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Local perception of rodent-associated problems in Sahelian urban areas: a survey in Niamey, Niger

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Abstract Rodents are involved in the epidemiology of many pathogens and are major pests for agriculture. Local perception and beliefs about rodents and their damages is a key element of control programs. We here present the first survey focusing on the human perception of rodent-associated problems in an African town, namely Niamey, Niger. In total, 170 interviews were conducted in 18 different urban districts where rodents (*Mastomys natalensis*, *Rattus rattus* and *Mus musculus*) are widespread and abundant. Rodent-associated problems were mentioned in almost all instances (96.5 %). Eight different categories of rodent-induced nuisances could be recurrently identified. The most frequently cited one consists in damages on food and food stocks (63.1 %), followed by damages on houses (47.3 %), furniture (19.5 %) and clothes (16.8 %). There was no significant association between damages and districts, which means that the perception of rodent-

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associated problems did not vary significantly across the city. Our survey strongly suggests that rodents may represent major pests not only for farmers, but also for inhabitants of towns, thus contributing to reinforce economic vulnerability. Finally, no mention of sanitary or medical problems was ever recorded during our survey, thus pointing towards an apparent absence of knowledge about the potential role of rodents in some public health issues.

Keywords Pest rodents · Food security · Public health · West Africa · Sahelian area

Introduction

Rodents are known to be involved in the maintaining, circulation and/or transmission of many human pathogens (e.g., Singleton et al. 2003a; RatZooMan Workshop 2006; review in Meerburg et al. 2009a). They are also considered as major pests for crops and food stocks, especially in developing countries (Leirs 2003; Meerburg et al. 2009b). In Tanzania, *Mastomys natalensis* was shown to impact maize production at a 5–15 % level, thus potentially representing a 60 millions USD loss per year (Skonhoft et al. 2006, and references therein). In Sahel, investigations were conducted in two different regions of Senegal: 58 % and 46 % of farms displayed signs of rodents attacks, thus suggesting that rodents represent major domestic and agricultural pests in rural areas (Duplantier and Handschumacher, unpublished results quoted by Granjon and Duplantier 2009). However, proper assessment of agricultural damages remains scarce, especially in the Sahelian region, most probably due to the lack of quantitative and large-scale data.

Niger is no exception and only two surveys of local pest rodent population dynamics have been conducted so far (Nomao 2001; Hima 2010), while no data are available at the national scale. Yet, rodent-associated damages on crops and food stocks in this country may be quite high. Indeed, according to local traditions, the year 1989, during which an outstanding rodent outbreak and subsequent massive destructions of millet and cowpea occurred, is even referred to as "the year of mice" (*chekaran kusu*, in hausa). From 1995 to 2011, 149 "attacks on crops by rodents" were recorded in 57 agricultural districts from 6 (out of 8) regions by the Nigerien Minister of Agriculture (DGPV 1995–2011). Among those, only seven bulletins provided quantitative estimations about seedlings destructions which ranged from 5–15 % (N=2) to 30–60 % (N=5).

In Africa, when available, data usually focus on agricultural damages in fields (e.g., Hopf et al. 1976; Gautun 1999; Mulungu et al. 2003; Bekele et al. 2003). To our knowledge, information about rodent-associated damages in households remains very rare (see Granjon and Duplantier 2009, and below, for an example in rural areas of Senegal). Yet, such damages may be economically important (Mwanjabe et al. 2002; Skonhoft et al. 2006; Yonas et al. 2010), especially in developing countries where traditional, either formal or informal, settlements are numerous, and where hygienic conditions can be poor. Gathering direct and measurable observations may not be easy, mainly in large cities where one may rely on indirect source of information, such as questionnaires. It has been shown that popular feelings about rodents and rodent-associated damages may be largely misleading for the design of control strategies *per se* (Singleton et al. 2003b). Nevertheless, a scientific approach to people's perception of such damages may provide indirect yet helpful insights into the overall impact of rodents in the human environment (e.g., Olaseha et al. 1994; Diarra 2002; Forst and King 2003; Phu Tuan et al. 2003; Sang et al. 2003; Makundi et al. 2005; Promkerd et al. 2008). In turn, it is also very useful for evaluating the degree of knowledge as well as beliefs on rodents by inhabitants: having people well informed and aware is the first step of any efficient rodent control policies (Diarra 2002; Forst and King 2003; Marshall and Murphy 2003; Taylor et al. 2008; Yonas et al. 2010; Morzillo and Mertig 2011).

