Session A5

Rangelands as dynamic systems — role of wildlife in rangelands

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Rangelands in southern Africa are increasingly being used for conservation, ecotourism, game farming and hunting. This impacts people’s livelihoods and the state of natural resources. Complementarity and competition between wildlife and domestic livestock can be explored.

Theme: This session focuses on ecosystem process in savanna with an aim to understanding the different roles of wildlife and domestic stock in the ecosystem. The objective is to understand how we can better manage such systems through either multi-use or single use (i.e. only wildlife or only stock) while sustaining the system into the future.

We address the following emerging issues through the symposium and associated posters: (1) complexity (and/or heterogeneity) and (2) scale as factors affecting: (i) productivity, (ii) resistance, (iii) stability, and (iv) sustainability of the ecosystem. We focus on African savanna as the major case studies, but draw on case studies (particularly in the posters) from other systems.

Invited Papers

Savanna (BBC Film)
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The functioning of ecosystems, especially of savannas, is a central theme of the VIIth International Rangeland Congress in South Africa. Many contributions to an understanding of these savannas at the congress are oral or poster presentations. Yet the complexity of these savannas and the way they function, can perhaps only be appreciated in a feature film. BBC has a long reputation for making films that are based on scientific information. The BBC Film ‘Savanna’ (2002, 55 minutes) will be introduced by the producer, Amanda Barrett, and shown in an early evening session. The consultants for this film (Jonathan Kingdon, Holly Dublin and Herbert Prins) are, we hope, all three attending the Conference, and they could be asked to sit with Amanda in case there are questions from the delegates.

Competing ‘herbivores’: fire released by extinction/extirpation of indigenous wildlife
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All over Africa, but also in the rangelands in the Americas, Australia and Eurasia, herbivore community structure has been modified through removal of indigenous wildlife, and introduction of domestic stock. Such changes in community structure (assemblage size or species sizes — see previous talks) may have affected community resistance to change and the long-term productivity/sustainability of the system. In particular, the effect of fire on savanna may have been enhanced by the extirpation of herbivores. What happened(s) when indigenous mammal herbivores went extinct on other continents or are extirpated in African landscapes? Did fire take over with cascading consequences for the remnant biota? We assess the changes in community complexity at different geographical and body-size scales. We conclude particularly about the role of management in ameliorating/reversing any effects of removal of natural herbivores, particularly in the African context, where many complex herbivore communities still co-exist with domestic stock.

Managing wildlife: the challenge of management intervention
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Ecosystem managers — be they national park managers, local communities, or private communities — often intervene to achieve higher efficiency of use of primary production, manipulate the balance between woody species and grass, change the effects of fire, or modify herbivore (wild and domestic) communities. The previous talks highlight issues of scale and complexity, which imply that management intervention can in fact take place at different levels (=scales). For example, intervening in fire can act at a regional level in terms of biogeographical processes, whereas increasing the size of a camp or reserve acts at a local level. Culling or removal of members of a target species may meet a short-term goal, but may in fact counter achieving a longer-term objective. How successful are these interventions, or should we in fact not be intervening at all? Is our knowledge of ecosystem functioning sufficient when we in fact discount the major component of the ecosystem (invertebrates)? Is ecology at this stage a predictive science that can be applied to current issues of sustainable utilisation of rangelands?

Size matters: body size scaling and resource use efficiency in ungulate guilds
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Ecosystem functioning depends on the composition of the herbivore assemblage (see previous talk). This assemblage, however, is
comprised of animals with different body mass. Body mass has an overriding scaling effect on key species specific characteristics (e.g. energy requirements, longevity, and home range size). Are these inherent characteristics, that scale with size, an important emergent property driving functioning of the complex herbivore communities in Africa (Africa has a remarkable array of very large herbivores)? Importantly, domestic stock comes in a range of sizes, and we can assess the consequences of changes the sizes of species in herbivore communities through changing land-use practices. Are sheep and goats less efficient than a combination of small and medium size antelope? Does removing megaherbivores from a community effect long-term productivity and sustainability of the ecosystem? After many years of ecology, it is of interest to ask whether animal ecologists can make a contribution to better use of rangelands.

