Multimammate rat (Mastomys erythroleucus) capture-mark-recapture data in Bandia (Senegal) between 1984 and 2012

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DATA ARTICLE

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Multimammate rat (*Mastomys erythroleucus*) capture-mark-recapture data in Bandia (Senegal) between 1984 and 2012

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Abstract

Long-term ecological data are of paramount importance to document the effects of global changes on biodiversity and dynamics of populations and communities. The site of Bandia, 70 km southeast of Dakar in western Senegal, has been the scene of numerous ecological studies since the 1970s. In the frame of projects led by researchers of the *Institut de Recherche pour le Développement* (IRD), rodent populations were monitored at various periods using capture-mark-recapture (CMR) protocols on trapping grids that yielded important datasets on population dynamics and ecology of the main species present. Among them, the Guinea Multimammate Rat *Mastomys erythroleucus* proved to represent the dominant species. Thus, CMR data were collected on *M. erythroleucus* between (i) November 1975–March 1981, (ii) January 1983–October 1986, (iii) January 1997–April 2001, and (iv) June 2007–June 2012. Raw data from the 1975–1981 period were not available, but those from the three other periods are now in the IRD data repository DataSuds at https://doi.org/10.23708/YEA5AR. They represent 2556 (re)captures of 1296 *M. erythroleucus* individuals. They include the identity of each animal captured with some biological attributes (sex, weight at first capture, and reproductive activity), exact date and point of capture (via a trap-specific code) at each trapping occasion, and additional comments that may help to interpret the data. This dataset concerning one of the most widespread rodent species of the Sahelo-Sudanian bioclimatic belt provides information that can be used to address various questions such as outbreak prediction or effects of climate change. The complete data set for this abstract published in the Data Article section of the journal is also available in electronic format in MetaCat in JaLTER at http://db.cger.nies.go.jp/JaLTER/metacat/metacat/ERDP-2024-05.1/jalter-en.

KEYWORDS

Bandia classified forest/reserve, live trapping, *Mastomys* rats, population dynamics, Sahelo-Sudanian savanna

1 | INTRODUCTION

The interest of long-term datasets to study changes in ecological communities has been acknowledged repeatedly (see Lindenmayer et al., 2012; Magurran et al., 2010, among others). Long-term time series are also key in understanding populations trends, such as population cycles of small rodents that undergo regular or irregular outbreaks as shown by Andreassen et al. (2020) both on temperate and tropical species. Capture-mark-recapture (CMR) protocols are of particular value in this respect, as they enable to access life history parameters at the individual level in the populations studied. Population size, survival, recruitment can be computed from such CMR data, and the factors acting on them evaluated, as exposed in details in Lebreton et al. (1992) or Pradel (1996). In tropical rodents, CMR data have represented the basis for fruitful hypotheses on the determinism of *Mastomys* rat population cycles and outbreak occurrence, both in Senegal (Hubert et al., 1978, Hubert, 1982, on *Mastomys erythroleucus*) and Tanzania (Leirs et al., 1996, 1997, on *Mastomys natalensis*). This genus comprises species of particular concern for human activities and health, as major pests for crops and stored foodstuffs (Stenseth et al., 2003) as well as reservoirs of zoonotic diseases (Gratz, 1997). Understanding their ecology in various contexts is thus a priority in order to be able to control their populations using ecologically- based management methods (Singleton et al., 1999).

In Senegal as in most of the Sahelo-Sudanian bio-climatic belt, *M. erythroleucus* often represents one of the dominant species in savanna small mammal communities (see Bâ et al., 2013; Granjon et al., 2004, and references therein). This is the case in Bandia, a site situated ca. 50 km west-southeast of Dakar that has been selected in the 70s as a pilot area for the study of ecological and epidemiological interactions in the Sahel (see introduction of Hubert, 1982). The study area was formerly part of the « Bandia forest » which was classified as such in 1933, and submitted to a management plan in 1953 (i.e., subdivided in plots for firewood and timber exploitation/plots for reforestation, together with a ban on livestock wandering). However, this regulation was hardly respected, and logging, fuelwood collection, poaching and wandering of livestock regularly occurred, leading to a progressive degradation of the environment until 1990 when the site was erected as the first private natural reserve of Senegal. From there, a 1500 ha fenced area further extended to 3500 ha in 2006 has permitted the regrowth of trees/shrubs, the reintroduction of large mammals and overall, the regeneration of a typical Sahelo-Sudanian tree savanna (see maps and details in Vincke et al., 2005 and Samb et al., 2020).

