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POPULATION DENSITIES AND HABITAT SELECTION OF THE YELLOW MONGOOSE (*CYNICTIS PENICILLATA*) UNDER SAVANNA CONDITIONS

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Carnivora, *Cinictis penicillata*, population ecology, habitat selection, savanna

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Abstract

The yellow mongoose population density was assessed by counting its dens. The study was conducted on the UNAM Ogongo campus. It is situated in the Cuvelai Drainage System, c. 50 km north-west of Oshakati, Outapi district, Omusati region, north-central Namibia (17º700 S, 15º310 E).The Cuvelai Drainage System is a unique ecosystem comprising a network of water canals (oshanas), mopane and acacia savannas. Four habitats were distinguished in the study area: pure acacia savanna (c. 380 ha); transformed acacia savanna mixed with human habitations, gardens, orchards, and arable fields (c. 200 ha); mopane savanna stocked with game (c. 1000 ha); and mopane savanna with livestock (c. 2000 ha). In total, 16 dens were identified in the pure acacia Savanna, 10 dens in transformed, but none in mopane savanna, neither in the one stocked with game, nor in the one with livestock. In the pure acacia savanna, the highest density was recorded at *Combretum*-dominated place, and none in *Acacia nilotica* dominated belt. Only two dens were located in the portion dominated by *Mopane colophospermum*. In general, the population density in the pure acacia savanna was assessed at 16.8–25.3 individuals per 100 ha, whereas in the human-modified acacia savanna at 20.5–30.0 ind./100 ha. The most important reason for the absence of the yellow mongoose in the mopane savanna is the soil type, not suitable for digging dens. Less important is the presence of oshanas flooded almost on a yearly basis, as the yellow mongoose often inhabit places close to water. Also, insects, especially termites, are common in mopane savanna, although population densities of small vertebrates are much lower here than in the acacia savanna. The land covered with the acacia savanna has a sandy soil, suitable for digging. Higher preferences for *Combretum* vegetation and outskirts of arable field can be explained probably by higher concentrations of small rodents (gerbils), which live there abundantly in burrow colonies. The overall population density of the yellow mongoose in pure acacia savanna at Ogongo was higher than in any other sites in southern Africa, where its density was assessed.

Cite as

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Щільність популяції та вибір місця проживання мангуста жовтого (*Cynictis penicillata*) в умовах савани

Гжегож Копій

Резюме. Щільність популяції мангуста жовтого оцінювалася шляхом підрахунку його нір. Дослідження проводилося на території кампусу UNAM Ogongo. Він розташований у дренажній системі Кувелай, приблизно за 50 км на північний захід від Ошакаті, район Оутапі, регіон Омусаті, північно-центральна Намібія (17º700S, 15º310E). Дренажна система Кувелай — це унікальна екосистема, що складається з мережі водних каналів (ошана), саван мопане та акації. У досліджуваній області виділено чотири типи середовищ існування: чиста акацієва савана (близько 380 га); трансформована акацієва савана, змішана з людськими поселеннями, садами, фруктовими садами та орними полями (близько 200 га); савана мопане, заселена дикими тваринами (близько 1000 га); савана мопане з худобою (близько 2000 га). Всього було виявлено 16 сховищ у чистій савані акації, 10 сховищ у трансформованій савані, але жодного у савані мопане, ні в заселеній дикими тваринами, ні в заселеній худобою. У чистій савані акації найвища щільність була зафіксована в місці, де переважав *Combretum*, і жодної — в поясі, де переважала *Acacia nilotica*. Лише дві нори були розташовані в частині, де переважав *Mopane colophospermum*. Загалом щільність популяції в чистій савані акації була оцінена в 16,8–25,3 особини на 100 га. Щільність у чистому масиві савани з акацією була розрахована як 16,8–25,3 особини/100 га, тоді як у савані з акацією, зміненій людиною, вона становила 20,5–30,0 особин/100 га. Найважливішою причиною відсутності жовтого мангуста в савані з мопане є тип ґрунту, який не підходить для риття нір. Менш важливим є наявність ошан, які затоплюються майже щороку, оскільки жовта мангуста часто мешкає в місцях, розташованих поблизу води. Крім того, в савані мопане поширені комахи, особливо терміти, хоча щільність популяції дрібних хребетних тут набагато нижча, ніж в савані акації. Земля, вкрита саваною акації, має піщаний ґрунт, придатний для риття нір. Більшу перевагу рослинності *Combretum* і околиць орних полів можна пояснити, ймовірно, більшою концентрацією дрібних гризунів (піщанок), які мешкають там у великій кількості в колоніях нір. Загальна щільність популяції жовтої мангусти в чистій савані акації в Огонго була вищою, ніж у будь-яких інших місцях на півдні Африки, де оцінювалася її щільність.