As part of a wider program that deals with rodent communities and their epidemiological role in the context of an explosive urbanization process, we conducted various investigations in Niamey, main city of Niger. We here report a dataset documenting the perception of rodent-associated nuisances by local inhabitants as revealed through 170 interviews across the city of Niamey. As such, our study adds to the rare investigations dealing with perception of rodent-associated problems that were conducted in the specific context of urban ensembles (e.g., Nigeria: Olaseha et al. 1994; Lao PDR: Promkerd et al. 2008; South Africa: Taylor et al. 2008: UK: Marshall and Murphy 2003).

Material and methods

Niamey, the capital city of Niger, lies within the typical Sahelian region, and receives ~515 mm rain per year (average 1982–2010; Centre Régional Agrhymet meteorological database, Niamey, Niger). Though reaching 1.1 million inhabitants in 2009 (last population census, National Institute of Statistics, Niger), it is yet quite recent since it was created *ex nihilo* at the very end of the 19th century. It has since then undergone impressive demographic and spatial expansions, especially during the last four decades (Sidikou 2010).

Sampling of rodents lasted from December 2009 to May 2011. It involved both Sherman and locally made wire mesh traps which were baited with a mixture of peanut butter and traditionally prepared "soumbala" powder (pounded grain of *Parkia biglobosa*). The detailed procedures, results and analyses of trapping sessions *per se* are described elsewhere (Garba 2012), and only the trapping success rates relevant to the present study are presented here below.

A total of 18 intra-urban popular "districts" were sampled (see Table 1 and Fig. 1). Within each district, 4–18 "sampling sites" were selected, thus leading to a total of 170 sampling units (Table 1 and Fig. 2). A site typically consisted of what was considered as a traditional shop or a habitat unit, namely either a single building if isolated, or, more often, an assemblage of houses aggregated within the same well delimited and closed space (i.e. a "concession", as routinely called in Niger; see Fig. 2b and c). Within each district, sites were chosen each 10–100 m until at least 50 traps could be set for four successive nights (which led to a total of 288 up to 707 night-traps per district; see Garba 2012). When we were not authorized to have access to one particular site, we made an attempt in the closest potential site. Overall, each urban district was sampled for sites that were distant by 10–300 m from each other. Although such distances may sound short, taking into account the complex structure of most urban landscape within Niamey, they in fact correspond to sites that may be separated by several blocks of buildings and/or streets (Fig. 2a).

Each district was investigated for the presence of rodents during four successive nights, for a total of 7,576 night-traps (details not shown; see Garba 2012). The rodent aspects are presented and discussed in details in another manuscript (Garba 2012), and we here focus on the human perception of rodent-associated troubles in the 170 rodent sampling units. However, in order to make the whole context available for the reader, the monitoring of rodents is briefly described. Captured rodents were brought alive in the lab (Centre Régional Agrhymet, Niamey) in order to be euthanized and sampled for further genetic and epidemiologic analyses. Many West African rodent genera consist of sibling species complexes (reviewed in Granjon and Duplantier 2009). This is the reason why special attention was paid to taxonomic identification, particularly in the difficult *Mastomys* genus. To do so, unambiguous species-specific identification was performed through karyotyping (*Mastomys*, *Rattus* and *Mus* genera; see Dobigny et al. 2008, 2011), cytochrome *b* gene-based RFLP

