

The Mammals of Adrar des Iforas (Mali), with special emphasis on small mammals

Systematic and Biogeographical Implications

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■ Introduction

The Adrar des Iforas (or Adagh des Ifoghas) Massif covers about 150.000 km² in Northern Mali (fig. 1). Like for most of the other Central Saharan massifs, data concerning its fauna are very sparse, and on the whole quite poor. AG SIDIYÈNE and TRANIER (1990) put forward a history and gave an up to date list of mammals known in the area. Unfortunately, information collected on small mammals remained very fragmentary. In order to complete the inventory initiated by these authors, we went to the Adrar des Iforas in February-March 1999 with the aim of focusing our efforts on small mammal collection and identification.

We here present a commented list of the mammalian fauna we met, with special emphasis on small mammals (mainly Rodentia and Insectivora) which species are still poorly known in Northern Mali. The different taxa were identified on a morphological basis when-

ever it was possible unambiguously. As for Rodents however, and because sibling species are frequent in West African genera (e.g. *Arvicanthis*: VOLOBOUEV *et al.*, 1987, 1988; *Gerbillus*: LAY, 1983; TRANIER and JULIEN-LAFERRIÈRE, 1988), chromosomal analyses were performed in order to characterise without any ambiguity some of the specimens collected.

These findings led to the addition of new species for the Adrar des Iforas and the finding of new chromosomal forms in the genera studied. Then, the analysis of the updated mammalian fauna of this massif allows us to propose a biogeographical scenario in order to explain the coexistence there of Saharan and typically Sahelian species.

■ Material and methods

Because of the extent of the Adrar des Iforas area, and of the difficulty to move along, we did not inventory the whole massif. We focused on the Western part of it, from south of Kidal ($18^{\circ}26'N/1^{\circ}24'E$) up to the latitude of Aguelhok ($19^{\circ}28'N/0^{\circ}51'E$) (fig. 1). We sampled different types of habitats, namely fallen granite rocks and caves in the Edjerir ($18^{\circ}12'N/1^{\circ}24'E$) and Humoum (Adrar Timejelalin, $18^{\circ}58'N/1^{\circ}02'E$) valleys and in Adrar Ichoualen ($19^{\circ}07'N/1^{\circ}12'E$), sandy depressions in the valleys of Edjerir, Ibdeken ($18^{\circ}45'N/1^{\circ}20'E$) and Ouertejach (Adrar Tirharhar, around $19^{\circ}30'N/1^{\circ}16E$), sandy wadis in Tararabat (Adrar Ichoualen, $19^{\circ}24'N/1^{\circ}14'E$), and anthropised areas like gardens (dates, tomatoes), grain stores (corn powder) and straw huts in Tararabat and in the city of Kidal.

The inventory was based on the analysis of raptors pellet and nest remains, on trapping results (wire mesh traps, Sherman traps, and hand captures), but also on direct (night drives or walks, stalking) and indirect observations (spoons, faeces and skeletons), often confirmed by discussions with nomad Tuaregs living in the area.

Karyotypes were obtained from fibroblast cell cultures established from biopsies made on animals brought back to the laboratory. Cells were maintained in metaphase with colchicine at 0.4% one hour before harvest. Cellular membranes were burst by a hypotonical solution

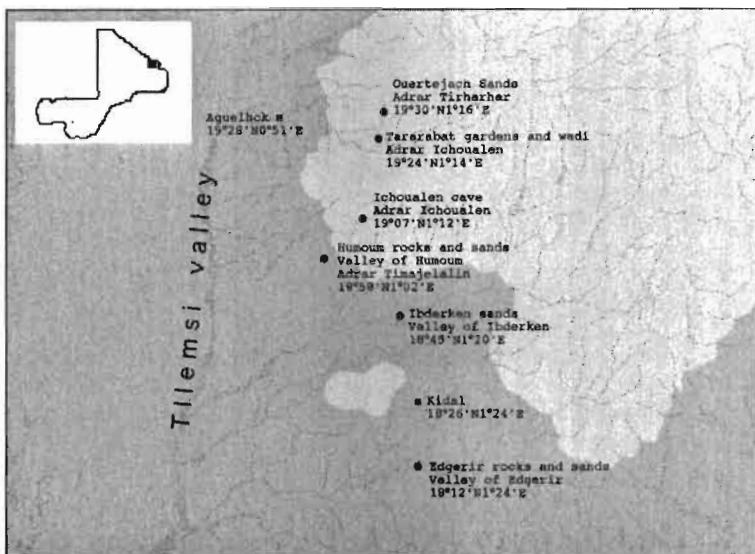


Figure 1
Map of the different trapping localities, in the Adrar des Iforas.

containing bidistilled water, KCl (0.075/M) and new-born calf serum (proportions 5:6:1), then the cells were fixed (methanol and acetic acid, 3:1) and stained with standard Giemsa. On a few occasions, femoral bone marrow cells were used for karyotyping, the hypotonical solution being then composed only of KCl (0.075/M). Diploid numbers ($2n$) and autosomal fundamental numbers (NF_a) could be determined.