More is better: community scaling (ecosystem complexity) and resource use efficiency

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Plant primary production is basically a function of soil nutrient status and rainfall. Plant material is grazed by herbivores and assimilated. With higher primary production, one expects greater secondary production. However, this begs the question as to whether greater community complexity (larger assemblages more species) results in greater than predicted productivity, that is, whether communities with more species make more efficient use of the primary production than smaller assemblages. In other words, are emergent properties of complex communities that increase productivity (or indeed other ecosystem measures such as resilience, stability, or fundamentally sustainability)? The answer has implications for types of land use that are based on harvesting, and we assess the question for wild herbivores, domestic stock, and a mixture of both.

Decreasing wildlife in Kenya: effect of increasing pastoralism

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The total extinction of herbivore species is rare. The two known recent extinctions are Bluebok and Quagga, both in South Africa, while in Kenya the Hirola is severely under threat just as the Dibatag in Somalia. The striking phenomenon is, perhaps, that basically all wild herbivores still exert their role in African rangelands. However, some species have become locally extinct. Island biogeography theory makes predictions about rates of extinction at the farm/reserve (island) level, while biogeographical processes at a larger scale (regional) also make predictions about rates of extinction. Biogeographical processes operating at different geographical scales are assessed for both wild herbivores and domestic stock to elucidate the level at which the strongest biogeographical processes operate, thus allowing predictions about sustainability of both diversity and ecosystems in terms of their geography.

Browse selection of black rhinoceros (Diceros bicornis) in two vegetation types of the Eastern Cape Province, South Africa, with particular reference to Euphorbiaceae

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The diet of the black rhino (Diceros bicornis) is analysed in the Thicket Vegetation of the Great Fish River Reserve (GFRR) in the Eastern Cape. Attention is focused on addressing the limitations of past research on the diet. The diet, according to vegetation types, and quantifying the important contribution of Euphorbia bothae, a succulent latex filled species, to the diet. Preliminary results indicate that there is a relationship between stem diameter and biomass for sections of E. bothae of known length. Grewia robusta and Euclea undulata are found to be the most important species in the diet of the rhino in the reserve as a whole, contributing a significant proportion of the diet in both the short and medium succulent thicket. E. bothae is found to contribute 41% of all bites in short succulent thicket characterised by this species.
Rhigozum obovatum and Lycium sp. are thought to be seasonally very important species. Work is underway to determine the average bite size on E. bothii by black rhino, to obtain data on the diet in all seasons for as many habitats as possible, and to determine the preferences of the woody species in the diet.

Red kangaroos in the sheep rangelands of Australia: tourism icons, assets or over-abundant competitors

A5.4

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The introduction of European farming practices into the range-lands of Australia saw the extinction or endangerment of many mammals below about 5kg in body mass. In contrast, the large kan-garoos like the red kangaroo (Macropus rufus) and the euro (M. robustus) grazers, remain abundant and widespread. This brings them into conflict with pastoralism where they are controlled to reduce grazing pressure and damage to infrastructure like fences. The products of this control program, the meat and skins, have until the last decade had low value. Recent management pro-

grams promote utilisation of kangaroos as a sustainable resource with a higher value product for human consumption as the flagship of such programs. This paper takes a different viewpoint and summarises the outcomes of a multifaceted research program that has examined the value of red kangaroos in wildlife tourism, the interaction with sheep and grazing impact in stocked and unstocked landscapes. Research has been conducted at the University of NSW Arid Zone Field Station at Fowlers Gap and Sturt National Park in the sheep rangelands of the far northwest of New South Wales. The results show that the red kangaroo is a highly recog-
nised icon of Australian tourism and the ‘Outback’ and is sought out by international and domestic tourists alike. When grazed with sheep, red kangaroos segregate and use different elements in the landscape. Destocked paddocks recover perennial vegetation while continuously grazed by kangaroos. In a large protected area, which has been destocked for 30 years, red kangaroos do not show water- focussed grazing allowing sheep-abundant and widespread recover where chenopod shrubland has not been irreparably degraded. Thus kangaroos can co-exist with sheep, and abundant populations can be maintained in destocked landscapes without continuing the degrading processes initiated and sustained since the Australian rangelands were turned to pastoralism more than a century ago. Kangaroos in these landscapes can be valuable and incomparable assets for Outback tourism.