On this site, CMR data were collected on various trapping grids, close to each other and of different sizes and configurations, during sessions usually separated by 1–4 months, at four distinct periods: (i) November 1975–March 1981 (Hubert, 1982), (ii) January 1983–October 1986 (Crespin et al., 2012; Duplantier & Granjon, 1988; Granjon, 1987), (iii) January 1997–April 2001 (Bâ, 2002), and (iv) June 2007–June 2012 (see http://vminfotron-dev.mpl.ird.fr:8080/bandia2_2/index.htm). Raw data from the 1975–1981 period are no longer available, but they have been exploited in details by B. Hubert and his collaborators (see Hubert, 1982; Hubert & Adam, 1983, 1985), and various population data on *M. erythroleucus* are provided in the annexes of Hubert (1982). The raw data collected and gathered here correspond to the three other periods (starting in 1983). They can be used to study population dynamics (including abundance, density, survival, and age composition), breeding cycle and small-scale movements. Combined with information on climate (and especially rainfall), vegetation or any other variable of interest, they may serve to test hypotheses linked to interindividual relationships within populations as well as to the determinants of abundance cycles in rodents, including those related to global change consequences. Correlative studies in population genetics could also be envisaged, especially for the 2007–2012 period where toe/ear samples removed for individual marking were systematically kept in ethanol.

2 | DATA DESCRIPTION

2.1 | Identifier

ERDP-2024-05.

2.2 | Contributor

2.2.1 | Dataset owner and creator

Laurent Granjon (email: laurent.granjon@ird.fr)

2.2.2 | Contact person

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2.3 | Geographic coverage

The trapping grids sampled at the different periods were all located in a circle of 500 m radius centered on 14.559° N/17.014° W, 3.5 km south-southeast of the city of Sindia and 17 km north-northwest of Mbour city centre on National Road 1 (Figure 1). They were set in spaces that are representative of the surrounding environment, easy to access and outside the area open to the public of the wildlife reserve. It is a typical Sahelo-Sudanian, sublittoral area with oceanic influences, characterized by a long dry season between November and May and a short rainy season between June and September (Figures 2 and 3), with mean annual rainfall of ca. 500 mm.

2.4 | Temporal coverage

The CMR trapping sessions organized during the three periods concerned by this compilation occurred as follows:

- Period 1984–1986: in January, April, August, and November 1984, February and December 1985, April, July, and October–November 1986 (9 sessions).
- Period 1998–2001: July and November 1998, April, July, and November 1999, April, July, and November 2000, April 2001 (9 sessions).