Ключові слова: хижі, *Cinictis penicillata*, екологія популяцій, вибір місця проживання, савана.

Introduction

The yellow mongoose, called also red meerkat *Cynictis penicillata* (Fig. 1) is a small carnivore from the family Herpestidae. It occurs in South Africa, Namibia, and Botswana. It lives in dens with many entrances around which it makes many latrines (Fig. 2, *a–b*). It inhabits predominately arid savanna, grasslands, and semideserts, largely corresponding to the West Arid Biotic Zone [Taylor 2013]. It is a cooperative breeder; a breeding unit (family) consists of a central breeding pair and their most recent offspring, subadults, the elderly, or adult relatives of the central pair.

The yellow mongoose is a highly opportunistic feeder, hunting mostly on small rodents, lizards, orthopterans (grasshoppers and locust), beetles, and termites (mainly *Hodotermes mossambicus*); supplementing with other insects, large arachnids, myriapods, frogs, and birds [Herzig-Straschil 1977; Avenant & Nel 1992; Nel & Kok 1999; Bizani 2014].

If settled near human habitations, it often feeds on anthropogenic food [Cronk & Pilliay 2019]. On the other hand, it is preyed upon mostly by snakes, jackals, and eagles. Its population densities were assessed in a few places in South Africa: 1) West Coast National Park [Cavallini 1993], 2) Farmland in Heidelberg area, Western Cape [Balmforth 2004], 3) Kuruman River Reserve, Northern Cape [Le Roux *et al*. 2008], 4) Great Fish River Nature Reserve, Eastern Cape [Le Roux *et al.* 2016]; and in one urbanised environment in Windhoek, Namibia [Kopij 2023a].

The present work was aimed to asses these parameters in a unique ecological area, the Cuvelai drainage System, north-central Namibia, which constitutes a subunit of the savanna biome.

Fig. 1. The yellow mongoose (Photo by W. Tarboton).

Рис. 1. Мангуст жовтий (Фото: В. Тарботон).

Fig. 2. Yellow mongoose dens (left, *a*) and latrine (right, *b*) (photos by G. Kopij).

Рис. 2. Лігва мангуста жовтого (ліворуч, *а*) та туалет (праворуч, *б*) (Фото: Г. Копій).

Study area

The study area was located on the UNAM Ogongo campus (Fig. 3). It is situated in the Cuvelai Drainage System, c. 50 km north-west of Oshakati, Outapi district, Omusati region, north-central Namibia (17º700 S, 15º310 E). The Cuvelai Drainage System is a unique ecosystem comprising a network of water canals (oshanas), mopane and acacia savannas. Ogongo has semi-arid climate. The summers are sweltering and partly cloudy; the winters are short, comfortable, and clear [Mendelsohn *et al.* 2000; Mendelsohn & Weber 2011]. The long-term annual amount of rain nearby Onguadiva was 724 mm (URL).