Differential use and impacts on rangelands by different sexes and family units of elephants

A5.5

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The Pongola Game Reserve elephant population consists of four groups of elephants. These are two closely associated family units of 13 and 19 individuals that are mostly together as a single bond group, an unrelated unit of more or less even aged young females with their offspring and male siblings that consists of seven individuals, that are sometimes in close proximity to the bond group and at other times removed from them, and three adult bulls of dif-
f

ferent ages that move alone or together and which associate temporar-ily with the female groups. The different groups occupy differ-
ent parts of the total range. The males have the largest home range that covers almost all of the reserve. The bond group occupies only a small part of the reserve, whilst the smaller female unit occupies a slightly larger range than the bond group with only partial overlap. The male range covers the ranges of both female groups and some areas where females do not occur. The impact of elephants on vegetation, in terms of the density and proportions of trees utilised and the density and proportion killed, is different within the home ranges of the different groups. Impact is highest in the area where there is overlap in the ranges of the three groups and lowest where the males and the smaller female group go less frequently. Impact is, however, not linearly related to the ecological density (occupancy per unit area per unit time) of the ele-
phants in the different home ranges. Impact is disproportionately high in areas where only males occur, or where males and the smaller female group occur, indicating that males have a higher impact on trees than females.

The lack of a linear relationship between impact and ecological den-
sity appears not only to be influenced by the sex of the animals, but by the mix of vegetation types as well.

Ground-dwelling animals influence soil conditions in the western United States

A5.6

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Burrowing by animals has often profound effects on soil and vegetation. Pocket gophers and ground squirrels create mounds which produce significantly different levels of nutrients and textures which are markedly different from the surrounding soil matrix. In the western United States, American badgers preying on ground squirrels excavate large quantities of soil to create a fan-shaped mound at the burrow entrance. These large mounds are a substantial feature of the landscape, markedly altering soil physical and hydrological properties of the soils. This paper describes a study of the impact of badgers and ground squirrels on soil processes and its likely impacts upon vegetation diversity and production.

Some impacts of wildlife-livestock interactions in the rangelands of Kenya

A5.7

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This paper examines the impacts of livestock and wildlife interactions in the rangelands of central Kenya. It explores the underlying ecological dynamics — competition and complimentarity for resources including water and forage. The paper also looks at emerging issues and concerns. The overall argument is centred on the need to evolve responsive policies to help in maintenance of overall biodiversity and ecological integrity of rangelands where wildlife and pastoral livestock are found in the Kenyan rangelands.

Socio-economics of community-based wildlife utilisa-
tion enterprises in Asals. Case studies from Laikipia and Kajiado districts

A5.8

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Wildlife is a natural resource in most of the pastoral areas and can be a source of supplementary income. However, most range production systems in Kenya overlook the contribution of wildlife, partly due to the prevailing forms of wildlife utilisation available and restrictive government policy. This study sought to establish the forms of wildlife utilisation and subsequent returns from the wildlife-based enterprises. Community perceptions on community wildlife project management as well as the factors influencing the choice of enterprises communities engage in.
The study approach taken was based upon formal individual, informal group and key informant interviews supplemented with literature review and secondary data in Kajiado and Laikipia districts. Three communities were selected in each district and a total of 255 and 249 individuals were interviewed in Kajiado and Laikipia districts respectively. The study found that there was both consumptive and non-consumptive wildlife utilisation in both districts. Communities in Kajiado obtained more returns than those in Laikipia district. However, returns to the wildlife-based enterprises were relatively low in all the districts. Distribution of returns to members was found to be uncoordinated and inequitable. All projects were poorly managed according to 56% and 60% of respondents in Kajiado and Laikipia districts. Project were not sustainable in their current state as indicated by 66% and 60% of respondents in Kajiado and Laikipia districts respectively. However, there exists enormous potential for the communities to increase their returns from wildlife by diversification of products. It is recommended that the relevant ministries should intervene in the management of the community projects. Communities should diversify their income generation activities so as to obtain higher returns.