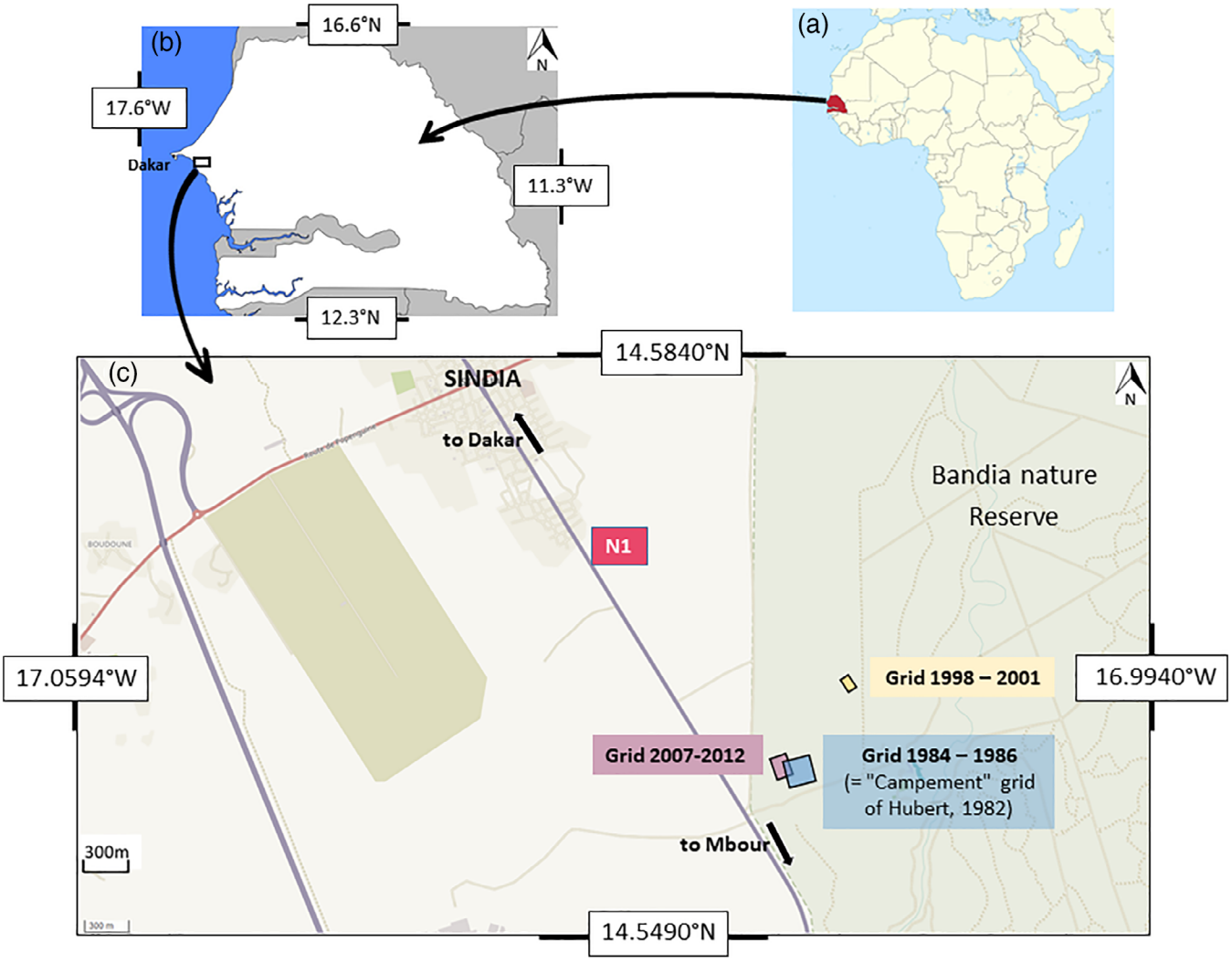

FIGURE 1 Map of Africa (a) locating Senegal (b) and situation map of the study area (c) with location of the grids sampled for rodents at the different study periods (N1 = National Road 1; map retrieved from OpenStreetMap at: https://www.openstreetmap.org/relation/192775#map=7/14.477/-14.548).

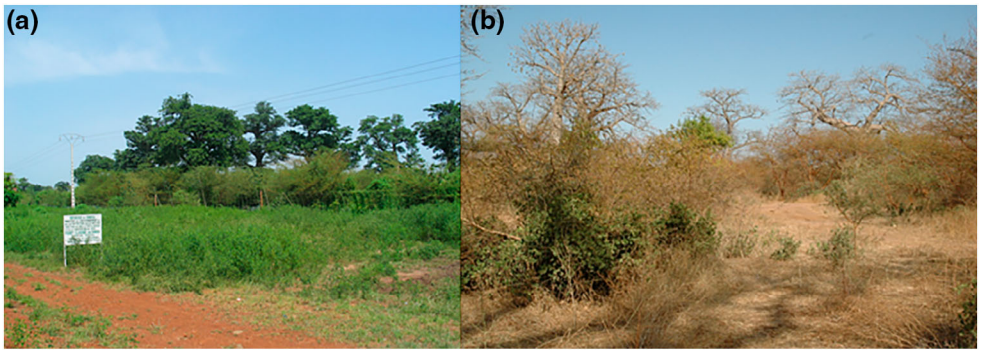

FIGURE 2 Photographs of the Bandia Nature Reserve; (a) From National Road 1, after the rainy season (November), showing the fence; (b) Inner part of the Reserve at the end of the dry season (June).