Table 1 Answers obtained to our questionnaires and presented per categories and per district (see text for details) as well as for the whole city of Niamey. In each case, the numbers of both exploitable and positive answers are presented. Percentages of positive answers are calculated in comparison to exploitable answers only

		LMO	BOU	KOT	KOU	BAF-2	DAR	CYA	CGA	GAM	GNA	GRM	ROF	TCH	WAD	YAH	YAB	PKE	KAR	All Niamey
	N interviews	7	8	7	12	10	8	14	9	13	11	7	4	5	7	9	12	9	18	170
Rodent-associated troubles	N exploitable answers	7	8	7	12	10	8	14	9	13	11	7	4	5	7	9	12	9	18	170
	N positive answers	7	8	7	12	10	8	13	9	12	10	6	4	5	7	9	11	9	17	164
	% positive answers	100,0	100,0	100,0	100,0	100,0	100,0	92,9	100,0	92,3	90,9	85,7	100,0	100,0	100,0	100,0	91,7	100,0	94,4	96,5
Damages on food and stocks	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	0	7	9	13	149
	N positive answers	4	6	6	5	7	8	11	0	7	7	3	3	3	7	-	1	7	9	94
	% positive answers	57,1	75,0	85,7	45,5	70,0	100,0	78,6	0,0	53,8	63,6	42,9	75,0	60,0	100,0	-	14,3	77,8	69,2	63,1
Damages on houses	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	1	7	9	13	150
	N positive answers	2	4	4	7	3	6	8	3	11	5	4	0	3	2	0	2	2	5	71
	% positive answers	28,6	50,0	57,1	63,6	30,0	75,0	57,1	37,5	84,6	45,5	57,1	0,0	60,0	28,6	0,0	28,6	22,2	38,5	47,3
Damages on furnitures	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	0	7	9	13	149
	N positive answers	3	1	2	2	1	3	3	2	0	0	1	1	1	4	-	2	2	1	29
	% positive answers	42,9	12,5	28,6	18,2	10,0	37,5	21,4	25,0	0,0	0,0	14,3	25,0	20,0	57,1	-	28,6	22,2	7,7	19,5
Damages on clothes	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	0	7	9	13	149
	N positive answers	1	2	1	2	4	1	2	0	3	1	0	0	1	2	-	2	2	1	25
	% positive answers	14,3	25,0	14,3	18,2	40,0	12,5	14,3	0,0	23,1	9,1	0,0	0,0	20,0	28,6	-	28,6	22,2	7,7	16,8
Fear, disturbance and noise	N exploitable answers	7	8	7	12	10	8	14	9	13	11	7	4	5	7	8	11	9	18	168
	N positive answers	2	0	0	0	0	0	2	3	1	1	2	0	0	0	0	2	1	1	15
	% positive answers	28,6	0,0	0,0	0,0	0,0	0,0	14,3	33,3	7,7	9,1	28,6	0,0	0,0	0,0	0,0	18,2	11,1	5,6	8,9
Rubbish and dirt	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	1	7	9	13	150
	N positive answers	1	0	2	1	1	0	0	0	0	1	0	0	1	0	0	0	1	0	8
	% positive answers	14,29	0,0	28,6	9,1	10,0	0,0	0,0	0,0	0,0	9,1	0,0	0,0	20,0	0,0	0,0	0,0	11,1	0,0	5,3
Bites	N exploitable answers	7	8	7	12	10	8	14	9	13	11	7	4	5	7	8	11	9	18	168
	N positive answers	1	0	1	0	1	0	0	0	1	2	0	1	1	0	0	0	1	0	9
	% positive answers	0,1	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,1	0,2	0,0	0,3	0,2	0,0	0,0	0,0	0,1	0,0	5,4
Others	N exploitable answers	7	8	7	11	10	8	14	8	13	11	7	4	5	7	0	7	9	13	149
	N positive answers	0	2	0	0	3	0	1	0	0	0	1	0	1	1	-	0	2	4	15
	% positive answers	0,0	25,0	0,0	0,0	30,0	0,0	7,1	0,0	0,0	0,0	14,3	0,0	20,0	14,3	-	0,0	22,2	30,8	10,1

(*Mastomys*; Lecompte et al. 2005) and/or genotyping using previously developed microsatellite markers (*Mastomys*: see Brouat et al. 2007; *Rattus*: see Konecny et al. 2012).

