. This may probably be due to the canopy formed by the trees and grasses that suppress other undergrowth. Artificial (exotic) plant species are lacking throughout Altish area.

### **2.1.9 Fauna**

Different species of large mammals, reptiles and birds occur in the Alatish Proposed National Park. The larger and medium sized mammals include elephants (*Loxodonta africana*), Buffalo (*Syncerus caffer*), lions (*Panthera leo*), leopards (*panthera pardus*) and warthog (*Phacochoerus aethiopicus*) (Appendix IV). The avian fauna of Alatish include *Coracias abyssinicus*, *Upopupa epops*, *Tutur abyssinicus* and *Leptoptilos crumeniferus* (Appendix III).

Alatish proposed National Park is exceptionally rich in reptilian diversity that include the African rock python (*Python sebae*), monitor lizard, the deadly poisonous Egyptian cobra (*Naja naja*), black mamba (*Dendroaspis polylepis*), the burrowing asps (*Atractaspis bibronii*) and (*A. microlepidota*) and Blanding's tree snake (*Boiga blandingii*) (Plate 8). Various coloured large and small lizards are very uniquely abundant particularly along the sandy river courses. The large isolated pools all along the Dinder River harbour not fewer than 26 different species of fish (Appendix IV). Arthropod species are innumerable including various species of honey bees (including the "Nigerian bees" that possess unique morphology and behaviour). The poisonous scorpion, *Anopheles* mosquito, wild tick, and flea that form part of the ecosystem.

### **2.1.10 Habitat Classification**

The presence of invariably uniform climate, altitude, soil type, temperature and rainfall seems to contribute for the existence of almost uniform and undifferentiated habitat type in Alatish area. Though the vegetation type is not clearly differentiated and demarcated into well defined habitat types, based on the classification of vegetation regions of Ethiopia (Yalden & Largen, 1972); habitat classification scheme of Grimsdel (1978); Western & Grimsdel (1979); White (1983); BOA/RD/LUPT (1997); the GIS vegetation data scanned from satellite (2004) and the vegetation classification data of the adjacent Dinder National Park (Dasmann, 1972), the habitat of Alatish can be grouped into four broad categories (wooded grassland, woodland, riverine woodland and mixed bamboo woodland).

#### **2.1.10.1 Wooded Grassland**

The most dominant habitat type of the area covering most of the central, northeastern, eastern, southern and western part of Alatish is what is referred to here as the wooded grassland type. In some areas, it is interspersed by other habitat types. This vegetation type covers most of the hilly terrains, hillsides, flatter areas and undulating plains. In this habitat type, the soil is reddish and sandy with shallow depth. However, few patchy black cottony soils, particularly along the riversides occur interspersed by sandy soil. In some areas, surface stoniness also prevail. Sparse trees with dense grassy undergrowth characterize this habitat type. Medium sized stem diameter

and height are the characteristics of trees of this habitat. The tree species common in this habitat type, in various proportions are *Combretum* spp., *T. laxiflora*, *P. lucens*, *C. collinum* and *A. leiocarpa*. Dominancy alternates among these major tree species. In addition to these, the south, southeastern and southwestern parts of this habitat have *Ficus* spp., *L. fruticosa*, *A. seyal*, *A. seiberana*, *A. digitata* and *H. thebiaca*. In this habitat type, the dominant grass towards the open drier, sandy and rocky soils are *H. cyanescence* and *P. unistem*. In better formed areas, *R. cochinchinensis* and *H. subplumosa* (grass that grow very tall in length) are also found.

#### **2.1.10.2 Woodland**

The woodland occurred in few grids (19, 26 and 27) of the lower-central Alatish. Dense trees and relatively sparse and tall grass as an undergrowth characterize it. Each tree has wider stem diameter than the trees in the wooded grassland and they are also taller in height. Trees and grass form canopy and the inner air is humid during the wet season. The trees also have dense branches, and broad and deep green leaves in the wet season. Leaf shedding in this habitat starts later than in the wooded grassland tree community. The dominating tree species in this habitat are *A. leiocarpus*, *P. lucens*, *T. laxiflorus* and *Combretum* spp. Along the river banks, *O. abyssinica* competes with the dominant grass species *R. cochinchinensis* and *H. subplumosa*. The character of this re-appears in pocket areas of wooded grassland where the cottony moist soil is impeded in the continuous reddish sandy soil.

#### **2.1.10.3 Riverine Woodland**

The riverine ecosystem, which is not very distinct, occurs along the riverbank of Dendir River, in some areas of the upper course of River Alatish, the few wetland areas of the mid-western and northern Alatish. The soil under this habitat is black cottony, moist and full of humous and the forest has multi-layer. However, all the trees are deciduous and shed their leaves during the dry season. The common tree species that occur in all Alatish area also occur in riverine woodland habitat. The only difference is in the tree growth features. The trees are very tall in height and wider in stem diameter, densely branched with deep green and broad leaves. Shedding of leaves is delayed when compared to some species of trees in the woodland area. Along the Dinder River,

*Ficus* spp. is the dominant tree species interspersed by *T. laxiflorus*, *A. leiocarpus*, *P. lucens*, *Combretum* spp. and *A. policantha*. Few creepers (e.g. *Carpairs tomentosa*) and climbers (e.g. *Cissus quadrangularis*) also occur in this area.

#### **2.1.10.4 Mixed Bamboo Woodland**

There are few areas where lowland bamboo species (*Oxytenanthera abyssinica*) and other woody tree species occur continuously in equal proportion for several kilometres. The specific locations of this continuous vegetation type are, the flat foothill area of Dinar Mountain, northern Alatish, and southeastern Alatish. What characterizes this area from others is the proportion of bamboo to wooded trees (i.e. 50:50 or 60:40) over large area. The tree species that exist along the bamboo vegetation are *A. leiocarpus*, *T. laxiflora* and *T. brownii*. Relatively sparse grass species such as *H. cyanescence* and few *H. plumose* are also present. This type of habitat occurs mostly on rocky areas and hilly slopes. This habitat is unique because *O. abyssinica* is dry and no green leaves are observed during both seasons. Signs of regeneration has not been observed during the study period.

## **2.2 METHODS**

### **2.2.1 Preliminary study**

Ecological study of small mammals (rodents and insectivores) in the Alatish Proposed National Park (APNP) was initiated in mid-August (2004) by undertaking a preliminary study to gather relevant data about the area from concerned government authorities, mainly from the Environmental Protection and Land-Use Authority of the Amhara National Regional State (ANRS, EPLUA), Bahirdar. Field data, regarding the diversity, spatial and temporal distribution, relative abundance and habitat association of small mammalian fauna of the Alatish area were collected during the wet (October-November, 2004) and dry (Feb.-March, 2005) seasons.

### **2.2.2 Sampling design**

Based on the topographic map of the area (1:250,000), the total area of Alatish was classified into 37 grids of approximately 10 km<sup>2</sup> (including all the marginal areas). Using the natural and international boundary coordinates of the four sides of Alatish area, vegetation type of the area was analyzed from the satellite image using GIS. This is used to implement the description of different vegetation regions of Ethiopia (Yalden & Largen, 1972). This provided a pictorial vegetation classification of the whole area of Alatish. The ground survey was based on this information. Using this as initial information, the vegetation type was identified as wooded grassland (WGL), riparian woodland (RWL), woodland (WL) and mixed bamboo woodland (BWL). Representative grids were randomly selected among the vegetation types. Each randomly selected grid site was numbered. Longitudinal and latitudinal coordinates of the boundaries were worked out from the topographic map (Appendix V). These were surveyed during the two data collection seasons. Accordingly, the eleven randomly selected grids, that are proportional to the size of the vegetation types (i.e. six grids for WGL, three for RWL, one grid each for BWL and WL) were surveyed. Grids 10 and 17 representing WGL and RWL were unsurveyed due to inaccessibility of the area. Grids 4 and 20, representing the WGL and WL, respectively, were also abandoned during the dry season due to the same reason.

### **2.2.3 Travel to the study site**

Travel to Gelegu (the capital of Quara Woreda) from Shinfa (the last point for car transport during the wet season) was accomplished by the locally constructed boat to cross the 200 m wide Shinfa River. A tractor was used transport for the 77 km distance. The 17 km distance between Gelegu and Mehadid (the nearest Kebele to the study area) also was traversed by Tractor. The one-way travel to cover all the sampled grids within the park covers a total distance of 251.28 km during the wet season and 159.14 km during the dry season. These were explored largely on foot and occasionally assisted by three camels provided by the Quara Woreda Administration. The travel team comprised 13 individuals. The eight fully armed militia and one policeman were assigned by the Woreda Administration, two Gumuz guides, and one wildlife scout, who was assigned by the Amahara National Regional State Parks Development and Protection Authority

(ANRS - PDPA). Two ecological surveyors, one for small mammals and the other for large mammals also accompanied the team. Each sampled grid site on the ground was traced and located using the Garmin 48, 12 Channel GPS (Version 2.01, Garmin corporation, 1998) and the 1:250,000 topographic map of the area (Ethiopian Mapping Authority, Revised edition, 1997). Temporary campsites were established at each sampled grid for 3-4 days per grid.

### **2.2.3 Data Collection**

Data on the diversity, spatial and temporal distribution, relative abundance and habitat associations of rodents and insectivore species of Alatish Proposed National Park were collected for both wet and dry seasons using the standard trapping techniques. Small (16x6.5x5.5 cm) and medium sized (23.5x8x8.9 cm) Sherman traps were used mostly and few large sized (35x8x9.5 cm) Sherman traps and metal snap traps were also occasionally used. Traps were randomly placed at different trap sites on each randomly selected grid. Each grid was sampled at least for two days, the first day to set traps, and the other to collect and record information. At each selected grid, suitable trap sites were surveyed a day before for rodent signs (burrows, runways) to increase the trap success (Delany, 1978; George, 1984). A 7x7 m trapping grid was established at each sampled grid and a total of 49 Sherman traps were set during the wet season. During the dry season few commercially available metal snap traps were used alternating between Sherman traps at 10 m interval (Perrin *et al.*, 1992). However, the snap traps were abandoned later as the trapped diurnal animals soon rote due to the high temperature, and ants ate most within a short period of capture. Traps were baited with peanut butter rolled with corn or barley flour. When a unique habitat, rather than the characteristic one was observed, few additional traps were set in at random to sample the fauna. These include the two trials to sample commensal rodents from few villages. Two special sites were conventionally sampled (7x7 m) because of the special properties of the areas. These were areas left from burning at the centre of the grid 20 and special grassy area of the grid 29 near the Ethio-Sudan border. Whenever necessary, the results were treated together with the results of the main trapping grids. Traps were covered by hay during the wet season, but due to the absence of hay during the dry season, they were covered by soft cloth. These padded clothes provide protection for trapped animals

against the strong heat and to conceal traps. Traps were usually set in the morning between 07:00 and 09:00 a.m. on the first day, and checked the same day in the afternoon between 17:00 and 18:00 p.m. for diurnal catches. All traps were checked for nocturnal catch and collected the next morning between 07:00 and 08:00 a.m. Some adjustments were carried out during the dry season. In areas where the diurnal catch were high, the occupied traps were all collected and the same number of traps were re-set to increase the chance of nocturnal catch. Repeated checks were not possible because of the shortage of time. During both seasons, burrows of ground squirrels or nests of tree squirrels were searched and the largest Sherman traps ( 35 x 8 x 9.5 cm ) were set in appropriate position of burrows. These were tied to suitable branches of trees as used by George (1984). Locally made snares were also used to trap ground squirrels. Some extremely trap shy and nocturnal species of rodents were excavated from burrows and sampled (Smith, 1968). Additional information on the specific location of the trap sites (Appendix VI), the general habitat type, the dominant vegetation and the special features of the area for each grid were recorded. The exact location of the observed rodents (porcupines, ground and tree squirrels) and their nest or burrow sites were recorded. All the necessary information of the trapped rodents were noted down.

Body measurements of each captured specimens; weight using various sized Pesola spring balance, head body length, tail length, hind foot and ear length were recorded. Sex of each individual was identified. Age structure (adult, young or juvenile) was recorded based on their weight and pelage colour (Afework Bekele, 1996). Size and position of testes for males, and vaginal conditions (closed or perforated), presence or absence of palpable embryo, condition of mammae (lactating or not) for females, were observed to determine the reproductive conditions of the captured animals. All special remarks of the captured animals such as partly or total loss of ears, foot, toes, tail, scars on the body, presence of parasites, fur texture and colour, tail and foot colour, number of mammae, number of embryos if pregnant, eye colour and size were recorded. All trapped animals were removed. Some were mounted as a voucher specimen. Skin and skull of the representative specimen of the captured animals were mounted (Hall, 1962) as a voucher specimen and deposited in the Zoological National History Museum, Biology Department, Addis

Ababa University. Liver tissue sample were also taken from some samples and preserved in saline solution for further chromosomal studies.

#### **2.2.4 Data Analysis**

The relative abundance of small mammalian fauna was assessed as the percentage trap success between seasons and different habitat types and a chi-square test was used to reveal difference. Shannon-Weaver Index was used to compute small mammal species diversity of the habitats. Simpson's Similarly Index was calculated to assess the similarity of the different habitat in respect of the presence of small mammalian species. Sample specimens of the dominant vegetation of the APNP area were collected, pressed and brought to the National Herbarium of Addis Ababa University for identification.

Taxonomic charactors listed in Misonne (1971), Kingdon (1974, 1997), Yalden *et al.* (1976), Btes (1988, 1994), Nowak (1991), Afework Bekele (1996a), were used for species identification. Further, the prepared vouchers were compared with the museaum specimens of Addis Ababa University.

### 3 Result

#### 3.1 Diversity and Relative Abundance

Three hundred and seventy one small mammals were trapped from 9 randomly selected study sites inside the Alatish Proposed National Park in two trapping seasons and 959 trap nights. Out of the small mammals trapped, 343 individuals (92.7%) represented 23 species of rodents while the remaining 27 (7.3%) represented the six insectivore species. These rodent species are classified into relatively more abundant and rare based on the number of individuals of each species trapped. The relatively more abundant species in descending order are: *Arvicanthis dembeensis* (27.8%), *Arvicanthis niloticus* (24.5%), *Desmomys harringtoni* (7.8%), *Mastomys natalensis* (7.02%), *Myomys albipes* (5.4%), *Acomys cahirinus* (4.1%), the yet to be identified rat "Murid sp. B (3.24%), *Acomys wilsoni* (2.9%), *Tatera valida* (2.4%). The relatively rare rodent species are: *Mastomys erythroleucus* (1.35%), *Acomys cineraceus* (1.35%), *Acomys* sp.A (1.08%), *Tatera phillipsi* (0.8%), *Mus musculus* (0.8%), *Tatera robusta* (0.5%), *Lemniscomys barbarus* (0.5%), *Mus tenellus* (0.27%), Murid sp. A (0.27%), and the single male striped ground squirrel *Euxerus erythropus* (0.27%). 7.6% of all the small mammals trapped comprised six species of insectivores including the Hedgehog (*Atelerix albiventris*) (0.5%); the shrews *Crocidura flavescens* (2.7%), *Crocidura turba* (2.7%), *Crocidura smithi* (0.5%), *Crocidura fumosa* (0.5%) and the yet to be identified shrew Soricid sp.A (0.27%). Larger rodents such as the porcupines, *Hystrix cristata*, the unstriped ground squirrel, *Xerus rutilus*, the bush squirrel *Paraxerus ochraceus* and the tree squirrel *Heliosciurus gambianus* were observed throughout the Alatish area. Trapping of these species, however, was not possible (Table 1).