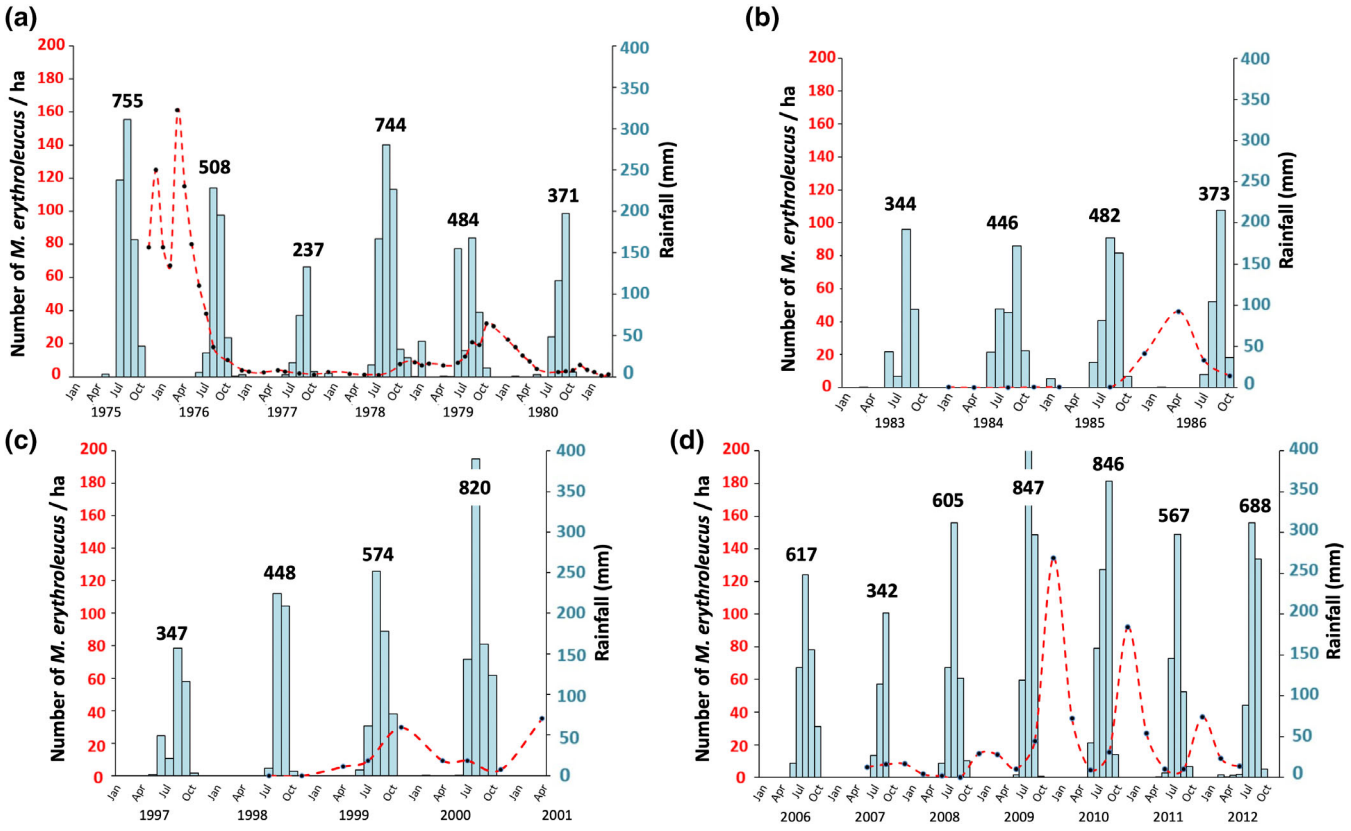

FIGURE 3 *Mastomys erythroleucus* density variations and monthly rainfall in the four periods when capture-mark-release on trapping grids were conducted: (a) 1975–1981 (data from Hubert, 1982), (b) 1984–1986, (c) 1998–2001, and (d) 2007–2012 (data from this data article). Black points and red dotted line = *M. eryhtroleucus* density (number of individuals caught per hectare); blue histograms = monthly rainfall (mm); bold numbers above histograms = annual rainfall (mm).

