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The population structure of four rodent species from a tropical region (Kisangani, D. R. Congo)

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ABSTRACT. This study summarizes the data on the population structure of *Deomys ferrugineus, Hybomys lunaris Lophuromys dudui* on the mainland and *Praomys jacksoni* on the mainland as well as on islands on the Congo River. All species at these three localities show a stable population structure without seasonal variation. Reproduction on the mainland populations is probably continuous year-round, with subadult presence during the whole year. The island populations of *P. jacksoni* have a different population structure from the mainland population, probably caused by the periodic inundations. The sex-ratio is even for *L. dudui* and *H. lunaris*. For *P. jacksoni* and *D. ferrugineus* however, more males were captured on the mainland. On the islands, the sex-ratio pattern is not clear cut and differs between years. No clear seasonal variation in sex-ratio has been found in our populations.

KEY WORDS : population structure, sex ratio, *Lophuromys*, *Praomys*, *Deomys*, *Hybomys.*

INTRODUCTION

Since 1979, the Faculty of Science, University of Kisangani conducts studies on Rodents in the region of Kisangani. During these studies, the structure of the rodent population and their ecological distribution was recorded. This work is a synthesis on existing data about the population structure of *H. lunaris, D. ferrugineus, L. dudui and P. jacksoni* from the region around Kisangani, from 1984 to 2000.

MATERIAL AND METHODS

Kisangani is located at 0°31' N, 25°11' E and lies between 360m and 460m above sea level. The area is situated in an equatorial climate type of the A_{fi} zone, according to the classification of Köppen (DUVIGNEAUD, 1974). The climate is characterized by the lack of a prolonged dry season. Precipitation is abundant with a monthly average of 152 mm, but rainfall is irregularly distributed. The mean relative humidity is 85% without much variation during the year. However, two short drier periods (December - February and June - August) and two wet periods (March - May and September - November) exist.

The survey is based on existing material collected from October 1984 to December 2000 from the city of Kisangani and its surroundings (Masako Forest Reserve and the islands Kungulu, Mbiye and Mafi on the Congo River). We used Victor snap traps and/or Sherman LFA live traps on line transects for our rodent trappings.

The results from October 1984 to December 1986 and 1997 are obtained at the Masako forest reserve on the mainland, except for *Lophuromys dudui*, where data from fallow lands near Kisangani city also exist and were pooled together with data from Masako. At Masako, 300 Victor snap traps have been used from 1984 to 1986 to totalize 13300 trap nights during a total of 27 months. The trapping effort was approximately evenly distributed during this period at Masako. In 1984, two months at the end of the wet season and one month of a 'drier' season were sampled. During 1997, 60 traps were used at Masako to totalize 780 trap nights. Sampling was only conducted during one wet season from September to November. In Kisangani city, 80 Victor traps were used with an unknown number of trap nights. Traps were baited with palm nut pulp (*Elaeis guineensis*), cassava, salty fish or peanut butter.

Mbiye and Mafi Islands were prospected together because of their vicinity. The study site was prospected in 1996 using 80 snap traps totalizing 2101 trap nights and again in 2000 using 83 Sherman live traps (2075 trap nights in total). At the Kungulu Island, 40 Sherman traps were used totalizing 960 trap nights in 1999. At all these localities, palm nut pulp was used as bait.

The trapping took place on transect lines with trap stations separated 10m from one another. The distance between the traplines varies between 500m to 1000m. We trapped across different habitats, including primary forests, secondary forests, fallow lands, periodically inundated secondary forests and along water courses. Within the city of Kisangani, we trapped in different types of fallow lands (older and younger fallow lands, concession of the university, …). The results from all habitats were pooled together since data on trap placement regarding to the habitat is not available.

The population structure is given for the two drier seasons and the two wetter seasons combined for the years 1985, 1986 and 2000. 1984 data represent part of the wet and one month of the 'drier' season (October – December). Data for 1997 and 1999 regarding to the seasons are not available.

Animals are categorized in groups based on reproductive characters as follows :

- Juvenile : females with non-perforated vagina and invisible teats or males with abdominal, non-developed testes
- Subadults : females with small visible nipples but a non-perforated vagina or males with non-scrotal testes (internally developed but not externally visible)
- Adults : females with large nipples and/or a perforated vagina or males with scrotal, externally visible testes

Body weight classes per age class were also calculated. Data were not available for the years 1984 and 1997. Data were grouped together per locality (for the years 1985 and 1986 at Masako). There was no variation in body weights between these two years (not shown).