Table 1. Diversity and relative abundance of the rodents and isecfivores of Alatish proposed National Park.

| Family      | Species                       | Total capure & percentage |          |
|-------------|-------------------------------|---------------------------|----------|
| Muridae     | <i>Arvicanthis dembeensis</i> | 103(27.8)                 |          |
|             | <i>Arvicanthis niloticus</i>  | 91(24.5)                  |          |
|             | <i>Desmomys harringtoni</i>   | 29(7,8)                   |          |
|             | <i>Mastomys natalensis</i>    | 26(7.02)                  |          |
|             | <i>Mastomys erythroleucus</i> | 5(1.35)                   |          |
|             | <i>Myomys albipes</i>         | 20(5.4)                   |          |
|             | <i>Acomys cahirinus</i>       | 15(4.1)                   |          |
|             | Murid sp.B                    | 12(3.24)                  |          |
|             | <i>Acomys wilsoni</i>         | 11(2.9)                   |          |
|             | <i>Acomys cineraceus</i>      | 5(1.35)                   |          |
|             | <i>Acomys sp.A</i>            | 4(1.08)                   |          |
|             | <i>Mus musculus</i>           | 3(0.8)                    |          |
|             | <i>Mus tenellus</i>           | 1(0.27)                   |          |
|             | <i>Lemniscomys barbarus</i>   | 2(0.5)                    |          |
| Crecitidae  | Murid sp.A                    | 1(0.27)                   |          |
|             | <i>Tatera valida</i>          | 9(2.4)                    |          |
|             | <i>Tatera phillipsi</i>       | 3(0.8)                    |          |
|             | <i>Tatera robusta</i>         | 2(0.5)                    |          |
| Soricidae   | <i>Crocidura flavescence</i>  | 10(2.7)                   |          |
|             | <i>Crocidura turba</i>        | 10(2.7)                   |          |
|             | <i>Crocidura smith</i>        | 2(0.5)                    |          |
|             | <i>Crocidura fumosa</i>       | 2(0.5)                    |          |
| Erinaceidae | <i>Soricid sp.A</i>           | 1(0,27)                   |          |
|             | <i>Atelerix albiventris</i>   | 2(0.5)                    |          |
| Sciuridae   | <i>Euxerus erythropus</i>     | 1(0,27)                   |          |
|             | <i>Paraxerus ochraceus</i>    | *                         |          |
|             | <i>Heliosciurus gambianus</i> | *                         |          |
| Hystricidae | <i>Xerus rutilus</i>          | *                         |          |
|             | <i>Hystrix xristata</i>       | *                         |          |
| Total       | 6                             | 29                        | 370(100) |

\* Observed

Most of the trapped small mammalian fauna of the Alatish Proposed National Park are identified and their exact taxonomic positions are given. However, there are still few species (14%) not identified with the available facilities. The descriptions of these species are given below and it is expected that all or some of them may be new species.

### **Soricid species A**

This is the only shrew specimen of this type trapped from a settlement area, northeastern part of Alatish Proposed National Park (12°12'N, 35°53'E). It has soft pale hair throughout its body. The elongated skull and the protruded snout resemble *C. flavescens* and *C. turba*. It has tapered upper lip with long sparse whiskers. The presence of white teeth may lead to mistaken identification with other species of the Genus *Crocidura*. It has short ears and minute eyes, and the backs of both feet are black and the black soles of both feet are bare. It is an adult female with six mammae. The short thick tail is covered by short hairs and interspersed by black long vibrissae all along its length. The body measurements include head body length = 140 mm, tail length 70 mm, hind foot length = 20 mm, ear length = 10 mm, and weight = 50 g. The special features of this species that make it different from the other group are the skull structure and unique dentition. Unlike those of *Crocidura*, its brain case is not flattened,  $I' - M^3 = 15$  mm. It lacks three unicuspid teeth behind the front incisors on the upper jaw as seen in *Crocidura* (in which case the dental formula become  $3113/2013 = 28$ ), or four unicuspid teeth as seen on the upper jaw of the Genus *Suncus* and *Sylvisorex* (in which case the dental formula for both genera become  $3123/2013 = 30$ ). This species has only two unicuspid teeth behind the upper front incisors. The dental formula is  $3013/2013 = 26$ . In addition,  $M^3$  of this species is not reduced as those of *crocidura* specimens. These unique features need further taxonomic investigation. Therefore, temporarily, it is assigned as Soricid species A.

### **Murid species A**

This species was trapped from the northern grid 13, (Megenagna trap site, wooded grassland habitat), 12°11'N latitude and 35°40'E longitude. It was a medium sized scrotal male rodent. Head and the body length (98 mm), tail (84 mm), hind foot (23 mm), ear (15 mm) and weighs 30 g. Other descriptions include: Creamy dark back colour (shiny), lighter dark ventral part, large

eye and ears, back of both feet whitish and sole dark, non-grooved incisors and exceptionally big testes. The bi-coloured tail is scaly. This individual has a rounded skull and the anterior palatal foramina extend down to half of the first molar.  $M^{1-3} = 5.1$  mm, and have quite unique frontally oriented cusps of the upper last (3<sup>rd</sup>) molars. Until further identification is carried out in the future, it was temporarily assigned as "Murid species A".

### ***Acomys* species A**

This specimen was also trapped in grid 13 during the wet season. However during the dry season, three specimens were trapped from different localities including the human habitations. It is a tri-coloured, spiny-skinned mouse. All its body is covered with spine therefore, no smooth hair except the vibrissae. The back colour is pale with narrow golden line on the sides, separating the pure white ventral part from the back. The rough spine extended to the face region unlike those of *A. cahirinus*, *A. wilsoni* and *A. cineraceus*. The ventral part is fully covered with white semispinous fur. Ears are large, oriented forward and more bat-like. Face part is darker than the back colour. This species has no tail or even its trace is absent. Body size ranges from 85 to 105 mm, and body mass between 34 and 44 g (Table 2). Due to the absence of sufficient literature and museum specimen to give the exact taxonomic position, for the purpose of the present study, it was temporarily placed under the Genus *Acomys* species A.

Table 2. Trap location, habitat type and detailed body measurements of four individuals of *Acomys* species A. (HB = head body length, T = tail length, HF = hind foot length, E = ear length, Wt = weight). (Length was measured to the nearest mm and weight in g.)

| Trap grid | Position         | Habitat | Sex | Age category        | Body Measurement |       |       |        |       |
|-----------|------------------|---------|-----|---------------------|------------------|-------|-------|--------|-------|
|           |                  |         |     |                     | HB(mm)           | T(mm) | E(mm) | HF(mm) | Wt(g) |
| 13        | 12°11'N,35°40'E  | WGL     | F   | Adult, non-pregnant | 105              | -     | 15    | 10     | 35    |
| 13        | 12°10'N,35°36'E  | RWL     | M   | Scrotal             | 100              | -     | 14    | 10     | 44    |
| 7         | 12°13'N, 50°34'E | RWL     | F   | Pregnant            | 85               | -     | 15    | 10     | 34    |
| Commensal | 12°12'N,35°53'E  | HH      | M   | Scrotal             | 105              | -     | 15    | 10     | 34    |

## **Murid species B**

The fourth group of medium sized rats was trapped only during the dry season. Twelve individuals of this species were trapped from three areas. This species superficially resembles *D. harringtoni*. It has harsh gray fur from the back and light paler hair on the ventral side. The special feature of this species is the presence of reddish coloured fur starting from the base of the tail that runs upward to the mid-back region, forming a "V" shaped structure. In some individuals, this extends up to the shoulder region leaving the mid-back region unstained. The upper incisors are grooved. It was observed foraging during late afternoon in Ardeba trap site. The body size ranges from 105 to 165 mm, and body weight from 50 to 152 g (Table 3). Except five specimens, the others were obtained dead in the Sherman traps. This animal may be partly or entirely diurnal. The tail is paler, scaly and slightly shorter than head and body. Similar to the above species, no literature was obtained to confirm the species and voucher specimens to compare with. So it was temporarily assigned as Murid sp. B.

### **3.2 Distribution by habitat type**

Most of the small mammal species were trapped from the wooded grassland (WGL). These include 17 of the 18 rodent species and five of the six insectivore species. Only the zebra mice, *L. barbarus* and the Soricid sp. A were not sampled from this habitat type. The only trapped ground squirrel *E. erythropus* was also trapped from this habitat.

The riverine woodland (RWL) habitat had the second highest number of species during the dry season. However, during the wet season, none of the 100 traps set in two representative grids caught rodents. During the dry season, ten rodent and one insectivore species were caught. Mixed bamboo woodland (BWL) habitat has the highest overall trap success. However, it is next to the riverine woodland in terms of the number of species caught. Dry season trapping was not carried out in the woodland (WL) habitat. However, trapping during the wet season show that this habitat is the poorest in terms of both species number and number of individuals. Only six individuals of two species of rodents were trapped during this season (Table 4, Fig. 5). The

Shanon-Weaver Index (H) result for the species diversity was 2.195, 1.766 and 1.399 for WGL, RWL and BWL, respectively.

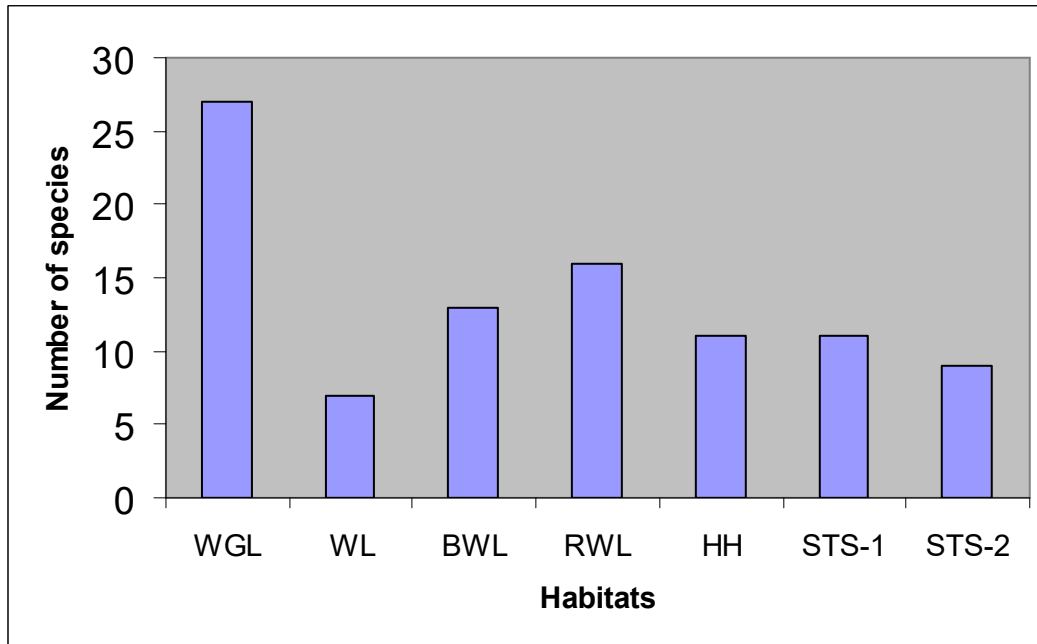
Table 3. Body measurements, habitat, grid, sex, age category and reproductive condition of Murid species B.

| Trap habitat | Grid | Sex | Age category | Repr. Condition | Body measurements |        |         |        |        |
|--------------|------|-----|--------------|-----------------|-------------------|--------|---------|--------|--------|
|              |      |     |              |                 | HB (mm)           | T (mm) | HF (mm) | E (mm) | Wt (g) |
| RWL          | 13   | F   | S. Adult     | Non-perforated  | 105               | 120    | 22      | 15     | 50     |
| RWL          | 7    | F   | Adult        | Perforated      | 145               | 140    | 30      | 15     | 120    |
| RWL          | 7    | F   | "            | Non- perforated | 160               | 145    | 32      | 14     | 142    |
| "            | 7    | M   | "            | Scrotal         | 155               | 145    | 30      | 13     | 120    |
| WHL          | 20   | F   | "            | Non- perforated | 155               | 130    | 30      | 12     | 152    |
| "            | "    | M   | "            | Scrotal         | 140               | 140    | 30      | 14     | 100    |
| STS 1        | 29   | M   | "            | Scrotal         | 155               | 138    | 30      | 14     | 142    |
| "            | "    | M   | "            | Scrotal         | 155               | 138    | 32      | 13     | 122    |
| "            | "    | F   | "            | Perforated      | 145               | 140    | 34      | 12     | 130    |
| STS 2        | 20   | F   | "            | Perforated      | 145               | 136    | 30      | 12     | 132    |
| "            | "    | F   | "            | Perforated      | 165               | 130    | 32      | 14     | 120    |
| RWL          | 7    | F   | "            | Perforated      | 150               | 135    | 30      | 14     | 100    |

Table 4. Distribution of different species of rodents and insectivores in four natural habitat types, human habitation (HH) and the two special trap sites (STS-1, STS-2) in APNP (WGL = wooded grassland, WL = woodland, BWL = bamboo woodland, RWL= riverine woodland)

| Species                 | Habitats |    |     |     |    |       |       |
|-------------------------|----------|----|-----|-----|----|-------|-------|
|                         | WGL      | WL | BWL | RWL | HH | STS-1 | STS-2 |
| <i>A. dembeensis</i>    | 49       | 4  | 28  | 14  | -  | 8     | -     |
| <i>A. niloticus</i>     | 43       | -  | 17  | 10  | 4  | 14    | 3     |
| <i>D. harringtoni</i>   | 12       | -  | 8   | 2   | 1  | 6     | -     |
| <i>M. natalensis</i>    | 10       | -  | 3   | 3   | 7  | 3     | -     |
| <i>M. erythroleucus</i> | 5        | -  | -   | -   | -  | -     | -     |
| <i>M. albipes</i>       | 6        | -  | 1   | -   | 5  | -     | 8     |
| <i>A. Cahirinus</i>     | 10       | 2  | 2   | 1   | -  | -     | -     |
| <i>A. wilsoni</i>       | 5        | -  | 4   | -   | 1  | 1     | -     |
| <i>A. cineraceus</i>    | 5        | -  | -   | -   | -  | -     | -     |
| <i>Acomys sp.A</i>      | 1        | -  | -   | 2   | 1  | -     | -     |
| <i>T. robusta</i>       | 2        | -  | -   | -   | -  | -     | -     |
| <i>T. valida</i>        | 2        | -  | -   | 2   | -  | -     | 5     |
| <i>T. phillipsi</i>     | 3        | -  | -   | 1   | -  | -     | -     |
| <i>Murida sp.A</i>      | 1        | -  | -   | -   | -  | -     | -     |
| <i>Murid sp. B</i>      | 2        | -  | -   | 5   | -  | 2     | 3     |
| <i>M. musculus</i>      | 1        | -  | -   | -   | -  | 1     | -     |
| <i>M. tenellus</i>      | 1        | -  | -   | -   | -  | -     | -     |
| <i>L. barbarus</i>      | -        | -  | -   | 2   | -  | -     | -     |
| <i>C. flavescens</i>    | 7        | -  | -   | -   | 3  | -     | -     |
| <i>C. turba</i>         | 4        | -  | 1   | 1   | 4  | -     | -     |
| <i>C. smithi</i>        | 2        | -  | -   | -   | -  | -     | -     |
| <i>C. fumosa</i>        | 2        | -  | -   | -   | -  | -     | -     |
| <i>Soricid sp.A</i>     | -        | -  | -   | -   | 1  | -     | -     |
| <i>A. albiventris</i>   | 2        | -  | -   | -   | -  | -     | -     |
| <i>E. erythropus</i>    | 1        | -  | -   | -   | -  | -     | -     |
| <i>P. ochraceus</i>     | *        | *  | *   | *   | *  | *     | *     |
| <i>H. gambianus</i>     | *        | *  | *   | *   | *  | *     | *     |
| <i>X. rutilus</i>       | *        | *  | *   | *   | *  | *     | *     |
| <i>H. cristata</i>      | *        | *  | *   | *   | *  | *     | *     |
| Total                   | 23       | 2  | 8   | 11  | 9  | 6     | 4     |