Since interviews were performed exclusively in all rodent trapping sites, our experimental design for interviews was dictated by the rules of sampling as they stand in population biology (sample size, data independence and representativity, etc.; see Legendre and Legendre 1998). As a consequence, interviews were systematically conducted in the same 170 sites immediately after the trapping cessions. In each site, questions were directly asked using local languages (djerma and hausa) to one person assumed to be able to provide accurate information (usually a family chief or, in some instances, his first wife or older son). Two questions were relevant to the present study. The first one was a 'closed' question (i.e. expected answers were 'yes' or 'no') about the presence of problems linked with rodents within the concession. The second question was 'open' (i.e., free answers with no suggestion being given) and concerned the type of problems encountered, if any. Once answers for all the 170 questionnaires were gathered, those that were explicit and unambiguous were classified into 8 clearly *a posteriori* identified categories: (i) damages on food stocks, (ii) damages on houses (e.g., holes in walls), (iii) damages on furniture, (iv) damages on clothes, (v) fear, disturbance and noise, (vi) rubbish and dirt, (vii) bites and (viii) others (e.g., nibbling on soap, theft of money and jewels, etc.). Ambiguous or non explicit answers were considered as non exploitable, thus resulting in differences in the number of exploitable answers per categories. As an example, if an answer was restricted to "problems inside the house", we were not able to score the precise type of damages (categories i, ii, iii, iv, v, vi and viii scored as "?", i.e. non exploitable), but we could still consider the absence of bites (category vii scored as "yes"). Among exploitable answers, presence (yes)/absence (no) of each category of answers was scored for each site. Altogether, these data allowed us to provide a percentage of sites per district where each type of damage was perceived.

Multiple Khi2 tests (Sokal and Rohlf 1995) were performed to assess potential non random associations between districts and the number of positive answers about rodent-associated troubles, as well as between districts and each major type of rodent-associated troubles (namely, damages on stocks, houses, furniture and clothes; see Results).

Results

As already said above, analysis of trapping results as well as proper investigations about commensal rodent communities and their spatial distribution within Niamey are beyond the scope of the present paper, and will be fully detailed elsewhere (see Garba 2012 for details). Nevertheless, important to the present study, one should keep in mind that trapping was successful in 125 out of 170 sites (73.5 %), and that rodents were found to be widespread and numerous in all investigated districts (see Garba 2012). In total, 557 individual rodents were captured, comprising 465 *Mastomys natalensis*, 62 *Mus musculus* and 30 *Rattus rattus*, reaching an overall trapping success rate of 7.5 %. Thus, *Mastomys natalensis* was by far the most widespread domestic rodent and was found in many sites of all but one localities investigated here (namely, BAF-2, BOU, CYA, CGA, DAR, GAM, GNA, KAR, KOT, KOU, LMO, PKE, ROF, TCH, WAD, YAB and YAH; see Fig. 1), while house mice and black rats were found only in one (GRM) and three (CYA, CGA and GRM) districts, respectively (Fig. 1; Garba 2012).

All 170 interviewed persons provided answers about rodent-associated troubles in the trapping site they were questioned about, with 164 (96.5 %) of them being clearly affirmative about the existence of such problems. Most of them ($N \geq 149$ of exploitable answers;