The sex-ratio per year and combined over all years was calculated for each species at Masako on the mainland (except for 1997 and for the sampled months during 1984) and on the islands combined. Chi square tests were used to test for significant sex ratio bias within each species between years, as well as bias in the combined sex-ratio for all species over all years were data exist for the species. We expect an even sex ratio in small mammals (Hardy, 1997), but sex ratio bias have already been found in other small mammals (for instance for wild *Mus minutoides* individuals, Krackow, 1997) and linked to ecological factors, for instance in the rodent species *Mastomys natalensis* in Tanzania (Kennis et al., submitted).

The material was fixated using 10% formaldehyde or 70% ethylic alcohol. The identification of the specimens was performed in the "Laboratoire d'Ecologie et de Gestion des Ressources Animales (LEGERA)" by comparing morphometric and craniometric data with those proposed by Meester & Setzer (1971), Hollister (1916), Hutterer & Dudu (1991), Hutterer & Happold (1983).

RESULTS

Population structure in relation to the season

The population structure of *H lunaris, D. ferrugineus, L. dudui* and *P. jacksoni* in and around Kisangani is similar. In all species the population structure does not vary with the season (Figs 1-4), based on seasonal data from the years 1985, 1986, 1996 and 2000. For the years 1997 and 1999, information about the season of the captures is not available. Moreover, there were no records of *D. ferrugineus*, *H. lunaris*, and *L. dudui* in 1996, 1999 and 2000 at the prospected island sites, and only *P. jacksoni* was captured there.

The amount of subadults is larger than the amount of adults and juveniles from 1984 to 1986; except for *L. dudui*, where adults are more common. In 1997 however, adults seem dominant for our four study species. For *H. lunaris*, subadults are not represented in our trappings during this year. For the island populations surveyed during 1996, 1999 and 2000, *P. jacksoni* shows a high number of adults compared to subadults and juveniles. Total number of captures for each species and season is given in Table 1.

TABLE 1

Total number of captures per season (if available) for all species and years. DS = dry season, WS = wet season.

Year	84	DS85	WS85	DS86	WS86	97
H. lunaris	13	47	75	262	193	6
L. dudui	10	65	99	138	142	25
D. ferrugineus	19	50	89	127	105	34
P. jacksoni[1]	42	59	138	235	219	42
Year	DS96	WS96	99	DS00	WS00	
P. jacksoni[2]	43	80	28	72	61	

[1] data from Masako on the mainland
[2] data from the different islands on the Congo River

Figures

Fig. 1

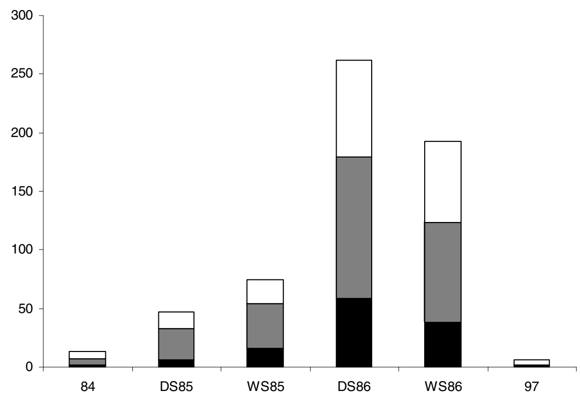

Fig. 2

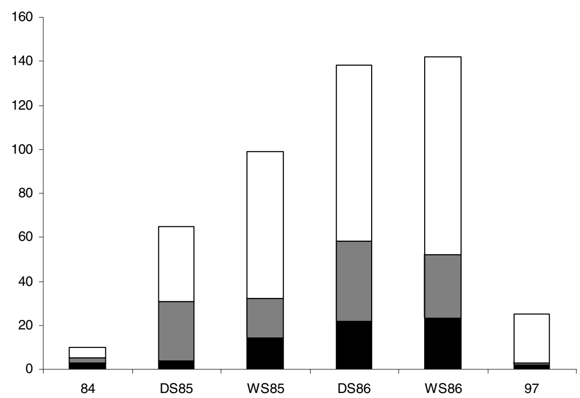

Fig. 1. – Population structure for *Hybomys lunaris*. Black = juvenile, shaded = subadult and white = adult. DS = dry season; WS = wet season. The Y-axis shows the number of captures.