\* Observed species



**Figure 5:** Number of species of small mammals in various habitat types in APNP

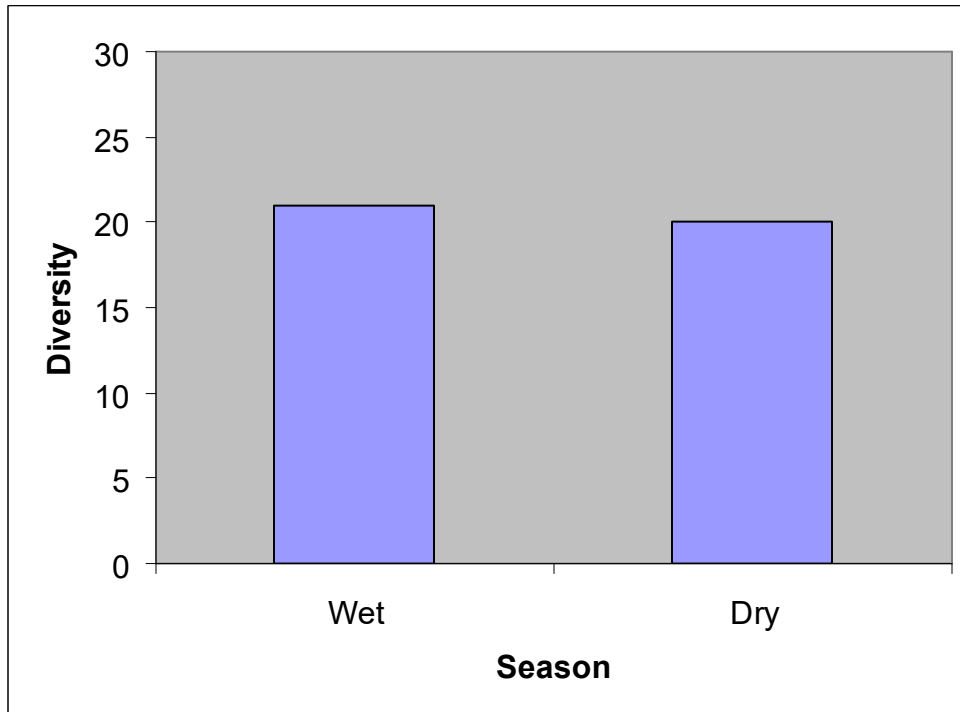
WGL= Wooded Grassland, WL=Woodland, BWL= Bamboo Woodland, RWL=Riverine Woodland, HH= Human Habitations, STS-1= Special Trap Site 1, STS-2= Special Trap Site 2.

### 3.3. Seasonal distribution

The overall species diversity difference between the two seasons (wet and dry) was not significant (21:19). However, some species, which were trapped during the wet season, were not captured during the dry season. Similarly, some species that were not present in the wet season collection were sampled during the dry season (Table 5, Fig. 6).

Table 5. Seasonal distribution and abundance of rodents and insectivores in APNP. (Dash indicates absence of the species.)

| Species                 | Season |     |
|-------------------------|--------|-----|
|                         | Wet    | Dry |
| <i>A. dembeensis</i>    | 41     | 62  |
| <i>A. niloticus</i>     | 5      | 86  |
| <i>D. harringtoni</i>   | 7      | 22  |
| <i>M. natalensis</i>    | 9      | 17  |
| <i>M. erythroleucus</i> | 5      | -   |
| <i>M. albipes</i>       | 8      | 12  |
| <i>A. cineraceus</i>    | 8      | 7   |
| <i>A. wilsoni</i>       | 3      | 8   |
| <i>A. cahirinus</i>     | 4      | 1   |
| <i>Acomys sp. A</i>     | 1      | 3   |
| <i>T. robusta</i>       | 2      | -   |
| <i>T. valida</i>        | 2      | 7   |
| <i>T. phillipsi</i>     | 3      | 1   |
| <i>Murid sp. A</i>      | 1      | -   |
| <i>Murid sp. B</i>      | -      | 12  |
| <i>M. musculus</i>      | 1      | 1   |
| <i>M. tenellus</i>      | 1      | -   |
| <i>L. barbarus</i>      | -      | 2   |
| <i>A. albiventris</i>   | -      | 2   |
| <i>E. erythropus</i>    | -      | 1   |
| <i>C. flavescens</i>    | 7      | 3   |
| <i>C. turba</i>         | 6      | 4   |
| <i>C. smithi</i>        | 1      | 1   |
| <i>C. fumosa</i>        | 2      | -   |
| <i>Soricid sp. A</i>    | 1      | -   |
| Total                   | 118    | 252 |
| Number of species       | 21     | 19  |



**Figure 6:** Seasonal diversity of small mammals in APNP

Variation in species diversity between habitats was greatly significant ( $X^2_3 = 19.5$ ,  $P < 0.001$ ). This is also true when the special trap sites and the human habitation diversities were considered ( $X^2_6 = 30.6$ ,  $P < 0.001$ ). The number of species captured from different grids of each habitat also varied considerably. Maximum number of species was captured from grid 20 (WGL of Demir trap site) during the wet season, in which eight rodent and four shrew species were trapped. This was followed by grid 7 of the riverine habitat during the dry season in which ten rodent species were trapped. Grid 13 (the riverine woodland part) and grid 20 (WGL) during the dry season, grid 37 (WGL) during the wet season and STS-1 during the dry season each produced 7 species of small mammals (Table 6). The commensal rodents *Rattus rattus* and *Rattus norvegicus* were not captured from the wild as well as from the human habitation during both seasons. No sign (e.g. mole hills) for the presence of mole rats were observed over the larger areas of APNP.

**Table 6.** Number of species of rodents and insectivores trapped during the two seasons in various grids, special trap sites and human habitation. (Dash indicates absence of trap or capture). (GL = Grassland).

| Grid  | Habitat type | Season | Trap nights | Catch | Success rate | No. of species |
|-------|--------------|--------|-------------|-------|--------------|----------------|
| 4     | WGL          | Wet    | 50          | 16    | 32%          | 5              |
|       |              | Dry    | -           | -     | -            | -              |
| 7     | RWL          | Wet    | 50          | -     | 0%           | -              |
|       |              | Dry    | 50          | 20    | 40%          | 10             |
| 13    | RWL          | Wet    | 50          | -     | 0%           | -              |
|       |              | Dry    | 50          | 23    | 46%          | 7              |
| 13    | WGL          | Wet    | 50          | 9     | 18%          | 5              |
|       |              | Dry    | 50          | 18    | 36%          | 6              |
| 20    | WGL          | Wet    | 50          | 23    | 46%          | 12             |
|       |              | Dry    | 50          | 30    | 60%          | 7              |
| 26    | WL           | Wet    | 50          | 6     | 12%          | 2              |
|       |              | Dry    | -           | -     | -            | -              |
| 29    | WGL          | Wet    | 50          | 33    | 66%          | 9              |
|       |              | Dry    | 50          | 17    | 34%          | 4              |
| 33    | BWL          | Wet    | 50          | 15    | 30%          | 4              |
|       |              | Dry    | 60          | 49    | 81.6%        | 6              |
| 37    | WGL          | Wet    | 50          | 12    | 24%          | 7              |
|       |              | Dry    | 50          | 15    | 30%          | 3              |
| STS-1 | WGL          | Dry    | 59          | 35    | 59.3%        | 7              |
| STS-2 | GL           | Dry    | 50          | 19    | 38%          | 4              |
| HH    | Commensal    | Wet    | 10          | 4     | 40%          | 3              |
|       |              | Dry    | 30          | 23    | 76%          | 9              |

### 3.4. Trap success by season and habitat type

Trap success between seasons showed significant variation ( $X^2_{1} = 7.6$ ,  $P < 0.01$ ). There was also variation in the trap success between the different sampled study grids during the two seasons ( $X^2_{8} = 62.6$ ,  $P < 0.001$ ). Grid 33 of the BWL during the dry season, grid 29 of the WGL during the wet season and grid 20 of the WGL during the dry season showed maximum trap success of 81.6, 66.0, and 60%, respectively (Table 6). The overall trap success was 38.6%. However, within the major habitat types, capture rate varied from 12 to 64% and the variation is highly significant ( $X^2_{3} = 46.9$ ,  $P < 0.001$ ) (Table 7). Except for the WL, within habitat trap success was also computed between the two seasons. Accordingly, trap success for habitats RWL and BWL was

high during the dry season and the variation was highly significant ( $X^2_1=43$ ,  $P<0.001$ , and  $X^2_1=23.3$ ,  $P<0.001$  respectively). The trap success in WGL did not show significant difference between the seasons.

Varieties of traps were set but only one of the local snares were successful to catch one adult male striped ground squirrel. Neither of the traps was successful to trap tree and unstriped ground squirrels.

**Table 7.** Trap nights, percent, number of grids and trap success in each habitat during the two seasons.

| Habitat | Number of grids | Trap nights | Per cent | Success rate in each habitat | Relative success |
|---------|-----------------|-------------|----------|------------------------------|------------------|
| WGL     | 5               | 450         | 47.40    | 39.1%                        | 18.35            |
| WL      | 1               | 50          | 5.26     | 12.0%                        | 0.60             |
| RWL     | 2               | 200         | 20.50    | 21.5%                        | 4.48             |
| BWL     | 1               | 110         | 11.50    | 64.0%                        | 6.67             |
| HH      | 2               | 40          | 4.17     | 67.5%                        | 2.80             |
| STS- 1  | 1               | 59          | 6.16     | 59.3%                        | 3.60             |
| STS -2  | 1               | 50          | 5.26     | 38.0%                        | 1.90             |
| Total   | 13              | 959         | 100.00   | --                           | 38.60            |

### 3.5 Species abundance in different habitats of APNP

The Genus *Arvicanthis* contributed the largest number of individuals constituting 52.4% of the total catch. *A dembeensis* and *A. niloticus* were trapped from all habitats except from human habitation for the former and WL for the latter. The most trapped rodent from human habitation; *M. albipes* was not sampled from WL and RWL habitats in both seasons. *M. natalensis* was a common rodent in all habitats except for the WL. It was also not sampled from the STS-2. *D. harringtoni* was a common rodent occurring in most habitats except for WL and STS-2. *M. erythroleucus* was sampled during the wet season only from one habitat (WGL). *Acomys*

*cahirinus* was common in all major habitats except in special trap sites. It was also not represented in a commensal fauna. *A. subspinosus* was sampled from WGL, BWL, and from STS-1. It is a major pest in the nearby Gumuz villages. *A. ceneraceus* was exclusively trapped from WGL only during the wet season. *Acomys* sp. A was sampled from WGL and RWL. It also occurs in human habitation. *Tatera robusta*, whose burrows were abundantly observed from most WGL habitats of Alatish, was not accessed for excavation or trapping during the dry season. No characteristic burrows of this animal were observed during the dry season. The readily trapped species of *Tatera*, *T. valida*, was sampled in both seasons at least from three habitats (WGL, RWL and STS-2). It was the most trapped animal in the STS-2 (GL habitat). *T. phillipsi* was excavated during both seasons from WGL and RWL habitats. The only specimen of Murid sp. A was sampled from Magenagna (grid 13) of WGL only during the wet season. Murid sp. B, which was not represented in the wet season collection, was abundantly sampled from WGL, RWL, STS-1 and 2 during the dry season. It is absent from human habitation. *Mus musculus*, was sampled from WGL and STS-1. However, its abundance was limited. Only one specimen of *M. tenellus* was sampled from WGL during the wet season. Two individuals of the Zebra mice (*L. barbarus*) were trapped from RWL habitat during the dry season. While *C. turba* was a cosmopolitan shrew in all Alatish habitats, *C. flavescens* was sampled only from WGL and human habitations. Both *C. smithi* and *C. fumosa* are WGL shrews. The special featured shrew (Soricid sp.A) was caught from residences of farmers (villages). The most abundantly observed rodent, striped ground squirrel *E. erythropus* was trapped with locally made rodent snare from northern Alatish. Two specimens of the larger insectivore, the African hedgehog (*A. albiventris*) were sampled from two grids of WGL (northern and southern Alatish area). They were collected but not trapped.

Eleven species of rodents have a highly restricted distribution since they were trapped from a single habitat. Six rodent species were trapped from two habitats and four species were captured at least from three habitats, and the rest from all habitats (Table 4).

Differences in the seasonal abundance of major rodents and insectivores were computed. Trap consistency between the seasons was absent. Some of the species that were common during the wet season were scarce or absent during the dry season trappings and vice versa. However, seasonal abundance of few species was highly significant. For example, differences in the abundance of *A. niloticus* and *D. harringtoni* were highly significant ( $X^2_1=72.1, P<0.001$ , and  $X^2_1= 7.75, P<0.01$  respectively). More animals were trapped during the dry season. For the rest of the major species, *M. natalensis*, *A. cahirinus*, *M. albipes*, *A. subspiosus*, *T. valida*, *C. flavescens* and *C. turba* the difference in abundance was not significant at  $P>0.05$  for all and *A. dembeensis* at  $P>0.01$  level. The relative abundance of major rodents in each habitat is given in Table 8. Accordingly, *A. dembeensis* is by far the highest in number in all habitat types, followed by *A. niloticus*, *M. natalensis* and *A. cahirinus*. Traps from the human habitation and special trap sites show how the common rodents and shrews are distributed throughout the Alatish area. The overall differences in abundance of species among the habitats of APNP are highly significant ( $X^2_5 = 286, P<0.001$ ).

The most abundant large rodents of Alatish Proposed National Park include the unstriped ground squirrel (*Xerus rutilus*), bush squirrel (*P. ochraceus*) and the tree squirrel (*H. gambianus*). However, although they are frequently observed, it was not possible to trap them even by using the local traps. *H. cristata* is the widely distributed and abundant large rodent of the area. It was commonly observed early in the morning and late in the evening. They used large burrows under big trees or near termitaries. Trapping more than five species of small mammals and insectivores from a grid is common in APNP. *Arvicathis* spp., *Acomys* spp., *Mastomys* spp, *Desmomys* and *Myomys* sp. are usually trapped from the same area. In most cases, in Alatish area, traps are more successful in areas such as under termite mounds, near and under fallen trees, sandy small peaks and under big rocks.