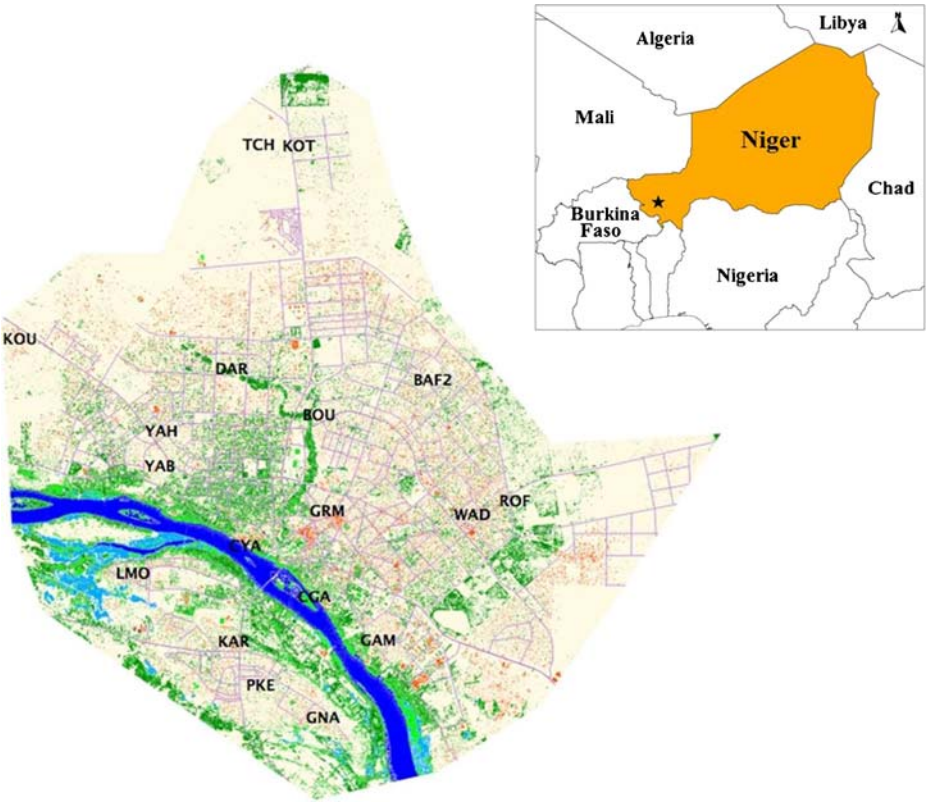

Fig. 1 Distribution map of the 18 districts of Niamey where rodent trapping and questionnaires were concomitantly performed. Acronyms refer to as: LMO for Lamordé, BOU for Boukoki, KOT for Koira Tégui, KOU for Koubia, BAF-2 for Banifandou II, DAR for Dar Es Salam, CYA for Corniche Yantala, CGA for Corniche Gamkalleye, GNA for Gnalga, GRM for Grand Marché, ROF for Route Filingué, WAD for Wadata, YAH for Yantala Haut, YAB for Yantala Bas, PKE for Pont Kennedy and KAR for Karadjié. Map background correspond to a GIS developed from a Spot satellite image (CNES, 2008©; see Acknowledgments). The insert shows the location of Niger within West Africa; Niamey is symbolized by a star

Table 1) mentioned nuisances that could be unambiguously classified into 8 distinct *a posteriori* defined categories. The compilation of all answers from the whole city (see Table 1 for details per district) shows that damages on food and stocks are the most cited ones (94 of 149 exploitable answers, i.e. 63.1 %, of the interviewed persons), followed by damages on houses (71 of 150, i.e. 47.3 %), furniture (29 of 149, i.e. 19.5 %) and clothes (25 of 149, i.e. 16.8 %). Less frequently do interviews reveal feelings of disturbance (fear, noise; 15 of 168, i.e. 8.9 %) or repulsion due to dirtiness (8 of 150, i.e. 5.3 %). Interestingly, some cases of bites were formally reported (9 of 168, i.e. 5.4 %). Finally, a number of answers could not be classified into any of the seven categories (15 of 149, i.e. 10.1 %; see "others" in Table 1).