Fig. 2. – Population structure for Lophuromys dudui. Black = juvenile, shaded = subadult and white = adult. DS = dry season; WS = wet season. The Y-axis shows the number of captures.

Fig. 3

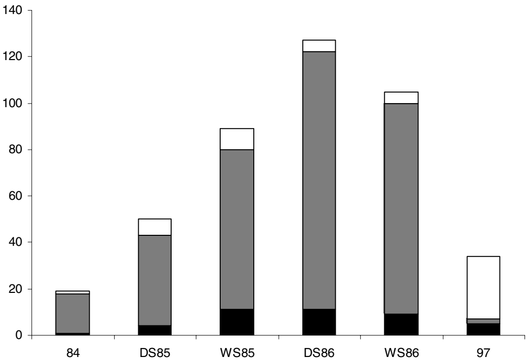

Fig. 4

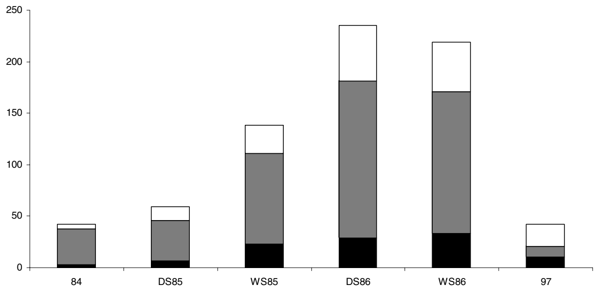

Fig. 5

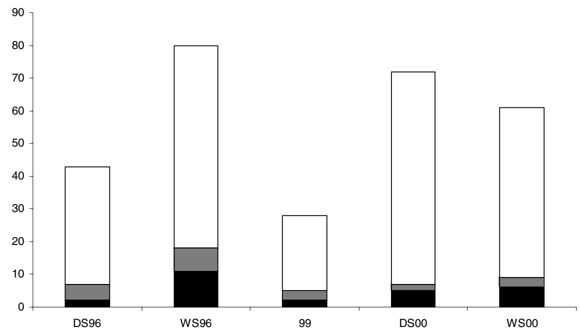

Fig. 3. – Population structure for *Deomys ferrugineus*. Black = juvenile, shaded= subadult and white = adult. DS = dry season; WS = wet season. The Y-axis shows the number of captures.
Fig. 4. – Population structure for the mainland populations of *Praomys jacksoni* (Masako, 1984-1986 and 1997). Black = juvenile, shaded = subadult and white = adult. DS = dry season; WS = wet season. The Y-axis shows the number of captures.
Fig. 5. – Population structure for the island populations of *Praomys jacksoni* (1996, 1999 and 2000). Black = juvenile, shaded = subadult and white = adult. DS = dry season; WS = wet season. The Y-axis shows the number of captures.

Age class composition

Body weight classes are given in Table 2. Upper limit of the body weight is given for juveniles and lower limit is given for adults. For subadults, ranges are given with outer bounds. The number of captures per age class is also indicated.

TABLE 2

Comparison between body weight W (in g) for all study species.Weight class data for 1884 and 1997 are not available. Data are grouped per locality. Lower limits are given for juveniles and upper limits are given for adults. For subadults, the range is given with outer bounds. Number of captures per weight class is given between brackets.

Year	85-86 W (g)	96 W (g)	99 W (g)	2000 W (g)
P. jacksoni				
Juveniles	<21 (91)	<22 (12)<23 (2)	<20 (8)	
Subadults	20-41 (423)	21-31 (11)	23-28 (3)	20-26 (10)
Adults	>40 (137)	>30 (100)	>29 (23)	>24 (117)
L. dudui				
Juveniles	<41 (89)			
Subadults	40-51 (240)			
Adults	>50 (115)			
D. ferrugineus				
Juveniles	<41 (33)			
Subadults	40-71 (312)			
Adults	>70 (26)			
H. lunaris				
Juveniles	<31 (116)			
Subadults	30-51 (271)			
Adults	>50 (190)			