**Table 8.** Relative abundance and distribution of major small mammals in different habitats (Ad= *A. dembeensis*, An = *A. niloticus*, Dh= *D. harringtoni*, Mn = *M. natalensis*, Me= *M. erythroleucus*, Ma = *M. albipes*, Ac= *A. cahirinus*, Ms B = Murid sp B, Cf = *C. flavescens*, Ct = *C. turba*, AC= *A. cineraceus*, Aw = *A. wilsoni*).

| Habitat | Small Mammal Species |      |      |     |      |      |     |     |      |      |      |      | Total capture |
|---------|----------------------|------|------|-----|------|------|-----|-----|------|------|------|------|---------------|
|         | Ad                   | An   | Dh   | Mn  | Me   | Ma   | Ac  | Aw  | AC   | MsB  | Cf   | Ct   |               |
| WGL     | 27.8                 | 24.4 | 6.8  | 5.6 | 2.8  | 3.4  | 5.6 | 2.8 | 2.8  | 1.1  | 3.9  | 2.3  | 176           |
| WL      | 8                    | -    | -    | -   | -    | -    | 4   | -   | -    | -    | -    | -    | 6             |
| RWL     | 32.5                 | 23.3 | 4.6  | 6.9 | -    | -    | 2.3 | -   | -    | 11.6 | -    | 2.3  | 43            |
| BWL     | 43.8                 | 26.9 | 12.7 | 4.8 | -    | 1.6  | 3.2 | 6.3 | -    | -    | -    | 1.6  | 64            |
| HH      | -                    | 14.3 | 3.6  | 25  | -    | 17.8 | -   | 3.6 | -    | -    | 10.7 | 14.3 | 27            |
| STS-1   | 22.8                 | 40   | 17.1 | 8.6 | -    | -    | -   | 2.8 | -    | 5.7  | -    | -    | 30            |
| STS-2   | -                    | 15.7 | -    | -   | -    | 42.1 | -   | -   | -    | 15.7 | -    | -    | 24            |
| Total   | 27.7                 | 24.5 | 7.8  | 7.0 | 1.35 | 5.4  | 4.0 | 2.9 | 1.35 | 3.2  | 2.7  | 2.7  | 370           |

### 3.6 Economic significance of rodents in Alatish area

#### 3.6.1 Rodents as food source

In Alatish, the locals use rodents as a food source. Both large and small pest and non- pest rodents are the important components of diets of the Gumuz indigeneous people residing near Alatish. They use APNP as hunting or trapping area. They are hunters and gatherers. The accessibility and easy trapability of rodents contributed for the high demand. They are also easily cooked and need no other additives except salt. People of all age, particularly the goat and sheep herders, participate in the trapping activity. Next to fishing, it is an area where females participate. There are two minor tribes, Datse and Gumuz. Among the rodents some are rejected by Datse but consumed by Gumuz, and vice versa. This rejection is also true in the case of larger mammals.

Table 9 shows the rodent species that are widely used as a food source in the area. Only shrews and all *Acomys* spp. are not consumed by both groups of Gumuz tribes.

**Table 9.** Rodent species that are commonly used by Gumuz people as a food source with the degree of preference.

| Family      | Species               | Degree of preference                     |
|-------------|-----------------------|--|
| Hystriidae  | <i>H. cristata</i>    | High, by both tribes                     |
| Sciuridae   | <i>E. erythropus</i>  | “ “                                      |
|             | <i>P. ochraceus</i>   | " "                                      |
|             | <i>X. rutilus</i>     | " "                                      |
|             | <i>H. gambianus</i>   | " "                                      |
| Erinaceidae | <i>A. albiventris</i> | " "                                      |
| Cricetidae  | <i>T. valida</i>      | Only Datse & all children of both tribes |
|             | <i>T. robusta</i>     | " " " "                                  |
|             | <i>T. phillipsi</i>   | " " " "                                  |
| Muridae     | <i>A. dembeensis</i>  | High, by both tribes                     |
|             | <i>A. niloticus</i>   | " " "                                    |
|             | <i>Murid sp. B</i>    | " " "                                    |
|             | <i>D. harringtoni</i> | " " "                                    |
|             | <i>M. natalensis</i>  | Only children of both tribes             |
|             | <i>M. albipes</i>     | “ “ “                                    |
|             | <i>L. barbarus</i>    | “ “ “                                    |

### 3.6.2 Rodent and insectivore pests in the Alatish area

Nine of the eighteen small rodents (50%) have representatives in human habitations, becoming chronic pests. *M. natalensis*, *M. albipes*, *A. wilsoni*, *Acomys* sp. A, *D. harringtoni*, and *A. niloticus* are the most notorious pests of the area. They consume stored grain, cotton, cooked food and household material. Similarly, three of the six insectivores are pests. In addition to consuming the above mentioned materials, *C. flavescens*, *C. tuba* and Soricid sp. A are notorious chicken raiders in all nearby villages of Alatish area. Porcupines are the most important pests of crop fields. Both the species of ground squirrels (*E. erythropus* and *X. rutilus*) are known stored grain pests. The most abundant rodent of the area, *A. dembeensis*, was not captured from human habitation. Most of the small rodent pests were trapped during the dry season.

### 3.7 Age distribution

All age groups were represented in the population of trapped animals during the wet season. Young animals from the wet season account for 34.3% of the total capture. Among the common small mammals, *A. cahirinus* had no young member trapped during this season. During the dry season, young animals of all species were rare. All trapped individuals of *A. dembeensis* and *A. niloticus* were adult except four and five male individuals, respectively, whose testes were partly descended. These individuals were grouped under sub-adult category. *M. albipes* (4), *M. natalensis* (7), *M. musculus* (1) and *T. Valida* (1) have young members in the dry season trapping. Male of the *L. barbarus* was sub-adult.

### 3.8 Reproductive Condition of small mammals in APNP

Reproductive condition of adult females trapped during the wet season was recorded. Accordingly, 68.7% of *A. dembeensis*, 60% of *M. natalensis*, 50% of *D. harringtoni*, 75% of *A. cahirinus* all 66% of *A. wilsoni* were pregnant (Table, 10). *C. turba* of the Omedla trap site gave birth to 5 fully matured juveniles in a Sherman trap. Few adult females of *A. dembeensis*,

*D. harringtoni*, *M. natalensis*, *A. cahirinus*, *C. turba* and *A. wilsoni* had lactating individuals. Only two juveniles were observed, one for *M. natalensis* and the other for *M. albipes*.

**Table 10.** Pregnant and lactating adult females from the wet season traps.

| Species                 | No. of adult females | No. of pregnant females | No of embryos | No. of lactating females |
|-------------------------|----------------------|-------------------------|---------------|--------------------------|
| <i>A. dembeensis</i>    | 16                   | 11                      | 4-6           | 4                        |
| <i>A. niloticus</i>     | 5                    | 3                       | 22 each       | 2                        |
| <i>M. erythroleucus</i> | 3                    | 1                       | 13            | 2                        |
| <i>D. harringtoni</i>   | 6                    | 3                       | 6-10          | 2                        |
| <i>A. cahirinus</i>     | 8                    | 7                       | 4-6           | 1                        |
| <i>C. turba</i>         | 2                    | 1                       | 5             | 1                        |
| <i>M. musculus</i>      | 1                    | -                       | -             | 1                        |
| <i>A. wilsoni</i>       | 3                    | 2                       | 4 each        | 1                        |

During the dry season, very few pregnancy cases were recorded. Except one individual all adult females of *A. dembeensis* were not perforated. Only 3 of the 43 adult females of *A. niloticus* were perforated. No visible pregnancy for *D. harringtoni* was observed during this season except that 6 of the 16 adult females showed vaginal perforation. Pregnancy was recorded only in five individuals of *A. cahirinus* each with only two embryos. Two pregnant females of *T. valida* bear six embryos each. A single *A. wilsoni* aborted two pre-matured embryos in the Sherman trap. Two lactating *M. natalensis* were caught from the Gumuz farmers houses. The rest of the adult females of this season had no perforated, pregnant or lactating members.

### 3.9 Trap condition, predation and parasites

92% of the diurnal dry season catches (*A. dembeensis*, *A. niloticus* and partly *D. harringtoni* and Murid sp. A) were found dead. The few animals that were obtained alive were those that enter trap before collection. Among the rodents trapped in both seasons, three-fourth or half of the tail

of 19 individuals were mutilated. Ants removed lips of 11 animals. Right hind foot of *M. natalensis* were also found mutilated. Most of these incidences were recorded during the dry season. Body of 16 animals were full of flea, and that of seven animals were fully covered with ticks.

*T. valida* and *Arvicanthis* harboured the most flea. Nine Sherman traps, during both seasons, trapped two animals each. Eight of these were of the same species, mixed sexes and almost similar age groups. Only one trap captured one adult and the very young male of *A. dembeensis*. One trap captured both adult male *T. valida* and *M. albipes*, in which the latter was dead and half eaten by the former. Double trapped species include *A. dembeensis* (3), *A. niloticus* (2), *A. wilsoni* (2), *M. albipes* (1) and *T. valida* and *M. albipes* both in one. All *Arvicanthis* spp., *D. harringtoni* and Murid sp. B are diurnal. They are more active between 06:00 and 10:30 a.m. in the morning and 15:30 and 18:30 p.m. in the afternoon. Very rare or no rodent of these species were seen between 10:30 and 15:30h; probably the period when day time heat was more intense.

### 3.10 Sex ratio

No significant sex ratio (male: female) difference was observed between seasons (48.3:51.7% for wet and 48:52% for dry season respectively). However, the sex ratio was significantly different in *D. harringtoni* (68.9%), *A. cahirinus* (73.3%), Murid sp B (66.6%) and *A. dembeensis* (57.3%). In all these species more females were trapped.

The major problems during the two seasons were trapping of non-targeted animals. Eight of the traps captured forest lizards although none of them died in traps. Three traps captured snakes, two died in the traps but one was alive. Eleven traps were burnt by forest fire of which three had animals (Plate 9). “Fellata” herds crushed five Sherman traps, and goat herdsmen stole few. The average body measurements for all adult small mammals trapped from APNP during both (wet and dry) seasons are given in Tables 11 and 12, respectively. Head and body length or weights of some major small mammal species show some differences between seasons.

**Table 11.** Average body measurements (mean  $\pm$  SD) of small mammals trapped during the wet season. (HB = Head body length, T = Tail length, HF = Hind foot length, Er = Ear length, Wt = weight. Length is measured in mm and weight in g).

| Species                 | Sex | No of individuals | Body Measurement |             |           |           |             |
|-------------------------|-----|-------------------|------------------|-------------|-----------|-----------|-------------|
|                         |     |                   | HB               | T           | HF        | Er        | Wt.         |
| <i>A. dembeensis</i>    | M   | 8                 | 157.3(13.2)      | 133.3(23.4) | 32.6(3.4) | 14.3(1.7) | 167.7(33.8) |
|                         | F   | 14                | 143(18.1)        | 124.4(19.8) | 30.6(2.4) | 12.6(2.4) | 112.2(36.6) |
| <i>A. niloticus</i>     | M   | 1                 | 120              | 118         | 31        | 9         | 69          |
|                         | F   | 1                 | 150              | 105         | 28        | 11        | 74          |
| <i>D. harringtoni</i>   | M   | 1                 | 125              | 125         | 25        | 16        | 70          |
|                         | F   | 6                 | 149.2(17.7)      | 132.2(20.4) | 31.6(2.1) | 13.3(1.8) | 119.6(41.5) |
| <i>M. natalensis</i>    | M   | 3                 | 124.5(18.3)      | 125.3(12.3) | 25(2.5)   | 14.6(1)   | 75.5(16)    |
|                         | F   | 5                 | 127.3(18.4)      | 121.6(16.4) | 21.3(3.2) | 15.6(2.0) | 70.6(27.4)  |
| <i>M. erythroleucus</i> | M   | -                 | -                | -           | -         | -         | -           |
|                         | F   | 3                 | 116.3(14.1)      | 104(15.0)   | 22.6(3)   | 14(1.7)   | 50(14)      |
| <i>M. albipes</i>       | M   | 3                 | 107.6(34.2)      | 122.3(17.7) | 22.3(2.5) | 14.6(1.2) | 46(25)      |
|                         | F   | 1                 | 105              | 105         | 21        | 15        | 38          |
| <i>A. wilsoni</i>       | M   | 1                 | 95               | 80          | 15        | 14        | 36          |
|                         | F   | 3                 | 108(14.6)        | 90(12.3)    | 15.5      | 13        | 41.3(3.5)   |
| <i>Acomys sp. A</i>     | F   | 1                 | 105              | -           | 15        | 10        | 35          |
| <i>M. musculus</i>      | F   | 1                 | 65               | 35          | 13        | 11        | 10          |
| <i>T. valida</i>        | M   | 1                 | 155              | 152         | 38        | 19        | 110         |
|                         | F   | 1                 | 140              | 150         | 37        | 17        | 106         |
| <i>A. cahirinus</i>     | M   | -                 | -                | -           | -         | -         | -           |
|                         | F   | 8                 | 102.7(6.6)       | 79.7(9.7)   | 15.1(0.6) | 11.3(0.7) | 44.7(6.3)   |
| <i>C. flavescens</i>    | F   | 1                 | 140              | 49          | 22        | 8         | 57          |
|                         | M   | 1                 | 140              | 71          | 14        | 5         | 44          |
| <i>C. turba</i>         | F   | 2                 | 134              | 70          | 18.5      | 8         | 40          |
|                         | M   | 2                 | 140              | 66          | 17.5      | 5         | 42          |
| <i>Soricid sp. A</i>    | F   | 1                 | 140              | 70          | 20        | 10        | 50          |
| <i>Murid sp. A</i>      | M   | 1                 | 98               | 84          | 23        | 15        | 30          |
| <i>C. smithi</i>        | M   | 1                 | 70               | 35          | 10        | 6         | 8           |
| <i>T. phillipsi</i>     | M   | 1                 | 130              | 130         | 36        | 14        | 89          |
| <i>A. cineraceus</i>    | M   | 2                 | 92.5             | 70.5        | 15        | 10.5      | 27          |
| <i>T. robusta</i>       | M   | 2                 | 128              | 147.5       | 33        | 16        | 109         |
| <i>M. tenellus</i>      | M   | 1                 | 60               | 30          | 11        | 7         | 10          |
| <i>C. fumosa</i>        | F   | 1                 | 75               | 40          | 11        | 6         | 8           |

Table 12. Average body measurements (mean + SD) of trapped small mammals during the dry season in APNP. (HB=head body length, T=tail length, Er=ear length, Wt=weight. Length is measured in mm and weight in g).