Cattle foraging behaviour: the influence of large mammalian herbivores in an acacia savanna, Laikipia, Kenya

A5.9

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The impact of large mammalian herbivores on cattle foraging behaviour was investigated during wet and dry seasons at Mpala Research Centre, Kenya, using a set of large mammal enclosures. It was found that past herbivory by cattle and wildlife significantly increased cattle biting rate and reduced bite mass, but had no significant impact on intake rate during both seasons. Megaherbivores did not affect cattle biting rate and bite mass irrespective of presence or absence of cattle. Across plots allowing large mammalian herbivory, cattle stepping rate was positively correlated with biting rate and negatively correlated with herbaceous cover during wet season. In addition, stepping rate was significantly higher in plots allowing cattle herbivory and those excluding large herbivores than in those allowing exclusive herbivory by wild herbivores. Themeda triandra was the staple food for cattle, making up over 40% of the diet, and its relative abundance was positively correlated with consumption. Relative consumption of this grass by cattle increased significantly due to wildlife herbivory. Forbs constituted 11.4% of cattle diet during dry season. During this season cattle, megaherbivores and wildlife significantly reduced the relative consumption of forbs by cattle. The results suggest that cattle adjust their biting rate and bite mass appropriately to maintain a constant rate of intake, and therefore the presence of wild large herbivores may not be detrimental to them in this ecosystem. However, there is potential for competition between cattle and wild herbivores for certain herbage species depending on the season of grazing.

Rangeland resource use by livestock and wildlife: a general perspective for Botswana

A5.10

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Recently, interactions between domestic livestock and wildlife have become of increasing concern to practitioners, professionals and policy makers. The concern has resulted from a rapidly changing society. Increased demand for wildlife meat, coupled with greater affluence and a higher human population, has greatly increased appreciation for wildlife. Moreover, recreation on both public and private lands has risen significantly in recent years. Alongside this trend, exists an assumption among some quarters of the society that wildlife does not overgraze while livestock do; that wildlife land use is sustainable while livestock land use is not and that livestock present a competitive challenge detrimental to wildlife. If the affluence of our society increases, the trend towards wildlife acceptability is likely to grow. The question is whether or not this should be at the expense livestock. Can we not harmonise this seemingly antagonistic tendency between wildlife and livestock?

Converting science to sustainable management: applications in small and intermediate size conservation areas

5.11

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Management, research and monitoring are inextricably linked to the successful running of the reserve. There is, however, very often little communication between these three arms of reserve/ranch organisation. Managers' decisions are often driven by long-term observation, the result of which after a period of time becomes 'pseudofact': Management therefore proceeds, often with success on 'gut feelings'. On the other hand researchers are largely driven by the need to publish. This again results in often useful yet highly academic publications that are difficult for managers to synthesise. Monitoring also generally takes place in a vacuum providing little practical information for managers and yielding few issues, again often through a lack of communication, that would yield topics for in-depth research. We look at a process, which might be very simple, to address the current situation. We look at scale issues as they relate to management, monitoring and research within the structure of clearly formulated objectives.