Sex – ratio

Table 3 gives an overview of the sex-ratio calculations for the years 1985 and 1986 at Masako. *Lophuromys dudui* and *Hybomys lunaris* show an even sex-ratio year-round at Masako, without seasonal variation. For *Deomys ferrugineus* at Masako, the sex-ratio is significantly biased towards males in both the 'drier' and wet seasons ($X^2 = 5.5$, $p = 0.019$). When combining the data from 1985 and 1986, the overall sex-ratio is also significantly biased towards males ($X^2 = 11.4$, $p = 0.001$). For *Praomys jacksoni* on the mainland (Masako), the overall sex-ratio combined over the two study years is significantly biased towards males ($X^2 = 22.3$, $p < 0.001$). Only during the wet season of 1985, there was no significant difference in captures of males and females. All the other seasons during the two-year period show a sex-ratio which is significantly biased towards males ($X^2 > 6.1$, $p < 0.014$).

Data collected on the islands show a different sex-ratio pattern (Table 4). More males are caught than females during the wet seasons of 1996 ($\chi^2 = 5$, $p = 0.025$) and the 'edrier' seasons of 2000 ($\chi^2 = 4.76$, $p = 0.03$). However, during the wet seasons of 2000, a significantly female biased sex-ratio exists ($\chi^2 = 3.99$, $p = 0.047$). The overall sex-ratio, combined over all study years, does not show a significantly biased sex-ratio ($\chi^2 = 2.39$, $p = 0.12$) but shows a tendency towards more male captures (54.4% of total captures).

DISCUSSION

Age structure

The regular presence of all age classes on the mainland in and around Kisangani, indicates a stable population structure, even in the different seasons. Rodent reproduction is thus continuous in and around Kisangani. Only the year 1997 shows another pattern, but this is probably due

TABLE 3

Sex-ratio of *H. lunaris, L dudui, D. ferrugineus and P. jacksoni* collected at Masako during the years 1985 and 1986. Significant deviations from an equal sex-ratio are indicated with an asterisk. DS = dry season; WS = wet season.

	Total		DS 85		WS 85		DS 86		WS 86	
	N	%	N	%	N	%	N	%	N	%
H. lunaris										
Female	327	51.1	29	40.8	33	40.2	164	53.6	101	55.8
Male	313	48.9	42	59.2	49	59.8	142	46.4	80	44.2
Total	640		71		82		306		181	
χ^2	0.31		2,4		3,1		1,5		2,4	
L. dudui										
Female	107	44	9	40.9	23	43.4	40	47.6	35	41.7
Male	136	56	13	59.1	30	56.6	44	52.4	49	58.3
Total	243		22		53		84		84	
χ^2	3.46		0,7		0,9		0,2		2,3	
P. jacksoni										
Female	298	41	41	35	75	47.2	94	41.8	88	39.6
Male	425	59	76	65	84	52.8	131	58.2	134	60.4
Total	723		117		159		225		222	
χ^2	**22.3***		**10,5***		0,5		**6,1***		**9,5***	
D. ferrugineus										
Female	168	41.6	36	46.1	39	43.8	53	39.2	40	38.5
Male	236	58.4	42	53.9	50	56.2	80	60.8	64	61.5
Total	404		78		89		133		104	
χ^2	**11.4***		0,5		1,4		**5,5***		**5,5***	

TABLE 4

Sex-ratio of *Praomys jacksoni* captured on the islands. Significant deviations from an equal sex-ratio are indicated with an asterisk. DS = dry season; WS = wet season.

	Total		DS96		WS96		99		DS00		WS00	
	N	%	N	%	N	%	N	%	N	%	N	%
Female	139	45.6	30	47.6	30	37.5	12	42.8	22	36	45	61.6
Male	166	54.4	33	52.4	50	62.5	16	57.2	39	64	28	38.4
Total	305		63		80		28		61		73	
χ^2	2.39		0.14		**5.00***		0.57		**4.76***		**3.99***	

to the low trapping effort that year and the short period of trapping (3 months in one wet season) compared to the year-round trapping conducted at Masako during the other years reported here.