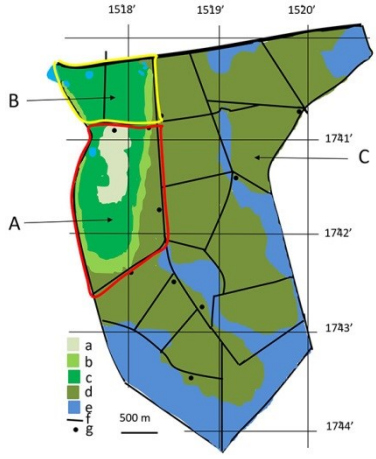

Fig. 3. The study plots: A—natural acacia savanna; B—transformed acacia savanna; C—mopane savanna. Explanation of colours: (*a*) *Combretum;* (*b*) *Acacia nilotica;* (*c*) *Acacia erioloba;* (*d*) *Mopane colophospermum;* (*e*) oshanas (flooded grassy depressions); (*f*) roads; and (*g*) water holes.

Рис. 3. Ділянки дослідження: А: природна акацієва савана, В - трансформована акацієва савана, С — мопанова савана. Пояснення кольорів: (*a*) *Combretum;* (*b*) *Acacia nilotica;* (*c*) *Acacia erioloba;* (*d*) *Mopane colophospermum;* (*e*) ошани (затоплені трав'янисті западини), (*f*) дороги; (*g*) водойми.

Four habitats were distinguished in the study area (Fig. 4–5): 1) pure acacia savanna; 2) transformed acacia savanna mixed with human habitations, gardens, orchards, and arable fields; 3) mopane savanna stocked with game (springboks *Antidorcas marsupialis*, gemsboks *Oryx gazella*, hartebeests *Alecephalus buselaphus*, giraffes *Giraffa camelparalis*, and zebras *Equus quagga*); and 4) mopane savanna with livestock (cattle, sheep and goats).