Multiple Khi2 tests showed no significant association either between districts and the mentions of rodent-associated problems as a whole (df=17, χ^2=9.1), or between districts and mentions of damages on houses (df=17, χ^2=24), clothes (df=16, χ^2=11.6) and furniture (df=16, χ^2=19.4). On the contrary, the test showed a significant association between districts and damages on food stocks (df=16, χ^2=37.9). However, in the latter

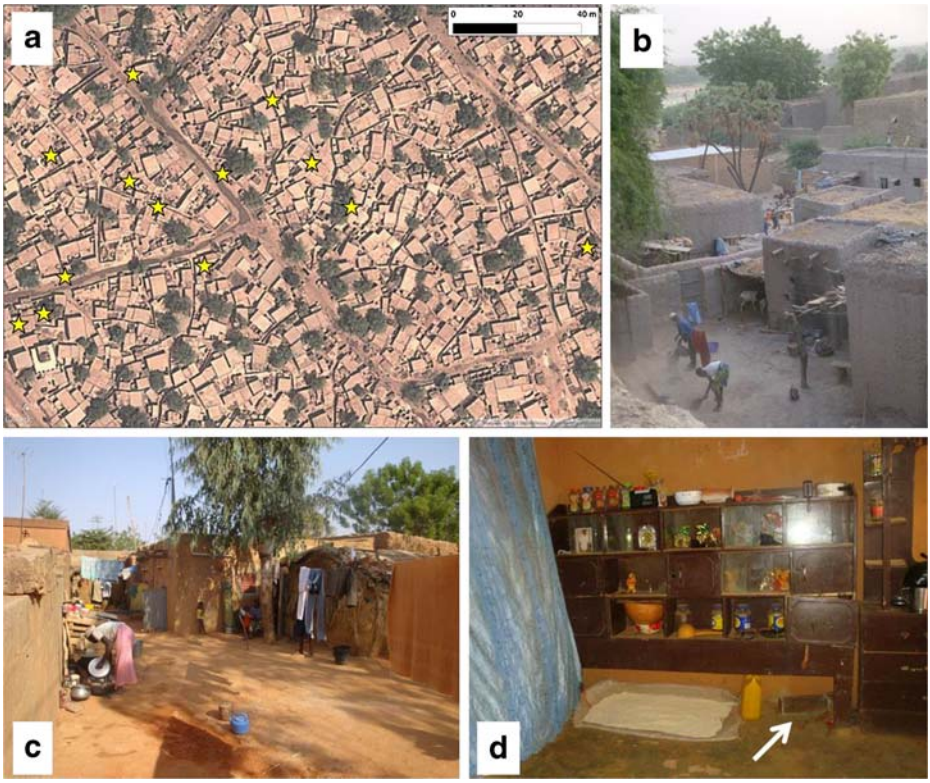

Fig. 2 Pictures illustrating various aspects of the urban landscape investigated in the present study (see also the description of our rodent-trapping protocol for details): (**a**) distribution map of the 13 trapping sites (*yellow stars*) within the Gamkalleye (GAM) district with a Google Earth image as a background; (**b**) pictures of a group of 'concessions' (see text) from the Corniche Yantala (CYA) district; (**c**) picture of inside a typical 'concession' from Yantala Haut (YAH) district); (**d**) picture of inside a room showing a trap (*arrow*)

case, answers obtained in one district strongly deviate from others: in CGA, none of the 8 interviewed persons did mention attacks on food stocks (Table 1). If this particular district is removed from the analysis, association between districts and mentions of damages on food stocks is not significant (df=15, χ^2=24.5).

Discussion

Surveys on local perception of rodent-associated problems in Africa are scarce (e.g., Diarra 2002; Makundi et al. 2005; Yonas et al. 2010). Olaseha and colleagues (1994) reported surveys conducted in both rural and urban areas in Nigeria; they did not, however, distinguish between the two zones, thus making unclear which of the data explicitly correspond to the investigations performed in cities. Thus, the study presented here is, to our knowledge, the first one focusing specifically on an urban context. We did not directly assess rodent-induced damages, thus precluding any reliable quantitative conclusions about their real socio-economic impact. Nevertheless, the interviews are all congruent in showing that rodents do represent an important source of nuisance for inhabitants of the capital city of

Niger: at least 85 % of them complain in each district, with 12 of 18 districts reaching 100 % for a global rate of 96.5 % all over the city (Table 1). Though indirect, these results confidently indicate that rodents are important and widespread urban pests in Niamey.