- Period 2007–2012: June, September, and December 2007, March, June, September, and December 2008, March, June, September, and December 2009, March, June, September, and December 2010, March, June, September, and December 2011, March and June 2012 (21 sessions).

2.5 | Methods

Capture-Mark-Recapture was conducted on square or rectangular grids of parallel trap lines spaced at a set distance apart. In the study by Hubert (1982), as well as during the 1984–1986 period (Granjon, 1987), the grids comprised 21 lines (A-U) of 21 traps (1–21), with an inter-traps and inter-lines distance of 10 m, thus covering a 200 × 200 m (4 ha) area. In the 1998–2001 period (Bâ, 2002), a smaller grid was sampled, consisting of four lines (A–D) of 10 traps (1–10), with an inter-traps distance of 10 m and an inter-lines distance of 20 m, yielding a grid area of 0.54 ha (60 × 90 m). Between 2007 and 2012, the grid comprised 15 lines (A–O) of 19 traps (1–19), with inter-traps and inter-lines distances of 10 m, hence a grid area of 2.52 ha (140 × 180 m). Traps were placed at the

best available spot (e.g., under a bush, along a fallen tree, or in front of an apparently active burrow) within ca. 1 m distance of the grid node. In all instances, trapping sessions lasted 6 days, including five nights during which *M. erythroleucus* captures occurred. The traps used were wire-meshed, single-capture live-traps (Manufrance© before 1998, then locally-made), (re)baited every afternoon with peanut butter, and checked every morning.

At first capture, each rodent was individually marked by toe and/or ear clipping, and the following data were recorded: location on grid, weight (to the nearest gram, using a Pesola© brand scale), sex; position of testes for the males (scrotal or abdominal); for the females, vagina perforate or not, nipples small or large (and possibly lactating), pregnant or not (as assessed visually or via palpation). The remarks "young adults" and "juveniles" have been mentioned at one occasion, in April 1986, for individuals that were not weighed. These field observations were based on size and general appearance of the individuals concerned and are only indicative of a general age class, in the absence of any quantitative data. On recapture during the same trapping period, only the number and location were routinely recorded.

2.6 | Data structure

2.6.1 | Data files

The raw information described above (§ 2.5) was available for the three last periods and is deposited as a series of 39 tab-separated values (tsv) files (YYYY-MM_Bandia_CMR.tsv), each corresponding to a trapping session (see § 2.5), at in DataSuds repository (IRD, France) at https://doi.org/10.23708/YEA5AR.

These files primarily give access to the numbers of *M. erythroleucus* individuals caught at each trapping session. To illustrate how these numbers vary across time, the corresponding density variations (numbers of individuals caught divided by the area covered by the grid at each session) are shown on Figure 3 together with monthly rainfall data collected in the nearby city of Mbour by the National Agency for Civil Aviation and meteorology (ANACIM), as used in Diallo et al. (2022). Data from Annex 1 of Hubert (1982) are also shown for the period 1975–1981. Rainfall of the year prior to the survey period is important, as reproduction, hence demographic cycle and especially density at year $n + 1$, is highly dependent on rainfall of year n.

2.6.2 | File format

Data files are encoded in UTF-8, in TSV format.

2.6.3 | Variable and unit definitions

The variable names and meanings as well as the content of the data files and the codes used are described in Table 1.

TABLE 1 Variable names and content, with meaning of the different codes used.

Variable name	Variable content / meaning	Meaning of the different codes used
Id#	Individual identifier	Number = combination of toe clipping (units and tens) and ear notching (hundreds) NoId#: Concerns individuals found dead at first capture
New/Recapt.	Indicate whether the individual is caught for the first time or recaptured from a previous session	In case or recapture, the session of first capture is mentioned
Species	Name of species	All specimens belong to *Mastomys erythroleucus*
Sex	male or female (or unidentified)	M: Male; F: Female; ?: unidentified
Sex. Act	Indicate whether the individual is sexually active or not	+: sexually active (i.e. males with scrotal testes; females with perforate vagina, pregnant or lactating) -: sexually inactive (i.e. males with abdominal testes; females with closed vagina and neither pregnant nor lactating) +/−: intermediate / ambiguous ?: not indicated
Weight	Individual mass, to the nearest gram	-
JJ/MM/YY	Dates of trap checking	The codes refer to the capture points identified by the identifier of lines (capital letters) and traps (numbers) in the trapping grid A1—A21 to U1—U21 in 1984–1986 A1—A10 to D1—D10 in 1998–2001 A1—A19 to O1—O19 in 2007–2012

2.7 | Accessibility

2.7.1 | License

2.7.2 | Location of storage

The data and related documentation that support the findings of this study are openly available in DataSuds repository (IRD, France) at https://doi.org/10.23708/YEA5AR. Data reuse is granted under CC-BY license.