| Species                        | Sex        | No of individual | Body Measurement |             |               |             |                |
|--------------------------------|------------|------------------|------------------|-------------|---------------|-------------|----------------|
|                                |            |                  | HB               | T           | HF            | Er          | Wt             |
| <i>A. niloticus</i>            | M          | 41               | 130.6(17)        | 123.5(12)   | 31.2(1.9)     | 12.7(1.7)   | 96.8(28.2)     |
|                                | F          | 40               | 130.4(9.2)       | 121 (10.6)  | 31(2.2)       | 12.3(1.4)   | 94(23.2)       |
| <i>A. dembeensis</i>           | M          | 22               | 135(18.1)        | 124.2(14.5) | 31.5(1.9)     | 12.7(1.2)   | 85.7(24.4)     |
|                                | F          | 39               | 131.8(10.4)      | 122(11.8)   | 31.3(1.4)     | 13(1)       | 92(21.4)       |
| <i>D. harringtoni</i>          | M          | 7                | 153.5(10.2)      | 136.5(21.5) | 33.4(3)       | 14.5(0.5)   | 132(29)        |
|                                | F          | 13               | 149.7(14.6)      | 134(15.6)   | 31(1.5)       | 14.3(1.9)   | 127.2(30.5)    |
| <i>M. natalensis</i>           | M          | 7                | 116.6(5.7)       | 119.3(2.3)  | 22.3(2)       | 14.6(06)    | 44(4)          |
|                                | F          | 11               | 119.3(4.9)       | 118.4(9)    | 23(1.3)       | 13.8(1.3)   | 45(6.7)        |
| <i>M. albipes</i>              | M          | 10               | 114(13)          | 126(13.2)   | 22.7(1.9)     | 14.6(0.5)   | 47.6(9.2)      |
|                                | F          | 2                | 85               | 108         | 19            | 12          | 20             |
| <i>T. valida</i>               | M          | 4                | 163.7(19.3)      | 171.5(6.2)  | 37.7(2)       | 17(1.4)     | 132.5(19.2)    |
|                                | F          | 2                | 167.5            | 175.5       | 40            | 18          | 150            |
| <i>A. wilsoni</i>              | M          | 5                | 99(9.6)          | 68(8.3)     | 14.8(1)       | 11.4(1.4)   | 35.2(19.2)     |
|                                | F          | 3                | 95(8.6)          | 65(10)      | 15(1)         | 10.6(0.4)   | 28.6(5.7)      |
| <i>Acomys sp. A</i>            | M          | 2                | 102.5            | -           | 14.5          | 10          | 35.2(19.237)   |
|                                | F          | 1                | 85               | -           | 15            | 10          | 134            |
| <i>Murid sp. B</i>             | M          | 4                | 151.2(7.4)       | 140.2(3.3)  | 30.5(1)       | 13.5(0.6)   | 121(17.1)      |
|                                | F          | 8                | 146.2(18.2)      | 134.5(7.7)  | 30(3.5)       | 13.5(1.3)   | 118(31.6)      |
| <i>A. cahirinus</i>            | M          | 4                | 91.3(12.4)       | 86.5(10.3)  | 15.5(1.7)     | 11.3(0.5)   | 29.5(8.6)      |
|                                | F          | 3                | 105(5)           | 100         | 17(1)         | 12(1)       | 38(5.2)        |
| <i>L. barbarus</i>             | M          | 1                | 90               | 120         | 25            | 12          | 28             |
|                                | F          | 1                | 90               | 130         | 26            | 10          | 39             |
| <i>A. cineraceus</i>           | M          | 1                | 82               | 45          | 11            | 10          | 28             |
|                                | F          | -                | -                | -           | -             | -           | -              |
| <i>T. phillipsi</i>            | M          | 1                | 120              | 128         | 34            | 15          | 80             |
| <i>M. musculus</i>             | M          | 1                | 75               | 36          | 10            | 7           | 7              |
| <i>C. smithi</i>               | F          | 1                | 75               | 48          | 11            | 6           | 8              |
| <i>C. turba</i>                | M          | 4                | 126.3(11)        | 68.7(1.3)   | 19.3(2.2)     | 7(2)        | 42.(5.2)       |
| <i>E. erythropus</i>           | M          | 1                | 220              | 210         | 62            | 7           | 272            |
| <i>C. flavescens</i>           | M          | 1                | 130              | 67          | 18            | 10          | 30             |
|                                | F          | 2                | 137.7            | 69          | 20            | 6           | 42             |
| .....<br><i>A. albiventris</i> | .....<br>M | .....<br>2       | .....<br>228.5   | .....<br>45 | .....<br>58.5 | .....<br>14 | .....<br>728.5 |

#### 4. Discussion

Twenty three rodent species including the four squirrels and a porcupine and six insectivore species were recorded from APNP and northwestern lowlands of Ethiopia. Two of the rodent species (*M. albipes* and *D. harringtoni*) and the three shrews (*C. flavescens*, *C. furba* and *C. fumosa*) were caught out of their former recorded altitudinal limits and geographic ranges, while others are well within their range from which they have been previously recorded in Ethiopia or elsewhere in East Africa. The three rodent species (Murid sp. A, Murid sp. B and *Acomys* sp. A) and a shrew (soricid sp. A) are newly described from APNP.

##### 4.1 Diversity, Distribution and Relative Abundance

*M. albipes*, the forest dweller of eastern and western plateaux (Yalden & Largen, 1992) is also a widely distributed common rodent in APNP both in the wild and in human habitations. Ingerson (1968) collected the species from southeastern Ethiopia between 2000 and 2700 m a.s.l. Dorst (1972) trapped the species at 1285 m a.s.l. in Merab Abaya. Yalden *et al.* (1976) reported its altitudinal range between 1500 and 3000 m a.s.l. In the same year, Yalden recorded this same species from southwestern Ethiopia at 820 m a.s.l. suggesting that the range of this species is limited by low rainfall rather than other factors such as high temperature. Afework Bekele (1996a) trapped the species from Menagesha State Forest between 2000 and 3300 m a.s.l. Yalden *et al.* (1976) also reported the occurrence of this species along the Ethiopian border with Kenya (Moyale) suggesting the probable range extension of the species into the neighbouring countries. Yalden (1988) emphasized its replacement by *Sternocephalemys griseicaudata* in open habitats between 2400 and 2900 m a.s.l. and by *S. albicaudata* between 3000 and 4000 m a.s.l. This is an indication for its intolerance for competition. Afework Bekele (1996a) showed that the species also was frequent in scrub or bushy vegetation outside the forest, indicating its tendency to range extension. The species has been recorded from various parts of Ethiopia including Debre Markos, Bahir-Dar, Dembecha, Kibre Mengist, Lekemte, Mendi, Lake Zeway, Nijabara, Goba, Muger River, Bako, Bedele and Alemaya (Yalden *et al.* 1976). All the above evidences suggest the tendency of the species to extend its range and occupy open niche. Besides, the northwestern lowland ecosystem is quite different from the extensively used and degraded

ecosystem of the northeastern counterpart. Therefore, there is a high possibility for *M. albipes* to expand its range from its former range (the northern highlands) to the stable ecosystem with diverse niches of the northwestern lowland particularly to the Alatish area.

*D. harringtoni* is the fairly abundant rodent in APNP next to *Arvicanthis* spp., It is also an endemic species whose range was thought to be restricted to the highlands of Ethiopia. The yellowish agout dorsal pelage and greyish white underside and the grooved upper incisors are the main features that distinguish it from *A. dembeensis*. Its former records include the Menagesha State Forest (Afewerk Bekele, 1996a). Entoto Mountain (Bekele Tsegaye, 1999) and Kombolcha, Katchisa River, Addis Ababa, Dangila, Kutaber and Koffoloe (Yalden *et al.*, 1976). This species was accepted to be a resident of the Ethiopian plateaux, and all the recorded areas lie between 1800 and 2800 m a.s.l. (Yalden *et al.*, 1976). This species used to occur largely with *M. albipes* showing a range overlap. Although further records and detailed published information about this species are lacking, there is a high possibility for the species to be pushed from highlands of Ethiopia to the nearby western lowlands of the region. This species was also captured from human habitations and from the extrem southwestern trap grid. The remaining rodent species, eventhough are new records for APNP, they are well within their altitudinal range where they have been recorded previously in Ethiopia and elsewhere in East Africa.

The unstripped grass rat, *Arvicanthis dembeensis*, is the most abundant and widely distributed small mammal throughout the APNP. It is essentially a lowland species with most records between sea level and 2200 m a.s.l. (Capanna *et al.* 1996). Former records of this species in Ethiopia include Shore of Lake Tana, Sadi-Malka, Shore of Lake Zeway, Awash River, Sidamo, Diddesa River basin, shore of Lake Abaya, Akordat, Holeta, Arba-Minch, Awash National Park, Koffole and central Ethiopia (Koka). The exceptionally recorded higher altitude range is in Kutaber (2600 m) a.s.l) (Yalden *et al.*, 1976). Its apparent range expansion was reported by Afewerk Bekele *et al.* (1993). *A. dembeensis* is considered to be the third endemic species of the genus to Ethiopia (Capula *et al.*, 1997). However, the current trapping of this animal from the most extreme southwest Alatish (Omedla trap site) near the Ethio-Sudan border makes its endemicity under doubt, as there is no barrier for this animal to cross the border.

The Nile-rat, *Arvicanthis niloticus*, is the second most common rat of APNP in all habitats including human habitations. Yalden *et al.* (1976) did not list records and distribution of this species in Ethiopia due to the then unsettled taxonomic problem of the whole genus. *A. niloticus* represents the Genus over large area of its range. Its distribution extends up to the Nile Valley and the Horn of Africa to Senegal across the sub-Saharan belt (Capula *et al.*, 1997). It favours savanna at lower altitude, in which case, APNP is the most favourable habitat. It has very few records from forest habitat (Fiedler, 1994). Volobour *et al.* (1988) sampled it from the Omo River Valley and Gambela.

The spiny mice, Genus *Acomys*, are associated with arid, mainly rocky habitats. They are also common in sandy deserts and semi-desert regions from sea level to 1500 m a.s.l. (Sokolov *et al.*, 1993). APNP provides conducive habitat for several species of this Genus. From taxonomic ground, Ethiopia is thought to be the evolutionary centre for the origin of the spiny mice (Ellerman *et al.*, 1953). The high diversity of *Acomys* spp. (the three named and the one yet to be identified) in APNP gives strong support to this idea. The former records of the species in Ethiopia are as follows: *Acomys cahirinus* Melka-Sadi, Gallabate, Dembea, Northern bank of Awash River, Diddesa River and Guder River. It occupies mostly lowland areas from sea level up to 1500 m a.s.l. (Yalden *et al.*, 1976). *Acomys cineraceus*, Melka-Sadi, Gudar River. It also extends to the eastern Sudan at Gallabat (Bates, 1994). *Acomys wilsoni* from extreme southern Ethiopia (Neghelle), Burga, Gandaraba and Lower Omo Valley. In neighbouring countries, it also occurs in eastern and southern Sudan, northern and Central Kenya (Bates, 1994).

Of the three multimammate rats, the two (*Mastomys natalensis* and *Mastomys erythroleucus*) have wider distribution over most of Ethiopia. Similarly, they are very common throughout most part of the west, central and eastern Africa (Lavrechenko *et al.* 1998; Venturi *et al.*, 2003). They are also the most common rodent species in APNP. Only the third species, *M. awashensis* is endemic to central Ethiopian lowland (Lavrechenko *et al.*, 1998), which is absent in this study area. The recorded occurrences in Ethiopia are as follows: *M. natalensis* - Southwestern Ethiopia,

Gambela, Dembea, Tekeze River, Lake Shalla Shore, Maji and Godere River. Its distributional altitude range is between 500 and 2900 m a.s.l. (Yalden *et al.*, 1976).

*M. erythroleucus* - Most common maize field rat of central Ethiopia (Afework Bekele & Leirs, 1997). It was also recorded from the Omo Valley, and mostly overlaps with the distributions of *M. natalensis* (Hubert, 1978).

Four of the six common *Tatera* species in Africa are recorded from Ethiopia (Bates, 1988). Only three are recorded for APNP during the present study. The previous records of the three species of *Tatera* include:

*Tatera robusta* ; Shore of Lake Zeway, Urso River, Erer River, Shore of Lake Abaya, Awash National Park. These mostly occur between 200 and 1700 m a.s.l. (Yalden *et al.*, 1976) and maize fields of central Ethiopia (Afework Bekele & Leirs, 1997). It is commonly distributed in the west of the Rift Valley, Omo Valley and Southwestern Ethiopia. In neighbouring countries, it is known from south and southeastern Sudan and northwestern Kenya (Bates, 1988). It occurs in all habitats of APNP.

*Tatera phillipsi*; Recorded localities in Ethiopia and Kenya are apparently restricted to the Rift Valley (Bates, 1988). It is sympatric with *T. robusta* in APNP. This contradicts with the generalization of Bates (1988) that states its distribution to be restricted in Rift Valley. Yalden *et al.* (1976) did not describe its occurrence and distribution in Ethiopia.

*Tatera valida*; Diddesa River, Gambela (Yalden *et al.*, 1976; Bates, 1988). Abay River Valley and extend to the Ethiopian plateaux and southeastern Sudan (Bates, 1988; Fiedler, 1994).

Two species of the genus *Mus* (*Mus musculus* and *Mus tenellus*) are recorded from APNP in the wild habitat. This contradicts with the description of Bates (1988) that reports their occurrence exclusively in urban and villages. Yalden (1988) described their occurrence in open habitats between 1510 and 3000 m a.s.l. This also contradicts with the current records from APNP (between 528 and 654 m a.s.l.). The former distribution and records in Ethiopia are as follows:

*Mus musculus*; Dire Dawa, Addis Ababa, Awash National Park, Shore of Lake Tana (Yalden *et al.*, 1976).

*Mus tenellus* ; This smaller species has a wider distribution and is recorded from Ogaden, Awash National Park, Gallabat, Godere Forest, Arba-Minch, Bako, Diddesa River (Yalden *et al.*, 1976). The record of this species from this area agree with the generalization of Petter (1972) who commented the wide distribution of this species especially in lower altitude between 600 and 2000 m a.s.l.

Of the two species of Zebra mice (*Lemniscomys*) occurring in Ethiopia, only one, *Lemniscomys barbarus* is recorded from APNP during this study. The former recorded areas and distribution in Ethiopia were scanty, only from Shore of Lake Abaya (Southeastern corner). The most common and the widely distributed species of the genus in Ethiopia is *L. straitus*. However, this species was not recorded during the present study.

The most common and, non-forested lowland habitat species, the striped ground squirrel, (*Euxerus erythropus*) is also common over the whole areas of APNP. Its former records in Ethiopia include Tekeze River, Dire-Dawa, Arba-Minch, Lake Chamo, Merab Abaya, Gambela, Lake Shalla, Lake Awasa, Bulcha Forest, all within altitudinal range between sea level and 2000 m a.s.l. (Yalden *et al.*, 1976).

The small unstriped ground squirrel, *Xerus rutilus*, is as common as *E. erythropus* particularly at the northern and eastern Alatis. The Kingdon distribution map (Kingdon, 1997) and the recorded distribution of this species by Yalden *et al.* (1976) restrict the range of its occurrence only to the eastern lowlands of Ethiopia. This contradicts with the current occurrence of this species in APNP. The former records from Ethiopia include Dire-Dawa, Southeastern part of Ethiopia, Errer River, Urso River, Alemaya, Sidamo-Bale Bridge, Bulcha Forest, Lake Abaya, and eastern Neghelli. It is the common ground squirrel of Ethiopia ranging from sea level to approximately 2000 m a.s.l. (Yalden *et al.*, 1976).