Management guidelines for herbivores in small and intermediate size savanna areas: a case study in the eastern lowveld of South Africa

A5.12

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The influence of principal driving determinants of structure and function in Lowveld Savannas in South Africa were examined for an eight year period to establish their relative influence on the forage resource (in particular focusing on the limiting grazing component). Rainfall, geology, soil, altitude, tree density and canopy cover, animal stockings rates and feeding class proportions and fire were investigated. Grass type, abundance and basal cover index were examined over 450 widely distributed sites covering c. 4 000km². Using ordination we satisfactorily examined the variation and differences in the herbaceous-response variables viz. perennial composition and cover. The analyses allowed for the broad grouping of areas of similar ecological potential (environment). Guidelines for animal stocking rates are proposed for the study area at a landscape level (1:250 000)

Wildlife reserves and pastoralism in tropical Africa: multiple use or competition for resources? The case of transhumance around the regional park of W (Niger, Burkina and Benin)

A5.13

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The regional park of W has been legally protected for more than 75 years and shelters a rich flora and fauna. Increasing human pressure, specially from the pastoralists, threatens the biological diversity. A recent rehabilitation project intends to establish permanent and sustainable management infrastructure involving the sur-
rounding populations. Transhumance in the park is illegal, but largely used and its control is presently difficult. A number of negative consequences on fauna are observed, specially in the Southern part of the park. The peripheral area lacks forage resources in the dry season and/or pastoral infrastructures, meanwhile large pieces of land and savannah are converted to field crops.

A study, based on surveys among the pastoralists and actual observation of cattle, aims to assess the importance of transhumance, to locate the ways of animal movements and the grazing areas and to analyse the recent evolutions and the motivations of pastoralists. Completing the previous information available in the literature, this study collects the basic knowledge before developing two strategic ways of intervention:

- Improving the conditions of transhumance, grazing and watering in the peripheral areas, to compensate for the forbidden access to the park
- Opening negotiations to study the possibility of a certain pastoral use in the park under definite and controlled conditions.

The prospect of opening the park to cattle and herders with the aim of a multiple use of resources poses difficult problems of diverse nature.

Relationship between range condition and the incidence of ticks in the Ngorongoro Crater, Tanzania

A5.14

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An invitation from the Frankfurt Zoological Society in Germany led to our participation in an interdisciplinary investigation into the recent alarming mortalities of game species in the Ngorongoro Crater in Tanzania. A total of five black rhinos, 22 lions, approximately 1 000 buffalo, 250 wildebeest and 100 zebra died in the Crater at the end of the year 2000. Veterinary investigations indicated that three of the rhinos and the lions died from babesiosis, the latter mortalities possibly being exacerbated by a plague of Stromyenteres stingling flies. The mortalities of buffaloes, wildebeest and zebra were apparently mainly due to nutritional stress resulting from a severe drought, however, in the case of the buffalo mortalities, high tick burdens and tick borne protozoal diseases involving babesiosis were probably also responsible. These high animal mortalities are viewed in a very serious light in Tanzania because the Serengeti ecosystem is one that the ecologically significant and important wildlife areas in Africa and forms the backbone of the highly lucrative eco-tourism industry in Tanzania. It was therefore considered essential to investigate the current disease situation in the Ngorongoro Crater and to develop strategies to prevent future outbreaks. A possible reason for the current high tick loads and incidence of babesiosis has been the suspension of controlled burning in the Crater since the early 1970’s. The investigation comprised determining the relationship between the standing crop of grass, the botanical composition of the grass sward, the areas preferred by the different ungulate species and the incidence of ticks. This involved conducting 33 veld condition and tick surveys in the Ngorongoro Crater and environs. It was found that there was a marked increase in the incidence of ticks when the grass sward exceeded 4 000kg ha⁻¹ and that mature stands of Chloris gayana (Rhodes grass) in full seed provided ideal habitat for excessively high densities of ticks. Results also showed that these areas were preferred by buffaloes which had suffered high mortalities from tick borne diseases. Conversely areas frequented by domestic livestock, particularly cattle, outside the Ngorongoro Crater had a significantly lower incidence of ticks and the standing crop of grass in these areas usually did not exceed 3 000–4 000kg ha⁻¹. These differences in veld condition and tick loads inside and outside the Crater led to the conclusion that the withdrawal of regular burning in the Crater since the early 1970’s had contributed to the excessive accumulation of moribund grass and the consequent high incidence of ticks. It was therefore recommended that a controlled burning program be re-introduced in the Crater to alter the micro-climate of the grass sward and make it less suitable for ticks.