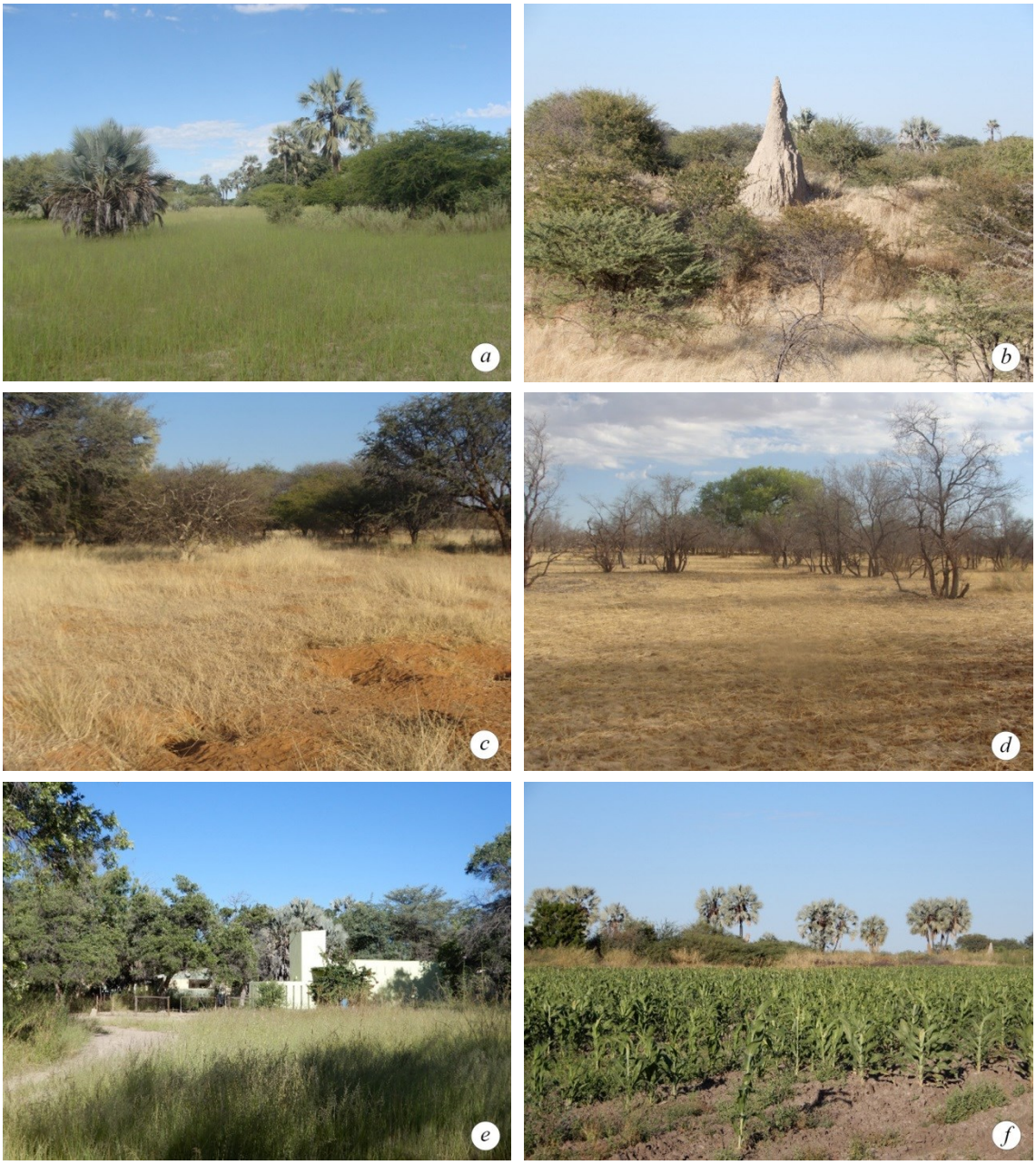

Fig. 4. Main habitats in acacia savanna in the study area: (*a*) *Acacia erioloba*; (*b*) transition from *Acacia erioloba* to *Acacia nilotica*; (*c*) dens on the outskirt of *Acacia nilotica*; (*d*) *Combretum*, (*e*) buildings within the acacia savanna; and (*f*) arable field within the acacia savanna (all photos by G. Kopij).

Рис. 4. Основні місця проживання в акацієвій савані в районі дослідження: (*a*) *Acacia erioloba*, (*b*) перехід від *Acacia erioloba* до *Acacia nilotica*; (*c*) лігва на околиці *Acacia nilotica*; (*d*) *Combretum*, (*e*) будівлі в межах акацієвої савани; (*f*) орне поле в межах акацієвої савани (всі фото: Г. Копій).