Clear trends also appear when looking at the types of nuisance that are quoted by interviewed people. First, we were able to attribute *a posteriori* most answers to seven well-defined categories (damages on food and stocks, houses, furniture, clothes, disturbance, dirtiness and bites), with a relatively low rate of non-exploitable answers and only 10 % of the answers being atypical (hence classified as "others"; see Table 1). Since interviews were all independently conducted, this suggests that rodent-induced problems are recurrent and similar among sites and districts throughout Niamey. Such results also suggest that our interviews are reliable since they provide repeatable answers, hence representing potentially reliable indicator of nuisances by themselves. Nevertheless, caution is needed and two major caveats of such indicators should be considered. First, we lack repeated interviews through time. Second, our data are only qualitative and would be greatly improved by the addition of a proper quantification of rodent impacts. Indeed, people may quote a particular type of damages that actually occurs everyday or, alternatively, occurred only once and/or a long time ago. These cases are obviously very different in terms of impact, and therefore in terms of rodent populations management. Potential improvements to counteract these caveats may include diachronic surveys and/or questions more specific to the frequencies and/or the last dates of a particular problem once the latter has been spontaneously cited.

Anyway, we propose that questionnaire-based surveys such as ours, which are relatively cheap and easy to perform, may be an important step for providing guidelines for further targeted (in both time and space) qualitative studies.

In one district, CGA, no damage on food and food stocks was reported (Table 1). This atypical case may be due to the local inhabitants' community: it is essentially made of fishermen families who live along the Niger riverside (Fig. 1) and who may not afford and/or are not used to accumulate important quantities of food. In great contrast, in all other districts, damages on food and/or food stocks were the most important type of rodent-induced nuisances reported by inhabitants. This is in good agreement with other studies showing that rodents are important enemies of crops (see references above), and explains why they are perceived accordingly by traditional farmers (e.g. Sang et al. 2003), sometimes far beyond insects (e.g. Phu Tuan et al. 2003; Makundi et al. 2005; Yonas et al. 2010). In the Sahel, investigations were conducted in two different regions of Senegal: 58 % and 46 % of farms displayed signs of rodents attacks, thus suggesting that rodents represent major domestic and agricultural pests in rural areas (Duplantier and Handschumacher, unpublished results quoted by Granjon and Duplantier 2009). In the two Nigerian villages Igbo-Ora and Idere, 73 % of inhabitants complained about rodent-induced damages on foodstuffs (Olaseha et al. 1994). Altogether, these results point towards a major role of pest rodents as an important yet often neglected threat to human food security not only in rural, but also in urban areas of Sudano-Sahelian regions.

Another striking result of our survey in Niamey is the widespread and frequent reports of some less expected categories of damages. For instance, almost half of the interviewed persons (47.3 %) report damages on their houses which usually corresponded to holes at the bottom of the walls. Niger is considered as one of the poorest countries in the World (Human Development Index 2012: 186 out of 186; see http://hdr.undp.org/en/statistics/) and most habitations are traditionally made. Niamey is no exception and encompasses many informal households. As an illustration, 1,220 buildings were inventoried among the 170 concessions investigated here, and 742 of them (60.8 %) were made of 'banco' (a mixture of clayey-sandy mud, straw and animals faeces) or consisted of huts (Garba 2012). Rodents easily dig

holes through such materials, thus quickly reaching the sandy soil where they can nest. During the short rainy season, violent storms and subsequent short but significant flooding occur; rodent holes favour water infiltration, as explicitly testified by several persons. Similar testimonies were also associated with increases in the Niger River level in the riverside districts (GAM, KAR, CYA and CGA; Fig. 1). Once again, these interviews-based trends are in line with the results retrieved in two rural areas of Senegal where rodent-induced damages were observed in 70–80 % of the investigated houses (Duplantier and Handschumacher, quoted by Granjon and Duplantier 2009).