Plant based utilisation frequencies of woody plants by southern African browsing ungulates

A5.15

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The acceptability of woody plant species by indigenous browsing ungulate species was investigated in a semi-arid savanna. The assessment was conducted at the end of the growing season (peak biomass). The relative number of utilised plants to unused plants was recorded in 18 belt transects, which ranged in size from 1 600– 2 000m² per transect. The greater kudu attained the highest biomass of the browsing community in the study area. Other prominent browsing ungulate species included impala, eland and giraffe. The assessment was restricted to the 0.8–2m above-ground horizontal layer, which represents the preferred browsing height of medium-sized browsing ungulates. Woody canopies were individually assessed from a fixed point per plant and the following utilisation categories were noted per plant: (1) not utilised; (2) only leaves utilised; (3) shoots (including leaves) utilised and (4) extensively utilised. A Chi-square test indicated that the species were selectively utilised (P < 0.001). The utilisation pattern observed in this study corresponded with the acceptability ratings derived for larger browsing ungulate species elsewhere. Woody species that were physically unarmred suffered relatively more damage (P < 0.001) to shoot-ends as compared to armed species (spines and thorns) where the leaves were more often utilised. This investigation confirms that woody species and plant parts are differentially utilised by medium-sized browsers.

Wild ungulate impact on browse in Montana, USA

A5.16

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Our purpose was to investigate the present condition and long-term ecological trends of shrub communities important for Montana wild ungulate populations. Our study considered browse in relation to forage production, relative thermal and security cover, reproductive success, growth, and successional patterns. Short-term enclosures located throughout Montana were used to determine browsing effects on an ecologically wide array of woody species. Environmentally paired portions of each enclosure were compared with unprotected areas outside the enclosure. Browse plants are currently heavily impacted by ungulates throughout Montana. The trend over the last half-century has been a decline of browse. This has implications for the welfare of browsing ungulates and many other organisms that have varying dependence on woody plants.

Effects of aerial spraying of Roundup® in bush encroached grassland on the grazing preferences of impala (Aepyceros melampus) and plains zebra (Equus quagga antiquorum)

A5.17

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Assuming that the camp he intended stocking with game had changed from sparsely wooded grassland to mostly closed woodland the owner of the property on which this study was carried out, used an aircraft to spray a number of strips, several hundred meters long, with Roundup®. The objective was to kill the trees (mainly Acacia spp.) and thereby cause the grass component to increase.
Although most of the sprayed trees were affected temporarily, few were killed by the Roundup®. However, almost all the grasses and other forbs were killed and soon replaced by a variety of alien problem plant species. Notwithstanding this outcome, impala and zebra that were introduced into this camp appear healthy and have bred successfully. This study was therefore undertaken to determine the potential carrying capacity of the existing non-woody vegetation and to compare this with the current stocking rate in order to predict the future outcome of the vegetation and animals in this camp.

Data collected from 42 200m long line-transects located throughout the camp were analysed using various routines available in the CANOCO software package. Results support subjective observations of the high incidence of alien problem plants in the sprayed areas while in those parts that were not sprayed Aristida junciformis is the dominant grass species.

Faecal analysis of impala and zebra dung collected at various places in the camp are currently being analysed in an attempt to determine what these animals are feeding upon in the camp.

Study on the community of small- middle-size soil animals of Songnen rangeland region in China

A5.18

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In this paper, the ecological characteristics of communities of small- middle-size soil animals of the Songnen rangeland region in China are studied. The results show that the dominant groups are Hypogastruridae, Actinedida, Gamasida and Oribatida; and the common groups are Isotomidae and Jassidae. The community diversity of small- middle-size soil animals is highest in grassland, and the habitat in grassland is superior to the other two. The number of individuals and groups of small- middle-size soil animals decreases with the increase in depth of the soil layer, and surface gathering is obvious. The primary factors affecting communities of small- middle-size soil animals are soil environmental factors.