*Paraxerus ochraceus* (Ochre bush squirrel) is the most common squirrel of the northern and eastern part of Alatish. In this area, it is mostly associated with the riverine habitat. In Ethiopia, it was formerly recorded from Barmadu, Ganana River and Dolo (Yalden *et al.* 1976). It is also the common squirrel in the wooded riverine strip, dry forest and thickets of the south and southeastern Sudan (Kingdon, 1997).

The woodland and savanna habitat squirrel, the Gambian Sun Squirrel (*Heliosciurus gambianus*) is the common tree dwelling squirrel over most of the wooded grassland and woodland habitats of the northern, eastern and southern Alatish. Its former records in Ethiopia include Kallu Valley, Shoa, Chor Gingil, Schimfa Chor, Madabia, Gallabat (Metema), Dembea, Ghinda, Mendi, Blue Nile Valley, Andaratscha, Tigri, Zegi, Bahirdar, Tississat, Omo Valley, west of Mabil, Merab Abaya, Gum-Yesus, Urgessa (Yalden *et al.* 1976). This arboreal squirrel is confined to the western half of the country from sea level to 2000 m a.s.l. and tolerant of conditions ranging from tropical deciduous forest to arid scrub (Yalden *et al.* 1976).

*Hystrix cristata* (Crested Porcupine) rodent with black body and black and white quills is an abundant fauna of APNP. It is also the most commonly recorded rodent in Ethiopia (Yalden *et al.*, 1976).

The other special groups of the small mammalian fauna of APNP are the six insectivores. The capture of five shrews was comparable to the collections of four species from Harrena forest by Yalden (1988) and Rupp (1980) who trapped five species. The uniqueness about three of these five species of shrews (*C. flavescens*, *C. turba* & *C. fumosa*) is their occurrence outside their recorded altitudinal ranges and the occupation of new habitat (the drier semi-arid lowlands of Alatish area). The fourth shrew, *C. smithi* is a lowland species and the last one is not yet identified. Delany (1964) stated that *Crocidura flavescens* is typically a forest species and Yalden *et al* (1976) described it as a large shrew occurring both on plateaux and lowland habitat (with various pelage coloration, dark brown when at plateau and paler for lower altitude (1500 m a.s.l.). Yalden *et al.* (1976) reviewed its records from various parts of Ethiopia. Among these

are Lake Langano, Lake Awasa, Robe, Debre-Markos, Addis Ababa, Gardula, Chilga Mt., Degen, Modjo, Selalle, Western shore of Lake Tana, Bahir-Dar, Dangila, Gimbi, Shewa Robit Bako and Jimma. The occurrence of this species in APNP may be a part of its range extension. However, it is a new record for this animal to occur in such low altitude area and different habitat types.

*Crocidura turba* is a very dark shrew comparable in size to *C. flavescens* (Tables 11, 12). This shrew is recorded to inhabit highland areas (Yalden *et al.*, 1976). It was the most trapped shrew in APNP in all habitats including the human habitations. Its former record was only from Njabara (Yalden *et al.*, 1976). It is newly recorded from the extreme lowland of Alatish that is far below its previously registered range.

*Crocidura fumosa*; Yalden (1988) described it as a moorland species most common between 3800 and 4000 m a.s.l. He also showed the capacity of the species to penetrate down to lower altitude like those of *Stenocephalemys* spp. The same year, Yalden noted the altitudinal range of the species to be between 2400 and 3850 m a.s.l. Former records of this species in Ethiopia include Dinshu, Mt. Albaso, Mt. Amedamit ranging between 1750 and 3900 m a.s.l. However, it was not recorded below this limit. Similar to *C. flavescens*, it is also successful in invading the wooded grassland habitat of APNP. It was represented by few individuals in APNP and was not trapped from other habitats and human habitation. Similar to the above two species, the occurrence of *C. fumosa* between 528 and 654 m a.s.l. is a newly recorded range of altitude.

*Crocidura smithi* is distinguished by its very small third unicuspid upper teeth; very large upper incisors, blue gray pelage dorsally and white ventrally, and white feet. It is a dry lowland habitat shrew (Yalden *et al.*, 1976). Only single individual was trapped from wooded grassland of APNP, and is considered rare during this study period. All the insectivores trapped in APNP are very familiar to the Gumuz who gave their local names. A few of these shrew species including the yet to be identified *Soricid* sp. A, are known to be notorious pests.

Of the four species of the genus *Atelerix*, (the African hedgehog), that are common in open, drier regions of Africa (Kingdon, 1997) only *Atelerix albiventris* is recorded from APNP. The former records of this species in Ethiopia include Dire-Dawa, Debahir River, Obock, Murri, Omager, Dongollo and Toyo plain (Yalden *et al.*, 1976). Two specimens were collected from northern and southern part of APNP, both in wooded grassland habitat.

The high diversity of small mammal records of the APNP from lower altitude may be described in two ways. One is the inadequacy of countrywide faunal exploration. The other possibility is the range expansion of small mammals in response to the ever narrowing of their habitat of the northern highlands due to extensive use by man. At present, APNP has a stable ecosystem with diverse niche to serve as a refuge for more highlanders.

When compared with studies in other localities of Ethiopia, the small mammalian faunal diversity of APNP is high and comparable with few records in Africa. The captured and observed rodents and insectivores reach 29 species. The trap experience in Ethiopia, mostly from the highland areas, include records of eight species of rodents from Bale Mountains (Sillero - Zubiri *et al.*, 1995), nine species from Menagesha State Forest (Afewerk Bekele, 1996a), Seven rodent and four shrew species from Bale Mountains (Yalden, 1988; Hutterer & Yalden, 1990) and ten rodent and five shrew species from Bale Mountains (Rupp, 1980). Recent works in Africa include the capture of seven rodent and five shrew species from Madagascar (Stephenson, 1993). Five rodent and two insectivore species from the Kenyan grassland habitat (Oguge, 1995), the collection of 14 small mammals from Zimbabwe (Linzey and Kesner, 1997), the records of nine species of small mammals from central Kenya (Keesing, 1998), 15 rodents and 10 insectivore species from Swaziland (Monadjem, 1999) and the capture of 11 rodent and two shrews from Mt. Elgon, Uganda (Clausnitzer, undated). These records show that the northwestern lowland ecosystem of Ethiopia (where APNP is found) is very rich in small mammalian diversity.

The species richness varies greatly among the four habitats of the APNP. The Shannon Weaver Diversity Index (H) also shows this. During the wet season, the wooded grassland habitat was

relatively open, and the majority of small mammals temporarily migrate into this area. The diversity of small mammals, during the wet season was low in bamboo woodland, negligible in woodland and absent in riverine woodland habitats. Similar observation was reported by Delany & Robert (1978), where they recorded negligible population of small mammals from Kenyan Rift Valley in mid-July. In the riverine woodland, the overflowed water from riverbanks makes the characteristic soil of the area (black cottony) swampy and damp. Burrows of small mammals are flooded, and no suitable substratum to construct new ones. During this season, small mammals are forced to leave the area for the relatively better nearby habitat. In this case, the most probable habitat would be the wooded grassland. Similar analogy may be given to the woodland fauna of the wet season. The dense vegetation of this area does not allow drainage. This makes the microhabitat of small mammals inhospitable to live in. In the case of bamboo woodland during this season, the interwoven stem and root system of bamboo and the dense grass growth creates non-conducive damp microclimate. However, few individuals were obtained from marginal areas of this habitat.

#### **4.2 Habitat association**

Most species of small mammals in APNP tend to prefer open habitats. This may be the reason why the relatively open habitat of the area, wooded grassland, harboured the greatest number of species. As Davis & Schmidly (1994) stated, most granivores typically occupy open habitats whereas the other species generally favour habitats with canopy. Over 77% of the trapped small mammals in APNP are granivores and omnivores. The absence of the widespread commensal rodent, *R. Rattus* and *R. norvegicus* from APNP and the surrounding area is unexpected. Their absence is also confirmed by the abundance of other species, like *Mastomys* spp. and *M. albipes* in human habitations, that otherwise were competitively excluded. These species might not have been introduced into these areas. Since they are easily transferred from one village to the other, the absence from this area may indicate their absence from the whole northwestern lowlands.

APNP is located at the transition ecotone from the highland "forest" to the Sahelian desert type ecosystem. This strategic geographic location and its inhospitability to human interference made it to have unique and undisturbed habitats. It is particularly suitable for all grass loving species. This is confirmed from the trapped species composition. This is particularly true for the genus *Arvicanthis*, which is shown by their occurrence all over the habitats of APNP in higher proportion.

The flat nature of Alatish, with no natural or artificial barrier for free movement, allows the animals to change their position following changes associated with seasons. The absence of animals from the riverine woodland during the wet season and their abundance during the dry season strengthens this possibility. No strict habitat specializations or habitat affinity is observed in most small mammals of APNP, except for the few rare species. For the survival of *Arvicanthis*, cover is the most important component of their microhabitat (Fiedler, 1974; Delany, 1986; Afework Bekele *et al.*, 1993). However, the complete absence of cover from over the larger area of Alatish during the dry season was not a problem for them. The cracks made by the black cottony soil during the dry season are the best area to escape from the danger of predation. The tunnels of the cracks extend over several metres allowing free movement and safe forage. As clearly shown in Tables 4 and 5, they are more abundant during the dry season. This observation is well in line with the findings of Delany (1986) and Afework Bekele *et al.* (1993), which showed the attainment of maximum number during the mid-dry season. In APNP, they comprised the bulk of the dry season capture after the burn and habitat degradation. *Mastomys* was reported to be a pioneer to invade such habitats (Oguge, 1995). But here, *Arvicanthis* took the status.

From the pest point of view, the absence of *A. dembeensis* from human habitation was unique. *A. niloticus* was also few in number from human habitation. At STS-2, no *A. dembeensis* was trapped, but *A. niloticus* occupied the few termite mounds of the open marginal areas that were not occupied by *T. valida* and *M. albipes*. The tendency of highland animals, *M. albipes* and *D. harringtoni* to move out of the riverine and woodland habitat of APNP area is still surprising.

Over 60% of the *D. harringtoni* was captured from wooded grassland habitat. None of the *M. albipes* was captured from woodland and riverine woodland, which are relatively closer to its native habitat. Eight individuals of *M. albipes* were trapped from the STS -2, (savanna grassland type habitat) together with *T. valida*.

Out of the 23 trapped species, ten were caught once with individual number ranging between one and five. The effect of habitat change varies between species (Ermans, 1984; Pahl *et al.*, 1988) and the species to disappear first might be those that are conspicuous and specialists on a particular vegetation type (Terbough & Winter, 1978; Emons, 1984). Most of the rare species in APNP are smaller in size. *M. erythroleucus* is one of the cryptic species of APNP in the present study. Only five individuals were trapped from a single wooded grassland trap grid (Omedla trap site) during the wet season. The “Fellata” cattle exceptionally devastated this area in the dry season. It is an area where the largest number of cattle was recorded during the dry season. Pastoralists best prefer this grid because it is in close proximity to Dinder River (the only water source). Few specimens of *Mastomys* were trapped from Omedla village and all of *M. natalensis*, in which case both live sympatrically in this grid. In this grid, maximum number of burrows of *T. robusta* was also observed during the wet season, but none during the dry season. Only few individuals of this species were obtained in natural habitat (grassland) and high in artificial (maize field) during the dry season in central Ethiopia (Afework Bekele & Leirs, 1997). However, such alternative facility was unavailable in the present study areas. High population fluctuation between seasons was well documented for this species in various parts of Africa (Hubert & Adam, 1983; Leirs, 1995; Afework Bekele & Leirs, 1997). Seasonal change in food supply and habitat condition causes movement of animals between refuge and the affected habitats (Hanson, 1977). Temporal disappearance of the rare species of APNP may be due to these facts.

*Acomys cahirinus* favours the open reddish sandy soil of the wooded grassland habitat. They also occurred in all the sampled habitats, but in lower number. There was no change in their seasonal abundance. However, their tendency to prefer more open and arid type habitat (wooded

grassland) is clear (Table 4). This general association with the rocky portion of the study area is also true for the other species of the genus. This rock inhabiting specialization of *Acomys* in dry situation was reported by many workers (Delany, 1972; Bates, 1994; Fiedler, 1994). They are non-burrowing rodents, but use burrows made by other species or use rock or earth crevices (Fiedler, 1994). The special observation of these species in APNP is their occurrence in large burrows made by ground squirrels. The mechanism of the abandonment is not clear, however, most large traps set for squirrels on their characteristic burrows, capture *Acomys* species. Both trapped *Mus* species were rare. Only three individuals, all from the wild, were trapped from wooded grassland habitat. *Lemniscomys barbarus*, the only specimen of the zebra mice (one male and female) were sampled from the riverine habitat during the dry season. Data gathered on rare species did not allow discussion of their other ecological aspects.

*Tatera* is the fairly common genus all over the lower half of the APNP. All the three species of the genus occurring in Alatish have one observable common character. All plug their burrows with loose soil or sand. Their abundance in the area is simply judged by observing these characteristic burrows. Inhabitants of closed burrow system are exposed to very different environmental conditions. Light, temperature, and humidity are relatively constant in their burrow system (Schmidt-Nielsen *et al.*, 1970; Arieli *et al.*, 1977). This behaviour of *Tatera* may be to overcome the highly intense heat of the day and minimize the water loss.

*T. robusta* is trap shy. *T. phillipsi* is also trap shy but two individuals were trapped in one occasion. Bait has apparently not been readily accepted by both the species (Fiedler, 1994). However, this observation agrees with this but contradicts with that of Afework Bekele & Liers (1997). They state the readily trappability of *T. robusta*. In APNP, both *T. robusta* and *T. phillipsi* prefer flat sandy plains mostly within the basin of River Dinder. Unlike these, *T. valida* prefers a relatively taller grassy area with black soil. It needs grass cover to construct its borrow while the others do not. Therefore, the absence of their characteristic burrows (for the plain lovers) during the dry season may be caused not by the absence of cover but the shortage of food and excessive trembling caused by cattle. During the wet season, *T. robusta* and *T. phillipsi* were

sampled by excavation. Distinguishing *T. robusta* from *T. phillipsi* morphologically needs closer observation of the tail structure colour as well as the skull structure. In the field, this is simply done by observing their burrow complexity and their social behaviour. As observed from five excavated *T. robusta* burrows, all contained a single individual. This is an indication of its solitary life style. Each sex has its own burrow beginning from the younger age. Each individual has an active burrow, that is plugged when it is in, and other holes at least three, alternative burrows that stay open for emergency in close vicinity to the active burrow. The burrows of this species lack complexity and are relatively shallow. Capturing this animal is difficult since it suddenly rushes from one burrow to the next. One has to dig all the burrows alternately following its entrance. In the case of *T. phillipsi*, the burrow system is deep and is highly complicated with several tunnels. To reach the nest area, somewhere at the rear end of one of the several tunnels, a minimum of half an hour digging is required. Animals were obtained at the last three chambers of the tunnel. In this case, young animals occupy the first chamber. The next is by juveniles, and the terminal nest is by both adult male and female. They are social animals. They leave their nest one at a time only when their chamber is knocked. These processes make capture relatively easy unless the burrows are near thickets of grasses or trees. Little deviation of the excavator increases the chance of escape in both cases. Only three animals from the three excavated family burrows were captured. The third species of the genus, *T. valida* is trap-prone. As a result, it was not possible to dig and observe the nature of its tunnel and family condition during the present study. Bates (1988) and Fiedler (1994) reported their occurrence in cultivated field as pests of field crops. However, during the present study, no animal was captured from human habitation and no characteristic burrows of these animals were observed from cultivated fields. The low capture of *T. robusta* during the wet season, and total absence of it during the dry season from the Kenyan sub-humid grassland were reported by Oguge (1995). This is in line with the current observation. *T. valida* is reported primarily to feed on the grass during the wet season and the underground parts of grasses, seeds and sedges in the dry season (Fiedler, 1994). Delany (1964) reported them feeding on insects including ants and arthropods. In the northern and southern parts of APNP, *T. valida* shares the grid with *M. albipes*. In one occasion, they were both trapped in one Sherman trap. The *M. albipes* was killed by severe bites and part of the

hind legs was eaten by *T. valida*. Such phenomena may be related to the stress associated by being in the trap or it may have a territorial reason.