Results

Chiroptera

A living specimen of *Rhinopoma* was captured by hand in the cave of Ichoualen. Furthermore, some skulls of *R. hardwickei* and *Asellia tridens* (TAYLOR, pers. comm.) were found in rejection pellets from fallen granite rocks in the Edjerir valley. The former species has never been mentioned before in the Adrar des Iforas, nor in Mali, but was

Presumed species	TRL (mm)	CH (mm)
<i>C. cf. somalica</i> (n = 6)	7.38 – 8.24 7.89 ± 0.36	4.85 – 5.32 5.06 ± 0.19
<i>C. cf. lusitania</i> (n = 3)	5.87 – 6.17 5.99 ± 0.16	3.81 – 3.9 3.84 ± 0.05
<i>C. cf. pascha</i> (n = 10)	4.32 – 4.92 4.75 ± 0.17	2.44 – 2.88 2.7 ± 0.12

Table 1

Measurements of mandibles of *Crocidura* found in nest remains. TRL and CH are respectively for Tooth Row Length and Coronoid Height. The range observed (first line), the mean (in bold) and the standard deviation for each presumed species and each measure are given.

known at the same latitude, from Mauritania and Niger (POULET, 1970; review in LE BERRE, 1990). *Asellia tridens* has already been reported by AG SIDIYÈNE and TRANIER (1990) and was known from Senegal and Chad (KOOPMAN, 1993).

Insectivora

Many tracks of hedgehogs were followed, but no specimen could be observed directly. So, it is impossible to precise the number and identity of the species inhabiting the area. The only indications may be derived from the comparison with the neighbouring Aïr massif in Niger, where *Atelerix albiventris* and *Hemiechinus aethiopicus* have been described (LE BERRE, 1990). The latter species is also known from Mauritania (GRANJON *et al.* 1997). Further prospections will be necessary to confirm the systematic status of the hedgehogs from the Adrar des Iforas.

Around one hundred rejection pellets of a nocturnal raptor, most probably the barn owl *Tyto alba*, were found in granite rocks of the Edjerir valley. Moreover, the cave soil was covered with nest remains, in which at least 13 different mammal taxa were recovered, among which dozens of skulls and mandibles belonging to 3 species of *Crocidura* (HUTTERER, pers. comm.). Using mandible measurements (tabl. 1), 3 groups could be distinguished, and may be referred to *C. somalica*, *C. lusitania* and *C. pasha* (HUTTERER, pers. comm.). *Crocidura lusitania* and *C. somalica* have already been trapped and described in

the Adrar des Iforas (AG SIDIYÈNE, 1989; HUTTERER *et al.*, 1992, respectively). Nevertheless, the specimens of *C. lusitania* are rather small, and may represent a local form (HUTTERER, pers. comm.). On the other hand, *C. pasha* represents a new record for Mali and for West Africa (HUTTERER, pers. comm.), being only known from Sudan and Ethiopia to date (HUTTERER, 1993).

It is interesting to notice the absence of *Crocidura* in our trapping results or night observations, which contrasts with their abundance in pellets and nest remains where they seem to constitute a major part of the raptor preys. This underlines the interest of that kind of material for faunistic inventory purposes.

Lagomorpha

Many hares were seen at night, and some during the day, in many places. But these observations were too transient for a precise identification. It may be *Lepus capensis*, as roughly proposed in a large-scale distribution map in LE BERRE (1990), but no reliable data are available about Lagomorpha in Northern Mali yet.

Rodentia

This Order has the most important specific diversity, as thirteen species belonging to five different families were identified. Captures (by traps and/or hands) allow us to confirm the presence of *Massoutiera mzabi* (Ctenodactylidae), *Jaculus jaculus* (Dipodidae) and to give the first mention of *Desmodilliscus braueri* (Muridae, Gerbillinae) which Heim de Balsac found in rejection pellets from west of the Tilemsi (cf. fig. 1) and which is here at the Northern edge of its distribution area (see AG SIDIYÈNE and TRANIER, 1990).

Direct observations were performed of *Xerus erythropus* (Sciuridae), thus supporting the findings of AG SIDIYÈNE (1989) and AG SIDIYÈNE and TRANIER (1990). This paleotropical species seems to survive in different Saharan massifs, and has even a relictual population in Morocco (HOFFMAN *et al.*, 1993; review in LE BERRE, 1990). Quills and tracks of *Hystrix cristata* (Hyracidae) were found, as expected given the fact that porcupines are present in the Mauritanian Adrar, in Aïr and in Maghreb up to Asia Minor and Southern Europe (WOODS, 1993; review in LE BERRE, 1990).