Two rather unexpected problems associated with rodents were damages on furniture (19.5 %) and clothes (16.8 %). Furniture made of painted wood are relatively rare within houses, and are considered precious since they are usually expensive and bought by parents for their daughters when they get married. Similarly, clothes have an important symbolic value since they are essentially worn for traditional ceremonies (baptisms, weddings, religious celebrations, etc.). In several instances, rodent nesting and even litters were reported within clothes storage spaces, something that clearly seemed to shock people. For those reasons, we believe that these quite high percentages are misleading in that they may reveal infrequent but marking events, rather than a proper quantitative picture of such rodent attacks. Nevertheless, these damages remain to be further investigated and quantified since similar when not higher values were obtained in Senegalese (25 %–44 % and 13–20 % of houses showed attacks on clothes and furniture, respectively; Duplantier and Handschumacher, quoted by Granjon and Duplantier 2009) as well as Nigerian (20 % of inhabitants signalled attacks on clothes; Olaseha et al. 1994) villages.

Finally, 9 rather isolated cases of bites (5.4 %) were mentioned from 8 different districts (Table 1). This is slightly higher than what was obtained in rural areas of Senegal (2 % to 3.5 %; Duplantier and Handschumacher quoted by Granjon and Duplantier 2009). In most instances, people spontaneously specified that bites occurred at night on tips or toes. Although rodent bites are most probably rarely imply in pathogen transmission to human, except maybe following secondary infection (Granjon and Duplantier 2009), the obviously widespread and very frequent contacts between rodents and humans in Niamey raises the question about consequences for public health. Indeed, rodents constitute reservoirs for a wide range of human pathogens (reviews in Gratz 1997; Meerburg et al. 2009a) and commensalism is expected to increase transmission risks (Mills and Childs 1998). This is particularly true in cities like Niamey where domestic animals (bovids and ovids, poultries, dogs, cats, etc.) live in very close promiscuity with human beings (out of the 170 concessions investigated here, 15.8 %, 28.8 % and 64.7 % of them sheltered poultries, ovids+caprids and bovids, respectively; Garba 2012). Interestingly, in absolutely no instance did we hear about medical or sanitary aspects during the 170 interviews performed in the framework of the present study. In other words, another major result of our survey is that Niamey inhabitants never associate rodents with potential risks for health. Although low knowledge about rodent-borne pathogens was also observed in a traditional district of Ibadan, Nigeria (15 %; Olaseha et al. 1994), this is in strike contrast with what was retrieved from a similar survey conducted in Manchester City, United Kingdom, where more than 96 % of the interviewed people associated mice, rats and diseases (Marshall and Murphy 2003), or from Djoliba, Mali, where only 40 % of the interviewed people ignored that diseases may be transmitted by rodents to human beings and animals (Diarra 2002). Yet, several human pathologies involving rodents as reservoirs were described in Niger, such as leishmaniases (Laporte et al. 1988; Gaultier et al. 1989; Develoux et al. 1992; SNIS 2010), brucellosis (Gidel et al. 1974), toxoplasmosis (e.g., Julvez et al. 1996) or rickettsiale diseases (Julvez et al. 1997), and many others most probably remain overlooked due to the lack of

appropriate studies and diagnostic medical facilities (e.g., Dobigny et al. 2011). Epidemiological investigations in urban and peri-urban rodent communities are currently on progress (e.g., Mercier et al. 2013), and may reveal the existence of rodent-borne human pathogens that were never recorded in Niger to date. If this was to be the case, popularization campaigns should play an important role in making local people aware of potential sanitary risks associated with rodents, especially in large cities like Niamey where human-rodents interactions are expected to be high.

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Conflict of interest The authors declare that they have no conflict of interest.

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