DIETERLEN (1986) found however that the age composition of rodents in primary forest changed significantly after reproduction. DUPLANTIER (1989) has also noted an influx of immature animals during the month of April for populations in tropical rainforest in Gabon, where the reproduction period extends from January to March. On the other hand, HAPPOLD (1974, 1979) found that the population structure of *Praomys tullbergi, Hylomyscus stella, Thamnomys rutillans, Lophuromys sikapusi* and *Graphiurus sp.* in the rainforest of Nigeria is composed of adults and subadults all year round, suggesting that the rodent populations there reproduce thus year-round. The continuous reproduction of rodents in and around Kisangani could be related to the absence of a real 'dry' season. We did not find any evidence to support the existence of well-defined reproductive periods in *L. dudui*, *P. jacksoni*, *D. ferrugineus* and *H. lunaris*.

In contrast to the rainforest, it is well known that most savannah species show distinct reproductive periods as documented by PIRLOT (1954) and DIETERLEN (1967) in Congo-Kinshasa, COETZEE (1965) in South Africa, SHEPPE (1972) and ANADU (1979) in Zambia, HUBERT (1977) in Senegal, NEAL (1977) in Uganda, LEIRS et al. (1989; 1990) in Tanzania. The population structure of savannah rodent populations thus changes considerably during the year.

Our data from the prospected islands show that the population structure of *Praomys jacksoni* on the islands differs from the population structure on the mainland. Although trapping effort and total number of individuals is lower on the islands than on the mainland, we think these results are real population effects because all the prospected years on the different islands show the same pattern. Adults form a much larger part of the population as opposed to the populations on the mainland (Masako and Kisangani). It is possible that these island populations have a different population structure because these islands are periodically inundated. The effect on the species composition is also clear, only the arboreal *P. jacksoni* was captured. During the inundation periods, animals have to find refuge in the trees. The arboreal *Praomys jacksoni* adults certainly can survive periodical, short inundation that last at most one week. Perhaps intraspecific competition for food during the inundations has an impact on the survival of juveniles and subadults or perhaps the juveniles (and maybe even subadults) have difficulties finding suitable trees to climb in and find refuge. Perhaps there is a competition for 'good' trees with abundant food between adults and sub-adults/juveniles. Further studies are needed to clarify the causes of this population structure difference.

Sex -ratio

DUPLANTIER (1989) and HAPPOLD (1983) observed a male-biased sex-ratio for some Muridae and Cricetidae, similar to our observations for the mainland population of *P. jacksoni* and *D. ferrugineus*. Studies conducted by HAPPOLD (1977), CROSS (1977), RAHM (1967) have also found a preponderance of males for *Praomys jacksoni, Hylomyscus stella* and *Deomys ferrugineus*.

For *Hybomys lunaris* and *Lophuromys dudui* however, the sex-ratio is equal during the year.

For these species, similar results were also obtained by SHEPPE (1972; 1973), HAPPOLD (1977) and DUPLANTIER (1989).

The island populations of *Praomys jacksoni* show variations in sex-ratio depending on the season. This variation is different in our two different study years. During the wet season of 1996, more males were captured at the islands Mbiye and Mafi. In 2000 however, more females were captured during the wet season at island Kungulu. The populations on these islands are not stable and the periodic inundations can also have an effect on the sex-ratio. At the mainland, the sex-ratio does not show seasonal variation. These results could be influenced by the trapping efforts (although similar on the islands), by the different trapping methods and by differences in trappability between the sexes. Sex-specific differences in home ranges and dispersal can possibly influence the trappability of the different sexes. HUBERT (1977) found for instance that in savannas, rodent home ranges of males and females increase during the reproduction period. HAPPOLD (1983) noted that the home range of Muridae and Cricetidae varies from 100 to 300 m² and does not differ much according to the sex. DUPLANTIER (1989) however, found that the average home range of Muridae can measure more than 1500 m² for females whereas for males the home range could be even larger, especially in species like *Praomys tullbergi, Hybomys univittatus* and *Deomys ferrugineus*. He also found that the home range is inversely proportional to the density of the rodent population. If home ranges are larger for one sex, this can produce differences in trappability because of the higher mobility of one sex. Trappability can also be influenced by pregnancy and the care for offspring (by the females, males or both). No data on sex-specific trappability and sex-specific mobility exist but capture-mark-recapture studies and population genetic studies will be undertaken in the near future.

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