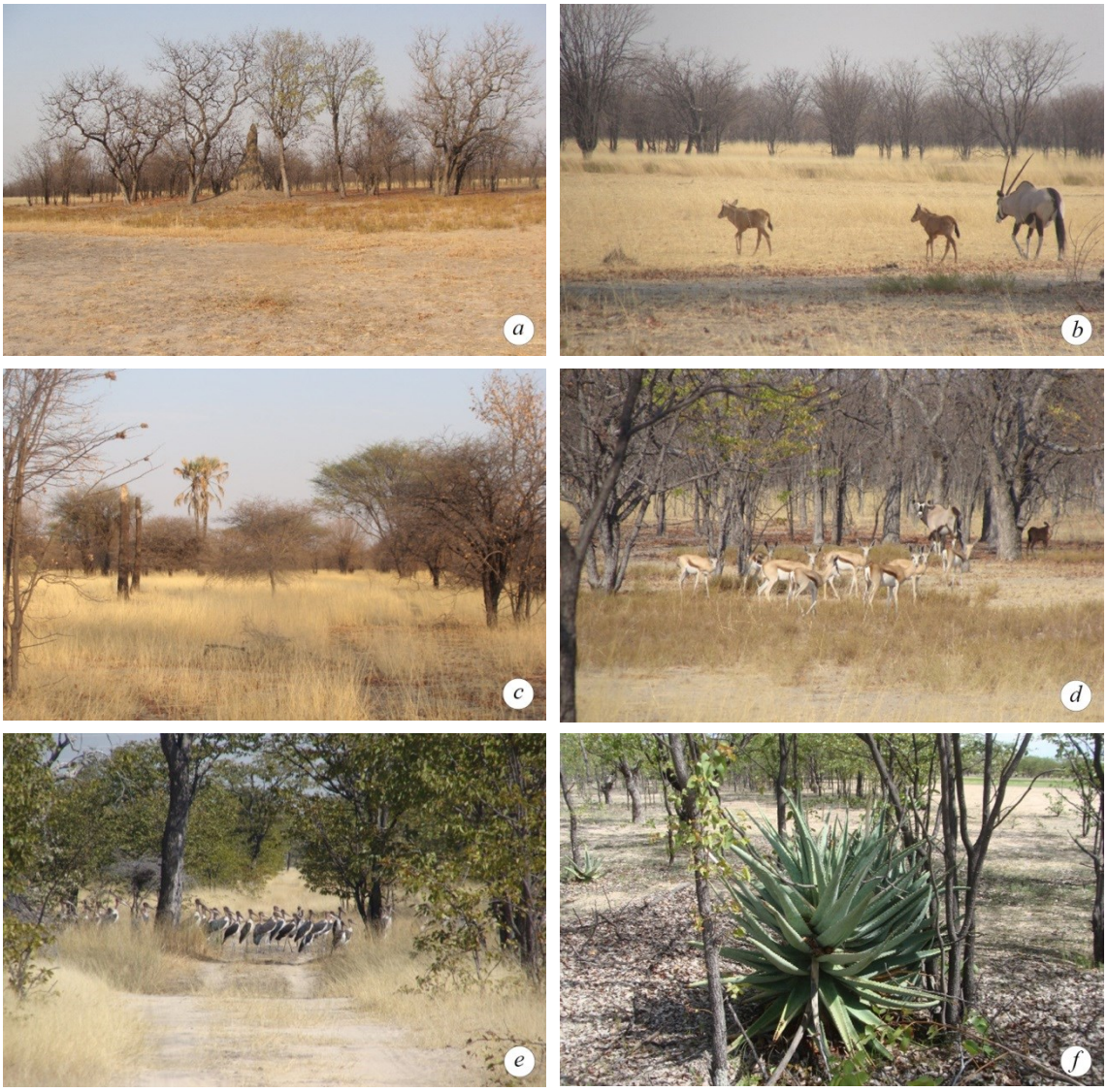

Fig. 5. Habitats in the mopane savanna: (*a*) termite mound and surrounding tree vegetation; (*b*) oshana (grassy depression flooded in wet season); (*c*) transition from *Acacia nilotica* to *Mopane colophospermum* vegetation; (*d*) mopane savanna stocked with wild game; (*e*) older stand of *Mopane colophospermum*; and (*f*) younger stage of *Mopane colophospermum* (all photos by G. Kopij).

Рис. 5. Середовища існування в савані Мопане: (*a*) термітник і навколишня деревна рослинність; (*b*) ошана (трав'яниста западина, що затоплюється в сезон дощів); (*c*) перехід від рослинності *Acacia nilotica* до *Mopane colophospermum*; (*d*) савана Мопане, заселена дикими тваринами; (*e*) старіше дерево *Mopane colophospermum*; (*f*) молоде дерево *Mopane colophospermum* (всі фотографії: Г. Копій).

The natural vegetation of the acacia savanna is composed mainly of *Acacia erioloba, A. nilotica, A. fleckii, A. mellifera, Albizia anthelmintica, Boscia albitrunca, Colophospermum mopane, Combretum* spp., *Commiphora* spp., *Dichrostachys cinerea, Ficus sycomorus, Grewia spp., Hyphaene petersiana, Sclerocarya birrea, Terminalia sericea,* and *Zyzyphus mucronata* [Kangombe 2007]. The mopane savanna is composed almost entirely of *Colophospermum mopane*. In the transformed savanna, there are also numerous exotic trees planted in and around human settlements, such as *Kigelia africana, Moringa oleifera, Melia azedarach, Dodonaea viscosa,* and *Eucalyptus camelduensis*. Both savannas are utilised as pasture for cattle, sheep, and goats.