The Insectivore group is represented by six species (7.6% of the total capture) of which five are shrews. Shrews occupy all habitats of APNP (except woodland) including the human habitation. Their diversity in APNP is well comparable with other areas of the country. Distribution and diversity of shrews is associated with forest and elevation (Yalden, 1988). It is associated with rainfall and elevation and restricted to moist habitats such as riverine vegetation and moist grassland (Monadjem, 1999). The high diversity of shrews in the low elevated, less topographic diversity and low rainfall area of APNP deserves a special study. Except for the *C. smithi* and Soricid sp. A, all were sampled during both seasons. Three of the five shrews were captured from the human habitations. They have become the most destructive home pests. Besides their use of all food items and household commodities, they are notorious chicken raiders. Among the samples, only the sizes of *C. fumosa* and *C. smithi* are relatively smaller. Short smooth shiny fur is the characteristic of all shrews of the APNP collection. Two specimens of the African hedgehog, one from the southwestern (Omedla trap site) and the other from northern APNP were obtained. The semi-arid habitat like that of Alatish is the most preferred area for this insectivore. Also the seasonal over-grazing activity makes the area more suitable for this species (Kingdon, 1997). *A. albiventris* is not a pest, but the tasty flesh of the animals is highly demanded by Gumuz indigeneous people. Their spines are also believed to have a multi-purpose medicinal value for all domestic animals. They have no burrows of their own, but use thickets for resting and hiding. These combined factors may threaten their survival in the area. The only specimen of striped ground squirrel, *E. erythropus*, was trapped by local snare from the northern part of APNP. It is an adult male specimen but shows high discrepancy with the available body measurements. The sampled specimen has the head body length of 220 mm, tail length 210 mm, hind foot length 62 mm ear length 7 mm and weight 272 g. The literature body measurement for this species was 300-400 mm for head and body, 185-270 mm for tail length, and 500-1000 g for body weight. The reason for this significant variation is not clear.

Alatish proposed National park is exceptionally suitable for ground and tree squirrels. This is shown by their abundance, throughout the whole area, particularly to the north, east and southern river basins. Both ground squirrels (striped and unstriped) occur together both in the park and near human habitations. They are extremely trap shy, particularly to the larger Sherman trap. Several trials using rope and nylon snares (as stated by George, 1984) failed. This is because, when they are snared they cut off the rope or nylon with their teeth and escape. The other important feature of these animals is that they completely abandon their burrows when they notice any manipulations around their burrows. In the southern and eastern part of the study area both ground squirrels were observed using the cracks of the black soil as an escape site. They may also use it as a temporary nest. The unstriped ground squirrel, *Xerus rutilus*, occurs in the more arid areas and up to 2000 m a.s.l. in the Sudan, Ethiopia, Kenya, Uganda and Tanzania (Fiedler, 1994). This is in line with the present observation, but contradicts with the more restriction of the range of this animal in Ethiopia to the eastern lowlands (Yalden *et al.*, 1976; Kingdon, 1997). They both are known to enter villages, pierce grain stores and feed on the grains, particularly sorghum. The Gumuz people regain the loss by killing and using their meat, but the non-Gumuz people kill or poison them and abandon the animal. The two tree squirrels, the Ochre bush squirrel (*P. ochraceus*) and the Gambian sun squirrel (*H. gambianus*) are also common tree dwelling squirrels in APNP. The Ochre bush squirrel is not as shy as the other counterpart. It is easily observable and is relatively fearless. The *H. gambianus* are smaller and fast runners on branches. They have a dark body colour, dense haired tail with visible black bars. They frequent trees with black barks. This behaviour makes observation more difficult than the other tree squirrels. Several trials were made to trap them by tying the larger Sherman traps on suitable branches near their nests, but with no success. Gumuz natives use the meat of both squirrels and hunting is carried out by the use of bow and arrows.

The large black bodied, nocturnal rodent with long, black and white quills (porcupine) are the common fauna of Alatish. Their presence is known simply by observing the tracks they left behind on loose and sandy soils. Fallen quills are also reliable indicators. Their characteristic large burrows are common in all sampled and travelled areas. Observing them while entering

their burrows early in the morning and when they leave their den in late evening is common. They are social animals, particularly a mother with two to four young is commonly observed. Active burrows are known easily but the most effective and reliable experience in this study area is observing the presence or absence of bats roosting on the wall of their burrows. During the present study, in the upper central Alatish, two recorded active burrows at 12° 05' N, 35°35'E and at 12°06'N, 35°35'E contained five and eight bats roosting on the wall, respectively. The other active burrow at the southern Alatish (Omedla grid) at 11°56'N, 35°16'E contained eleven larger sized bats. These big burrows had more than one entrances. Hunting porcupines is relatively simple. Once the active burrow is identified, the hunter observes the direction of the burrow using torchlight. Then the nest site is estimated at the rear end of non-branched tunnel. This was dug until one reaches the nest area. If the animal tries to escape (rarely), the assistant waiting at the entrance makes a simple kick on the snout, the most sensitive area. Sophisticated weapon is unnecessary except a metre and short solid stick. The special association of bats and the nests of porcupines need further observation. However, the porcupines are losing their lives as a consequence of this association in APNP. They are still abundant in APNP because they mostly use areas far away from water points that are not easily accessed by hunters. The Gumuz people crave for it because it is a source of very tasty meat, source of income and are known as a remedial medicine.

The three small mammals whose identification was not carried out during the present study are probably special fauna of the APNP that need further taxonomic work. Except for the shrew and Murid sp. A, the two other species have sufficient samples. The skin mount, the skull and the whole animal (in formalin) are kept in the Zoological Natural History Museum of Addis Ababa University for further work. Only a single specimen of Murid sp. A was trapped from Megenagna trap site during the wet season, but was not sampled in the later season. However, since Soricid sp. A is a pest; there will be another chance to sample it again.

### 4.3. Trap success

The special features of the habitats affected trap success (Table 4). By excluding the special trap sites, the overall success of the four major habitats varied from 25.3% (wet) and 47.8% (dry) season. The very low trap success of the woodland and the zero success of riverine woodland during the wet season balance the complete abandonment of the two grids (4 and 26) during the dry season. However, the productivities of these areas were judged from the dry season traps except for the woodland, which was not accessed due to the complete absence of water during this season. The 47.8% trap success during the dry season was beyond the expectations. Very low trap success was expected due to the absence of accessible surface water over the larger portion of APNP, the drastic effect of forest fire that swept out every undergrowth and the devastation of the area by livestock. The very low and non-trap success of the woodland and riverine woodland during the wet season, respectively, were comparable to similar experience of some researchers elsewhere. For example, Rupp (1980) obtained 0% success in 300 trap nights from southeastern Ethiopia, near Neghelle. Rupp (1980) recorded 3.3.% success in 120 trap nights near Godere River, southwestern Ethiopia. Yalden (1972) recorded 2.7% success in 741 trap nights near Neghelle. The overall trap success in APNP, 38.6%, is still high and comparable with other works in Ethiopia. Yalden (1975) achieved 19% trap success from the high altitude of south Goba. Rupp (1980) obtained 35% success from the same area. The trapping in Harrena Forest by Yalden (1988) yielded 24-27% success. The average trap success rate from the Menagesha State Forest was only 9.1% (Afework Bekele, 1996b). From the sampled habitats, the overall trap success was highest in bamboo woodland (58.2%). This habitat was relatively less affected by fire. The thick, dense stands of individual bamboo prevent fire from penetrating into the centre of the habitat. Similarly, this nature of the bamboo did not allow the big horned "Fellata" cattle to enter the center and explore the remaining ground cover. Probably this area is refugia to the transient rodents of the nearby habitat that seek relatively favourable area. Next to bamboo woodland is the wooded grassland. It covers the largest area of the APNP. It has more small pockets of microhabitats which is free from fire and inaccessible to the livestock population. The relatively openness of this habitat during the wet season makes it a place for immigrant small mammals of the nearby habitats. The effect of wet season trap failure caused the

overall success of the riverine woodland lower. Success for the special trap sites deserves its own explanations. STS-1 was an unburnt habitat, and still not accessed by the "Fellata" herds because it is far away from the water holes that the herds use. So "Fellatas" were unable to use this area for grazing. STS-2 was a savanna type grassland (on the border line between Ethiopia and Sudan). The place is unburnt, but extensively grazed. However, it supported a good number of small mammals. The success rate from human habitation was special. The high success may be due to the closeness of villages to the park. The only unburnt area near the park is found around the villages. It is easier for small mammals to move from these temporary refuge areas to villages.

Several workers also documented between-habitat trap success variation. Sillero-azubiri *et al.* (1995) obtained different success rates from the five sub-habitats in the Bale Mountains. Sanetti (43%), Web Valley (38.8%), the montane grassland (33.5%), the ericaceous belt (21.6%) and Tullu Deemtu (13.5%). Trap success for the three different sites were 1.6%, 10.9% and 26.9% in the Menagesha State Forest (Afework Bekele, 1996a). During the dry season, the riverine woodland is a suitable rodent habitat into which they temporarily migrate. The grass species of the areas is dominated by *S. sudanensis* and *S. versicolor*. These grasses are exceptionally tall with thick stems and dry out late. The less strong early dry season fire is unable to burn their stems and seeds. The larger trees of these habitats are also not susceptible to fire since fire is set off before their leaves wilt. At the same time, leaves are shed after the fire. This provides good cover and serves as food for the remaining insects. The highly abundant seeds of the two grass species, the dried and fallen fruits of *Allophylus macrobutrys* and *Ficus* spp. are important food sources for the small mammals during this season. The cracks of the black cottony soil of this habitat create good shelter for all small mammals including the ground squirrels.

The cumulative problems during the dry season seem intolerable for some rare species (species with low numbers in the sample). Because most of these were absent in the dry season trap. The repeated capture trial during the dry season, from where they were sampled during the wet

season was also not successful. Probably, the habitat devastation during the dry season may force them to develop an escape mechanism. Some individuals that were absent during the wet season were captured during the dry season (Table 5). Their low population density, the unbearable physical conditions and their behavioral adjustment to overcome these might have played a role. Duration of the trap night was reported by Delany (1972) as a major reason for low chance of capture for certain rare animals. Trap response of individuals, and the chance of the animal to encounter the traps (George, 1984) may also play a part for the absence of rare individuals in either season. The absence of Murid sp. B from the wet season trap is surprising. Because the species is not conspicuous and was sufficiently sampled during the later season.

#### 4.4 Pests

The two ground squirrels and the porcupine are known pests of the area. Besides, the nine small mammals have become permanent commensal pests moving between villages and the park. The presence of these pest species both in villages and in the wild shows their free movement between these two areas. Trap success of both seasons from human habitations shows more animals during the dry season. This also indicates more animal flow to the villages during the dry season. Several reasons may be forwarded for this. The effect of forest fire affects every cover and food for most small mammals. This is combined with the intense temperature and total absence of accessible water during the dry season. The close proximity of the villages and absence of barrier that prevents the movement also assist the animals to move freely. The complete absence of the specialist commensal rat (*Rattus* spp.) assist the free invasion, because in most area where *Rattus* spp. is dominant other rats like *Mastomys* spp. are competitively expelled (Fiedler, 1994). The small mammals co-exist in villages as they were doing in the field. However, the mechanism is not known. These pests do not attack crops from the field because only *Arvicanthis* spp. and *Desmomys* were observed running on branches. However, these were fewer on the commensal catch and the effect is not felt by the villagers compared to the other commensal ones. However, in the agricultural fields, sorghum and nuts are among the crops most attacked by ground squirrels and porcupines.

Information on the effects of fire on small mammals is immense. Its effect have been shown in lowering the species diversity (Clausnitzer, Undated), in the destruction of vast areas of their habitat and food, hanging their behaviour (Delany, 1972), and in population fluctuation (Delany, 1972; Haim & Izhaki, 1994). Similar effects may possibly happen to the small mammalian fauna of APNP due to the inevitable annual dry season fire. Many authors also demonstrated effects of habitat change on small mammals due to heavy utilizaiton by ungulates and livestock. Resulting in rapid reduction in the species diversity (Keesing, 1998), significant density decline (Haske & Kampbel, 1991) and sudden local extinction of uncommon small mammals (Keesing, 1998; Joubert & Ryan, 1999). The effect might be the same to the small mammalian fauna of APNP due to the uncontrolled grazing by the tens of thousands of the "Fellatas" herds.

The number of species caught from each grid of the sampled study habitat and the special trap sites, ranges between two and twelve, average six (Table 6). There is a high range of overlap. The Simpson Similarity Index for the three major habitats (0.72) shows high similarities among the small mammal community. Several workers demonstrated that the co-existing small mammalian species partition their resources mainly along the microhabitat dimension (Oguge, 1995; Sllero-Zubiri *et al.*, 1995). The detailed mecahnism of small mammal co-existence in APNP needs further study. However, the two seasons trap evidence and additional observations show a high degree of species tolerance in sharing their habitats. In one instance, *M. musculus*, *A. dembeensis*, *C. smithi*, *C. flavescens*, *C. turba* and *M. natalensis* were captured from a small area surrounding two closely situated medium sized termite mounds (Demir trap site).

#### **4.5 Age structure and reproduction**

The age distribution in a population of small mammals in various seasons is directly related to the seasonality in reproduction of the species. When reproduction is seasonal, animals of all age groups may appear in the population within that specific season range and slowly become uniform. On the other hand, all age groups appear in the population, irrespective of the season, if the animals reproduce all year round. The small mammal communities in the APNP showed

these general principles. Young members account for 34.3% of the total population during the wet season. In general, the correlation between rainfall and the seasonality of reproduction, for the majority of the small mammals in Africa has gained acceptance by many workers (Delany, 1972; Happold, 1974; Taylor & Green, 1976; Perrin *et al.*, 1992; Afework Bekele & Leirs, 1997). The presence of pregnant or lactating females, juveniles and young during the wet season trapping is an indication of this general agreement. No pregnant, lactating or young members of *Arvicanthis* spp. were observed during the dry season trap. This observation goes in line with the records of Taylor & Green (1976), Afework Bekele & Leirs (1997) and Laurechenko *et al.* (1998) that associate reproduction of *Arvicanthis* spp. with rainfall. However, it contradicts with the report of Delany (1972), Delany & Roberts (1978) that state the continuous breeding throughout the year. In the present study, during the dry season, no pregnant or lactating females of *M. natalensis* were captured from the wild. But, among the commensal ones, the presence of two lactating females and the capture of seven young animals in this season is an evidence for the presence of a continuous breeding in these animals. This is in agreement with the findings of continuous breeding throughout the year (Delany, 1972; Happold, 1974; Perrin *et al.*, 1992; Afework Bekele & Leirs, 1997). Pregnant animals were not recorded for *M. albipes* in both seasons, but there were three young and two lactating females during the wet season and four young and two lactating females during the dry season capture. This also shows the aseasonality of breeding in this species. This also agrees with the reports of many workers (Happold, 1974; Afework Bekele, 1996). The occurrence of females with vaginal perforation in *A. niloticus* and *D. harringtoni* shows the presence of reproductively active members in the population during the mid-dry season in the study area. The occurrence of two pregnant females, each with six embryos in *T. valida* during the dry season contradicts with the report of Fiedler (1994) describing the rainy season breeding property of the genus.