The data is also available in JaLTER MetaCat at http://db.cger.nies.go.jp/JaLTER/metacat/metacat/ERDP-2024-05.1/jalter-en.

2.8 | Publications

Bâ K., 2002. *Systématique, écologie et dynamique des populations de petits rongeurs potentiellement réservoirs ou hôtes de virus au Sénégal*. Mémoire de diplôme EPHE, Montpellier, 126 p.

Crespin L., Duplantier, J.M. & Granjon, L., 2012. Demographic aspects of the island syndrome in two Afrotropical *Mastomys* rodent species. *Acta Oecologica*, 39: 72–79.

Granjon L., 1987. Évolution allopatrique chez les muridés: mécanismes éco-éthologiques liés au syndrome d'insularité chez *Mastomys* et *Rattus*. Thèse de doctorat, Université Montpellier 2, 163 p.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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REFERENCES

Andreassen, H. P., Sundell, J., Ecke, F., Halle, S., Haapakoski, M., Henttonen, H., Huitu, O., Jacob, J., Johnsen, K., Koskela, E., Luque-Larena, J. J., Lecomte, N., Leirs, H., Mariën, J., Neby, M., Rätti, O., Sievert, T., Singleton, G. R., van Cann, J., … Ylönen, H. (2020). Population cycles and outbreaks of small rodents: Ten essential questions we still need to solve. *Oecologia*, *195*, 601–622. https://doi.org/10.1007/s00442-020-04810-w

Bâ, K. (2002). *Systématique, écologie et dynamique des populations de petits rongeurs potentiellement réservoirs ou hôtes de virus au Sénégal* (p. 126). Mémoire de diplôme EPHE, Montpellier (France).

Bâ, K., Kane, M., Gauthier, P., & Granjon, L. (2013). Ecology of a typical west African Sudanian savannah rodent community. *African Journal of Ecology*, *51*, 447–455. https://doi.org/10.1111/aje.12055

Crespin, L., Duplantier, J. M., & Granjon, L. (2012). Demographic aspects of the Island syndrome in two Afrotropical *Mastomys* rodent species. *Acta Oecologica*, *39*, 72–79. https://doi.org/10.1016/j.actao.2012.01.002

Diallo, S., Faye, M., & Nacro, H. B. (2022). La variabilité pluviométrique et ses impacts sur les rendements et les surfaces cultivées dans le bassin arachidier de la région de Thiès (Sénégal). *VertigO—la Revue Électronique en Sciences de L'environnement [Online]*. https://doi.org/10.4000/vertigo.34710

Duplantier, J.-M., & Granjon, L. (1988). Occupation et utilisation de l'espace par des populations du genre *Mastomys* au Sénégal: étude à trois niveaux de perception. *Sciences et Techniques de l Animal de Laboratoire*, *13*, 129–133.

Granjon, L. (1987). Évolution allopatrique chez les muridés: mécanismes éco-éthologiques liés au syndrome d'insularité chez *Mastomys* et *Rattus*. *Thèse de Doctorat, Université Montpellier*, *2*, 163.

Granjon, L., Houssin, C., Lecompte, E., Angaya, M., César, J., Cornette, R., Dobigny, G., & Denys, C. (2004). Community ecology of the terrestrial small mammals of Zakouma National Park, Chad. *Acta Theriologica*, *49*, 215–234. https://doi.org/10.1007/BF03192522

Gratz, G. (1997). The burden of rodent-borne diseases. *Belgian Journal of Zoology*, *127*, 71–84.

Hubert, B. (1982). Dynamique des populations de deux espèces de rongeurs du Sénégal, *Mastomys erythroleucus* et *Taterillus gracilis* (Rodentia, Muridae et Gerbillidae): I. *Etude démographique. Mammalia*, *46*, 137–166.