One portion of the mopane savanna is also stocked with wild ungulates, such as springboks, gemsboks, hartebeests, zebras, and giraffes.

There are several permanent water bodies with standing water, and the area borders with an artificial water canal to the north and an extensive oshana (natural grassy depression filled with water in the rainy season) to the east.

Methods

The whole area was thoroughly traversed by walking slowly in the mornings along longitudes and latitudes separated one from another by 10 seconds, using GPS. The land was surveyed for the presence of birds (studied here by the means of the Line Transect Method), and all detected yellow mongoose dens were also plotted on the map using GPS [cf. Kopij 2018, 2023b]. Fresh latrines were examined for the presence of fresh excrements; only such sites were considered as occupied (see Figs. 2–3). Both the excrements and the animals themselves, often seen near the dens, were the best proof of what species occupied the den.

Population density was calculated for four distinguished habitats. The density was expressed as the number of groups per 100 ha and as the number of individuals per 100 ha. Mean number of individuals per group was assumed to be 4–6 (mean 5.2). This assumption was calculated as an average from the following recorded group sizes: 3.7 in Kuruman River Reserve, Northern Cape [le Roux et al. 2008]; 6.3 in Western Cape near Heidelberg [Balmfort 2004], and 6–5 individuals near the Vaal Dam in the Free State [Earle 1981].

Results

In total, 16 dens were identified in the pure acacia savanna (Table 1, Fig. 6), 10 dens in the transformed (a mosaic of natural and modified) acacia savanna (Table 2, Fig. 7), but none in the mopane savanna, neither in the one stocked with game, nor in the one with livestock. In the pure acacia savanna, the highest density was recorded at *Combretum*-dominated place, and none in *Acacia nilotica* dominated belt. Only two dens were located in the portion dominated by *Mopane colophospermum* (see Table 1). In general, the population density in the pure acacia savanna was assessed at 16.8–25.3 individuals per 100 ha.

In the transformed acacia savanna, the overall population density was even higher than in the pure stand of the acacia savanna (20.5–30.0 individuals per 100 ha). The yellow mongoose tends to locate its dens in pure acacia savanna close to built-up areas, and on the peripheries of arable grounds.

The yellow mongoose was not recorded at all both in the mopane savanna utilised as pasture for cattle, sheep, and goats, nor in the mopane savanna stocked with game mammals. It should be added that both plots were abundant in water almost throughout the year.

Table 1. Population density of the yellow mongoose in the pure acacia savanna (plot A). N = number of dens or individuals, Den. = density (den or individuals per 100 ha)

Таблиця 1. Щільність популяції мангуста жовтого в чистій акацієвій савані (ділянка А). N = кількість нір або особин, Den. = щільність (нір або особин на 100 га)

Habitat type	Area size	Dens		Individuals	
		N	Den.	N	Den.
Combretum	40 ha	4	10.0	16–24	40.0–60.0
Acacia erioloba	190 ha	10	5.3	40–60	21.1–31.6
Acacia nilotica	60 ha	0	0.0	0	0
Mopane colophospermum	90 ha	2	2.2	8–12	8.9–13.3
Total	380 ha	16	4.2	64–96	16.8–25.3

Table 2. Population density of the yellow mongoose in the transformed acacia savanna (plot B); N = number of dens or individuals, Den. = density per 100 ha

Таблиця 2. Щільність популяції мангуста жовтого в трансформованій савані Акація (ділянка B); N = кількість нір або особин, Den. = щільність на 100 га