*Acomys* has pregnant females in both seasons and shows a considerable variation in the number of embryos between the seasons. During the wet season, pregnant females had 4 to 6 embryos. But during the dry season, pregnant females invariably contain only two embryos. This phenomenon, where the number of embryos is reduced during the dry season was reported by

Pianka (1970). He observed that when *Arvicanthis* breed aseasonally, its litter size is smaller than usual. This may hold true in the case of *Acomys* in APNP. No pregnancy was observed during the dry season for all trapped shrews. Similar to most small mammals, the wet season may be the preferred-breeding season. Five of the eight females of Murid sp. B were perforated. However, it was not possible to judge the reproductive condition of this animal during the wet season. The dry season trap shows the presence of reproductively active females in the population. The compiled data does not allow the analysis of the reproductive condition for rare species.

The high intensity of the dry season ambient temperature of APNP area did not allow live trapping of diurnal animals with the available traps. Most animals were obtained dead in Sherman traps. The various techniques used by the trapper (covering the traps with a pad of clothes and covering with hay) were not successful. In order to trap live diurnal animals during the dry season, other mechanisms should be sought.

#### **4.6 Trap condition, Predation and parasites**

The presence of individuals with mutilated foot, tail or ears from the trapped population of both seasons show the presence of high predation pressure. It is observed that Alatis area is rich in small carnivores (serval, mongoose, jackals, civets, ratel), raptors (owls, eagles) and varieties of snakes (cobras, mambas, asps and pythons). The small mammal species of APNP definitely are prey base for these. Keesing (1998) recorded that these are among the predators that are largely dependant on rodents for food. In area where rodents are abundant, following their seasonal distribution, e.g. bamboo woodland, and riverine woodland during the dry and wooded grassland during the wet season, direct observation and several signs show the abundance of these predators. Sillero-Zubiri *et al.* (1995) positively correlated the total biomass index of diurnal rodents to the observed and counted density of Ethiopian wolf (*Canis simensis*) in the Bale Mountain National Park.

During the wet season, all grasses of APNP were full of wild ticks. They invade possibly all mammals. To humans in the area, they were the second notorious parasite next to the *Anopheles*

mosquito. These ticks were not observed during the dry season from the wild. The reason is that the forest fire sweeps them out. The major reason for "Fellatas" to set fire, as was told by native Gumuz people, was to eradicate these ticks. These tick species also invade small mammals. They serve as a reservoir. The other parasite that is common on most rodents is flea. These cause inconveniences while working on rodents. Rodents are the most important reservoirs and transmitters of the deadly zoonotic diseases, such as plague, leptospirosis, boutonneuse fever (African tick typhus), and murin typhus (Fiedler, 1994). The special nature of rodents of APNP is their free movement between the wild and the villages. This creates a good opportunity for parasites to invade human habitations and, viceversa. Serological surveys in Kenya (Davis *et al.*, 1968) showed that *Arvicanthis* and *Mastomys* spp. residing in the field are important reservoir host of plague, which were known only from black rat. One species of *Tatera's* flea, *Philoxea* maintains a permanent reservoir of plague (Delany, 1972). The occurrence of flea and ticks on members of the small mammal fauna of APNP (*Arvicanthis*, *Mastomys* and *Tatera*) will create future potential for reservoir of these diseases. Once these organisms contract the pathogens, transmission will be very simple and eradication will become difficult. Environmental stress causes animals to develop special characteristics that at least alleviate them from the extent of harsh conditions. Only four of the 23 trapped small mammals from the APNP were diurnal. *A. dembeensis* and *A. niloticus* are entirely diurnal animals of the area and the present observation shows that *D. harringtoni* and Murid sp. B are active any time. The high intensity of daytime heat in APNP forces the diurnal rodents to have easily recognizable activity pattern. Diurnal *Arvicanthis*, both in the morning and in the late afternoon, were observed foraging particularly in the riverine habitat during the dry season. This activity time, between 06:00 and 10:30 a.m. in the morning and between 15:30 and 18:30 p.m. in the after noon are the most preferred time. This means that most of their diurnal activity time is restricted to before and after the most intense day heat. During the dry season, in most parts of APNP, there is no accessible surface water for any small or large mammals. The only water sources are from large pools that contain water on the bank of Dendir River. The special mechanisms on how most rodents in the area cope with shortage of water sets need special study. However, the diurnal rodents of the area, *Arvicanthis* spp. were observed feeding on the root bark of the big fleshy tree (*Adensonia digitata*) in the

southern Alatish. Reports show that certain rodents consume more green materials than seeds because the former serve as water source (Perrin & Bayer, 1994). Most other small mammals of APNP may use similar mechanism.

APNP is exceptionally rich in the diversity of animals. The most striking thing is that Sherman traps do not selectively trap rodents. Whatever sizeable animal enters and steps on its treadle, it shuts behind it. The catch of non-targeted vertebrates was reported as a major trap problem (George, 1984). Trapping various sized and coloured desert lizards particularly from rocky areas was a common practice during the present study. The trapping of three snake species was frightening. One from the southern grid (Omedla site), the second from the southeastern (bamboo woodland trap site) and the third from the upper central grid (Demir site). The Demir site trap was the small-scaled burrowing asp, *Atractaspis microlepidota*. It fully entered trap and was obtained dead, during the dry season. The other species were spongy skinned Blanding's tree snake (*Boiga blandingii*) and only half of the body joined the trap. It died while trying to escape. The one at the southeastern Alatish (bamboo woodland trap site) was trapped alive. Freeing the 68 cm long snake from the trap was a major problem. Heating by fire was the only solution. During this process, part of the body was burned and skin decolorized. Since the scales were peeled off, identification was not possible. This coupled with intensity of heat, absence of water and remoteness of the area made the study interesting

## 5. Conclusion and Recommendations

An ecological study was carried out for two (wet and dry) seasons in APNP dealing with the diversity, distribution, relative abundance and habitat associations of small mammals. Twenty nine species of small mammals were recorded for the first time in the area. These included 23 rodents and 6 insectivores. Three rodents (Murid sp. A, murid sp. B and *Acomys* sp.A) and a shrew (Soricid sp.A) are newly described from APNP. Two species of rodents (*M. albipes* and *D. harringtoni*) which were thought to be endemic mammals of Ethiopian highland forests are recorded in Alatis lowland, outside their formerly recorded altitudinal limits and geographical ranges. Similarly the three shrews (*C. flavescens*, *C. turba* and *C. fumosa*), which were never recorded from areas below 1500 m a.s.l. in the country were recorded from their new altitudinal limit and geographic ranges. The capture of over 60% *D. harringtoni* from wooded grassland habitat and the absence of *M. albipes* from riverine woodland and woodland habitat is the other surprising finding. Trapping *M. albipes* from a borderline of Ethiopia and Sudan (STS-2) makes its endemism under big doubt.

The new records show that the small mammal fauna of APNP comprises species from various habitat types. For example, arid and semi-arid species (*Tatera*, *Acomys*, *Atelerix*), grassland species (*Arvicanthis*, *Xerus*, *Euxerus*), Savannah species (*Lemniscomys*, *Xerus*, *Euxerus*), highland forest species (*Myomys*, *Desmomys*, and most *Crocidura*) and the cosmopolitan rodents that are able to move between wide ranging altitudinal variations and habitats (*Mastomys*, *Mus*, *Hystrix*). The small mammalian faunas of APNP are categorized as abundant and rare based on their relative number in the total sample. Most rare species were absent from the more affected (fire and cattle grazing) areas (e.g. *T. robusta*, *M. erythroleucus*, *M. tenellus*, Murid sp. A and *C. fumosa*). From the two seasons trapping, it is clearly shown that the wooded grassland habitat produced the highest number of species followed by riverine woodland. The next is bamboo woodland and lastly the woodland habitat. The two seasons trap result show that variation in the species between seasons is insignificant, 21 species in wet and 19 in dry. However, some species that were captured during the wet season were absent in the dry season trap and viceversa. The recorded higher average trap success in APNP, as compared with similar

work in Ethiopia and elsewhere in East Africa shows high diversity in this lowland ecosystem. However, not all habitats of the APNP are equally suitable. This was shown by the significant variation in trap success between habitats that range between 12% (wet season, woodland) and 58% (bamboo woodland during the dry season). Some grids within habitats provided highly favourable conditions for small animals.

The result also showed that irrespective of the climatic and anthropogenic effects of the dry season, the trap success was significantly higher than the wet season (47.8% vs 25.3%). When diversity and success were compared between the seasons, high diversity but low success during the wet and low diversity but high success trend during the dry season was observed. The relatively open habitat of wooded grassland during the wet season created favourable condition for small mammals. However, the humid, damp and moist, and flooded microhabitats in bamboo woodland and riverine habitats were not favourable for small mammals during the wet season.

The presence of free movement of animals between habitats following changes associated with seasonal variation. The absence of animals in some habitats (e.g. riverine) during the wet season and their abundance in this habitat during the dry season was evident. Cover is the most important microhabitat component for *Arvicanthis*. But the absence of this during the dry season was not a problem for the species as the cracks of black cottony soil of the riverine habitat and pocket areas of such soil type in other habitats provided protection. Among the major rodents, *Acomys* spp. did not show changes in seasonal abundance. It occurred in all habitats but more in the open, reddish, drier and sandy habitat (wooded grassland). *A. wilsoni* and *Acomys* sp. A are notorious home pests. Among the *Tatera* group the high ground lover *T. valida* was fairly represented in both seasons. This selected area might have contributed for its abundance. From the result, it is clear that *T. robusta* is more intolerant to the habitat destruction than *T. phillipsi*. Closer observation of their behaviour in the field assisted in their taxonomy. The insectivore group is represented by 7.7% of the total capture. They were distributed over larger portion of Alatish except the woodland habitat. Three of the five shrews also occurred in the human habitation and have become notorious pests. The multipurpose use of the African hedgehog by

the Gumuze society may threaten its survival. The special association of bats and porcupine holes facilitated the dry season hunting pressure. The cumulative effect of the dry season hardship in APNP (fire, excessive grazing and trembling, lack of water, high temperature and high predator pressure forced some of the small mammal species to move between villages and the park seasonally. The dry season trap success from the villages indicates the direction of flow.

The capture of six species of small mammals (in average) in a grid from the wild and nine from human habitation show the degree of co-existence of the species. The calculated similarity index supports this. From the available data breeding in most small mammals species of APNP is seasonal and is associated with rainfall. The abundance of medium and small carnivores, raptors and snakes in areas where small mammals are abundant clearly show that small mammals form a prey base for these animals. From the trapping experience in APNP, it was clear that all closed and heavy Sherman traps do not only catch large rodents or shrews but also lizards and snakes. great care is needed during checking and unloading the content.

The two seasons field work in APNP revealed the richness of the area in terms of unique biological resources. When compared to any other area in the country, APNP is exceptionally rich in small mammalian diversity. This shows those inaccessible remote areas of the country harbour probably unique, rare, endemic or endangered fauna of special ecological, biological and conservation interest. However, due to various reasons, the predominating research experience of the country concentrate on few easily accessible areas. Fauna of very few areas of the country particularly those representing the highlands and forests are better explored for their faunal composition and ecology. However, those of remote areas particularly representing the lowland, arid, semi-arid and desert areas of the country are not explored. They are probably far, remote, no facility, and may have harsh and inhospitable climate. Facing the challenge and reaching these areas should be a priority. In order to have a comprehensive understanding about the Ethiopian mammalian fauna, every corner within the geographic boundary of the country need to be assessed and catalogued. As the priority steps towards the conservation of the biological resources, ecological survey based on temporal and spatial inventories of the mammalian faunal

diversity of the country is mandatory. Concerning the small mammalian fauna of APNP, the unique fauna in the unique lowland ecosystem is also a prey base for various carnivores of special conservation interest. Further detailed studies focusing on individual species and community ecology must be undertaken. The pioneering initiatives taken by ANRS towards the conservation of the biological resource of the region is highly appreciated and is educative. It is the only Regional State to establish an independent authority that has a mandate of developing and protecting the biological resources of the region under various conservation strategies. The commitment at the various level (Regional, Zonal and Woreda) of government bodies, the energetic staff members of the newly established authority, the good will and ambition of the society towards the establishment of Alatish National Park is highly encouraging. These all lay fertile grounds to speed up the realization of gazetting Alatish as the national conservation interest. Other factors that maintain the area as a special conservation habitat are isolation, less accessibility, less interference of humans, the inhospitability for settlement and the stability of the ecosystem. APNP's strategic geo-physical location also increases its national and international interest. It is a protective zone against the encroachment of the Sahelian desert. It is home for both resident and transient migratory mammals and birds. It is home for large number of unique and probably new species of small mammals. The presence of the Gumuz indigeneous people with a unique culture, tradition and life style, increases the anthropological interest of the area. Gazetting APNP and protecting it as a National Park, in addition to the above purposes could further facilitate the development of tourist industry. It will play a great role in attracting valuable foreign exchange into the country both nationally and locally.

The protected area will also serve as a recreation centre for both foreign and domestic visitors. Its strategic position being near to the northern Ethiopian tourist routes, its nearness to visitors from the Middle East and southern European countries, and above all its closer situation to the nearby well-known Dinder National Park of Sudan will make the area more significant.

Gazetting Alatish as a National Park and conserving its natural resources will add the potential of Ethiopia's higher educational institutions and higher research centres to carry out various

development researches concerning the lowland ecosystem, flora and fauna that will further contribute to the scientific knowledge. Therefore, gazetting APNP as a National Park will have the greatest environmental, ecological, cultural, educational, economic, scientific and recreational values. Therefore, to maintain the area as a stable biological resource conservation base, the following issues must be given priority:

1. In order to make APNP a permanent home of the unique, diverse, endemic and endangered fauna of the nation, action should be taken to resolve the issues of the "Fellata", the Sudanic Arab and other minor tribes of nomadic pastoralists.
2. Fire is important to maintain certain ecosystems. The flora and fauna of APNP seem very adapted to the annual fire. However, the short and long term effects of fire on the fauna and flora must be studied, evaluated and managed.
3. The livelihood of Gumuz indigenous people surrounding APNP is entirely dependant on the resources of the park. Any development activity that ignores the local people will not be effective. These people must, at least through time, divert their way of life and partly lift their dependency on the park's natural resources. Any action taken should consider the interest of the local people.

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