Hubert, B., & Adam, F. (1983). The regulation of the population dynamics of two Sahelian rodents in Senegal: An hypothesis. *Annales du Musée Royal d'Afrique Centrale, Sciences Zoologiques*, *237*, 193–201.

Hubert, B., & Adam, F. (1985). Outbreaks of *Mastomys erythroleucus* and *Taterillus gracilis* in the Sahelo-Sudanian zone in Senegal. *Acta Zoologica Fennica*, *173*, 113–117.

Hubert, B., Adam, F., & Poulet, A. (1978). Modeling of the population cycles of two rodents in Senegal. *Bulletin of Carnegie Museum of National History*, *6*, 88–91.

Lebreton, J. D., Burnham, L. P., Clobert, J., & Anderson, D. R. (1992). Modeling survival and testing biological hypotheses using marked animals: A unified approach with case studies. *Ecological Monographs*, *62*, 67–118.

Leirs, H., Stenseth, N. C., Nichols, J. D., Hines, J. E., Verhagen, R., & Verheyen, W. (1997). Stochastic seasonality and nonlinear density-dependent factors regulate population size in an African rodent. *Nature*, *389*, 176–180.

Leirs, H., Verhagen, R., Verheyen, W., Mwanjabe, P., & Mbise, T. (1996). Forecasting rodent outbreaks in Africa: An ecological basis for *Mastomys* control in Tanzania. *Journal of Applied Ecology*, *33*, 937–943.

Lindenmayer, D. B., Likens, G. E., Andersen, A., Bowman, D., Bull, M., Burns, E., Dickman, C. R., Hoffmann, A. A., Keith, D. A., Liddell, M. J., Lowe, A. J., Metcalfe, D. J., Phinn, S. R., Russell-Smith, J., Thurgate, N., & Wardle, G. M. (2012). Value of long-term ecological studies. *Austral Ecology*, *37*, 745–757. https://doi.org/10.1111/j.1442-9993.2011.02351.x

Magurran, A. E., Baillie, S. R., Buckland, S. T., Dick, J. M. P., Elston, D. A., Scott, E. M., Smith, R. I., Somerfield, P. J., & Watt, A. D. (2010). Long-term datasets in biodiversity research and monitoring: Assessing change in ecological communities through time. *Trends in Ecology & Evolution*, *25*, 574–582. https://doi.org/10.1016/j.tree.2010.06.016

Pradel, R. (1996). Utilization of capture-mark-recapture for the study of recruitment and population growth rate. *Biometrics*, *52*, 703–709.

Samb, A., Mbaye, M. S., Diouf, J., Dieng, B., Camara, A. A., Ka, S. L., Sidyba, M., Diouf, N., Sylla, S. N., & Noba, K. (2020). Réserve Naturelle de Bandia (Sindia/Sénégal): Caractérisation floristique et l'état de conservation de la diversité végétale. *International Journal of Development Research*, *10*, 38027–38033. https://www.journalijdr.com/sites/default/files/issue-pdf/19365.pdf

Singleton, G. R., Leirs, H., Hinds, L. A., & Zhang, Z. (1999). Ecologically-based management of rodent pests. Re-evaluating our approach to an old problem. In *Ecologically-based Management of Rodent Pests* (pp. 17–29). Australian Centre for International Agricultural Research (ACIAR).

Stenseth, N. C., Leirs, H., Skonhoft, A., Davis, S. A., Pech, R. P., Andreassen, H. P., Singleton, G. R., Lima, M., Machang'u, R. S., Makundi, R. H., Zhang, Z., Brown, P. R., Shi, D., & Wan, X. (2003). Mice, rats, and people: The bio-economics of agricultural rodent pests. *Frontiers in Ecology and the Environment*, *1* (7), 367–375. https://doi.org/10.1890/1540-9295(2003)001[0367:MRAPTB]2.0.CO;2

Vincke, X., Hornick, J. L., Njikam, N. I., & Leroy, P. (2005). Gestion de la faune sauvage au Sénégal: comparaison du Parc national du Nioko-Koba et de la Réserve privée de Bandia. *Annales Médecine Vétérinaire*, *149*, 232–237.

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