Habitat type	Area size	Dens		Individuals	
		N	Den.	N	Den.
Pure Acacia Savanna	139 ha	6	4.3	24–36	17.3–25.9
Human-modified Acacia Savanna	26 ha	3	11.5	12–18	46.2–69.2
• Disturbed savanna	5 ha	0	0.0	0	0
• Arable fields	15 ha	3	20.0	12–18	80.0–120.0
• Orchards	5 ha	0	0.0	0	0
• Sport field	1 ha	0	0.0	0	0
Built-up areas	35 ha	1	2.6	4–6	11.4–17.1
Total	200 ha	10	5.0	40–60	20.5–30.0

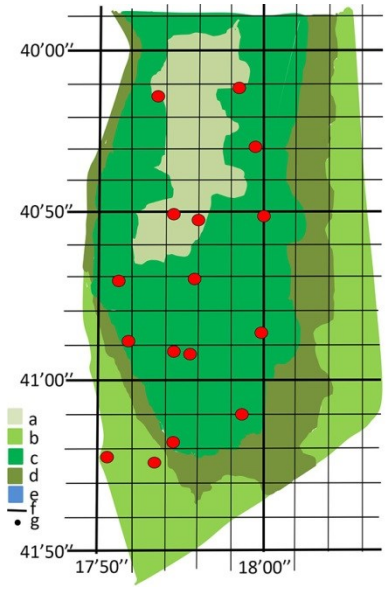

Fig. 6. Distribution of yellow mongoose dens (red dots) in the study plot A. Explanation of colours: (*a*) *Combretum*; (*b*) *Acacia nilotica*; (*c*) *Acacia erioloba*; (*d*) *Mopane colophospermum*; (*e*) oshanas (flooded grassy depressions); (*f*) roads; and (*g*) water holes.

Рис. 6. Розподіл нір мангуста жовтого (червоні крапки) на дослідній ділянці А. Пояснення кольорів: (*a*) *Combretum*; (*b*) *Acacia nilotica*; (*c*) *Acacia erioloba*; (*d*) *Mopane colophospermum*; (*e*) ошани (затоплені трав'янисті западини); (*f*) дороги; (*g*) водойми.

Fig. 7. Distribution of yellow mongoose dens (red dots) in the study plot B. Explanation of colours: (*a*) *Acacia erioloba*; (*b*) built-up areas with *Acacia erioloba*; (*c*) disturbed *Acacia erioloba*; (*d*) orchard; (*e*) sport field; (*f*) water bodies; (*g*) arable field; (*h*) roads; and (*i*) fences.

Рис. 7. Розподіл нір мангуста жовтого (червоні крапки) на дослідній ділянці В. Пояснення кольорів: (*a*) *Acacia erioloba*; (*b*) забудовані території з *Acacia erioloba*; (*c*) порушені *Acacia erioloba*; (*d*) сад; (*e*) спортивний майданчик; (*f*) водойми; (*g*) орні землі; (*h*) дороги; (*i*) огорожі.

Discussion

The most important reason for the absence of the yellow mongoose in the mopane savanna is the soil type, not suitable for digging dens. Less important is the presence of oshanas flooded almost on a yearly basis, as the yellow mongoose often inhabits places close to water. Also, insects, especially termites, are common in mopane savanna, although population densities of small vertebrates are much lower here than in the acacia savanna (own observ.).

The land covered with acacia savanna has a sandy soil, suitable for digging. Higher preferences for *Combretum* vegetation and outskirts of arable fields can be explained probably by higher concentrations of small rodents (gerbils), which live there abundantly in burrow colonies (own observ.).

Although yellow mongooses belong to the 'solitary' group of mongooses [Veron *et al.* 2004] and are generally regarded as solitary foragers, previous studies revealed a great deal of variation and plasticity in the socio-spatial ecology of the genus *Cynictis*. The yellow mongoose has in fact a cooperative breeding system, whereby non-breeding members of a group feed and care for the young [Rasa *et al.* 1992].

Home range sizes of the yellow mongoose have been recorded as a minimum of 26 ha [Balmforth 2004] and a maximum of 250 ha (mean 70 ha; [Taylor & Meester 1993]), with male home ranges being more than twice as large as female home ranges. Home range sizes vary seasonally, with both sexes reducing home range sizes during colder periods [Mbatyoti, 2012]. Mean group size ranges from 2 to 13 ind. 3.7 in Kuruman River Reserve, Northern Cape [le Roux *et al.* 2008]; 6.3 in Western Cape near Heidelberg [Balmfort 2004], 6–5 ind. near the Vaal Dam in the Free State [Earle 1981].

In Potsberg Nature Reserve within the West Coast National Park, with grassland/bush on a sandy coast, 16–19 ind. with seven dens were recorded in an area of 2900 ha. Population density was calculated therefore as 1.1–1.3 ind. per 100 ha, and 0.23 groups per 100 ha [Cavallini 1993]. Le Roux et al. [2008] studied another low-density population (4–14 ind./100 ha) in the Kuruman River Reserve in the Northern Cape and found that groups consisted of 2–7 animals, including offspring. In the city of Windhoek, Namibia, at least 21 dens with at least 100 individuals were recorded. The overall estimated population density was at least 2 individuals per 100 ha and at least 0.4 groups per 100 ha. It was the highest around shrubby hills [Kopij 2023b].

Finally, in a medium-density population (23–26 ind./km^2) living in a farmland near Heidelberg (Western Cape), yellow mongooses formed groups in which both males and females defended a common territory that was used equally by all group members (6.3 on average). Overlap between home ranges of group members was extensive, whereas the ranges of neighbouring groups overlapped little or were clearly distinct from one another [Balmforth 2004]. The overall population density of the yellow mongoose in pure Acacia Savanna at Ogongo (16.8–25.3 ind./100 ha) was therefore higher than all above-quoted, and it was even higher (20.5–30.5 ind./100 ha) in transformed Acacia Savanna (Table 3). The high density recorded in the Ogongo acacia savanna can be linked with high density of rodents (gerbils), termites, and other invertebrates, as well as with sandy soil suitable for digging.

Table 3. Population density of the yellow mongoose in southern Africa

Таблиця 3. Щільність популяції мангуста жовтого в південній Африці

Locality	Habitat	Area size [ha]	Density (ind./100 ha)	Source
South Africa, Western Cape	Coastal grass/bush; West Coast National Park	2,900	1.1–1.3 (0.23 group)	Cavallini [1993]
Namibia, Windhoek	Urbanised environment (Highland Savanna)	5,000	>2.0 (>0.4 group)	Kopij [2023a]
South Africa, Eastern Cape	Grassland; Great Fish River Nature Reserve	?	4–10	Le Roux *et al.* [2016]
South Africa, Northern Cape	Kuruman River Reserve	3,200	4–14	Le Roux *et al.* [2008]
South Africa, Western Cape	Farmland in Kalahari Thornveld; Heidelberg area	?	23–26	Balmforth [2004]
Namibia, Omusati Region	Pure acacia savanna	380	16.8–25.3 (4.2 group)	This study
Namibia Omusati Region	Transformed acacia savanna	200	20.5–30.5 (5.0 group)	This study

A high density of the yellow mongoose (133–200 ind./km^2) was recorded in a grassy area of c. 20 ha in size in a land of c. 70 ha, which for most part of the year became an island on the Vaal Dam, Free State, South Africa. Earlé [1981] initially described a structure of group territories defended by both males and females, with up two 13 group members sharing a common den. Territory limits were patrolled regularly and scent-marks and faeces deposited at border latrines [Earle 1981]. However, the recorded exceptionally high density cannot be taken as an example of population density. It should be considered an unusual concentration caused by artificial factors (a garbage dump on an artificial island of an artificial dam).

Declarations

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