Chromosomal analyses enabled us to specifically determine non-ambiguously most of the specimens of *Gerbillus* (Muridae, Gerbillinae) captured in the different sites. All of them are new mentions for this region: *G. campestris* (Edjerir; n = 2; 2n = 56; NFa = 68), *G. nanus* (Edjerir, Tararabat and Ouertijach; n = 4; 2n = 52; NFa = 58), *G. tarabuli* (Edjerir; n = 2; 2n = 40; NFa = 74) and *Gerbillus* sp. (Ouertijach; Tararabat; n = 3; 2n = 38, NFa = 72, which may correspond to *Gerbillus pyramidum* known in Egypt and Sudan (GRANJON *et al.*, 1999). On the other hand, karyotype studies also allow us to confirm that the unstriped grass rats captured were referable to *Arvicanthis niloticus* (Muridae, Murinae) (Edjerir and Tararabat; n = 5; 2n = 62; NFa = 62), as suspected by AG SIDIYÈNE (1989), and that the spiny mice were tentatively referable to *Acomys* cf. *airensis* (Muridae, Acomyinae) (Edjerir; n = 2; 2N = 44 and 46; NFa = 66). Finally, the capture of *Myomys daltoni* (Muridae, Murinae) (Kidal; n = 1; 2n = 36) in the city of Kidal represents the northernmost mention for the genus and the species on the African continent. All these cytogenetical results and their systematic implications are detailed elsewhere (DOBIGNY *et al.*, 2001).

The analysis of raptor nest remains and rejection pellets confirmed the occurrence of *Desmodilliscus braueri*, *Jaculus jaculus*, *Arvicanthis niloticus*, and added *Mus* (subgenus *Nannomys*) sp. (DENYS, pers. comm.), as a first mention in the Adrar des Iforas. The systematics of this subgenus needs thorough revision (MUSSER and CARLETON, 1993), nevertheless its presence in the Adrar des Iforas constitutes the northernmost point of its currently known distribution.

From an ecological point of view, some interesting observations were realised. Indeed, the captures of *Arvicanthis niloticus*, *Acomys* cf. *airensis* and *Myomys daltoni*, and also *Gerbillus* cf. *pyramidum* and *G. nanus* in gardens, store houses and straw huts in the valley of wadi Tararabat or in Kidal city (*Myomys*) show that these species can dwell near human settlements. Some direct observations in stores and discussions with tuaregs indicate that they can even become a real pest for stored foodstuff. On the other hand, all these species, except *Myomys daltoni*, have also been trapped or observed in other valleys (Humoum, Edjerir, Ouertejach, Ibdeken) where human influence is very weak.

Moreover, we could notice several cases of sympatry, as in the Edjerir valley where *G. nanus* and *G. tarabuli* are coexisting in bushy and

sandy beds. The same was observed in stores and gardens in Tararabat where *G. nanus* and *G. cf pyramidum* were caught in the same trap lines. It would be interesting to conduct further ecological studies to understand the way these species live together and share the available resources.

■ Discussion

Of course, this inventory may not be exhaustive, first because the Adrar des Iforas is a large massif, some habitats of which we did not study, second, because some species may have been missed by us. For example, AG SIDIYÈNE and TRANIER (1990) found a specimen of *Gerbillus gerbillus*, a species we did not record during our own study. However, the techniques used to survey this small mammal community (rejection pellets and raptor nest remains, hand captures, trapping, direct or indirect observations and chromosomal analyses) appear complementary (tabl. 2).

Data about the fauna of Central Saharan massifs are rather sparse, especially concerning small mammals. Among these massifs, the Adrar des Iforas one has been one of the least studied by scientists during this century. Consequently, many of the observations reported here represent first mentions for the region (Chiroptera: *Rhinopoma hardwickei*; Insectivora: *Crocidura pasha*; Rodentia: 4 species of the genus *Gerbillus*, *Myomys daltoni*, *Acomys airesensis*, *Desmodillus braueri*, *Mus (Nannomys)* sp.). From there, it is possible to update the list of mammal species recorded in the Adrar des Iforas during the last century (see Appendix). Many of these taxa, especially the medium-sized and larger ones, have become extinct during the last decades, mainly because of the advance of the desert, human pressure, and the appearance of fire arms and vehicles which have intensified hunting pressure (AG SIDIYÈNE and TRANIER, 1990). Part of the remaining mammalian fauna of this region of Mali seems to be really endangered and, without any accurate protection, many species may disappear before being really known.

From the species list compiled here (see Appendix), one can distinguish two faunas, according to their biogeographical origin. The first

Species	Chromosomal Analysis	Rejection pellets, nest remains	Trapping (wire mesh and sherman traps)	Hand captures	Direct observations	Indirect observations (tracks, faeces, skeletons, quills, etc.)
<i>Acomys airensis</i>	+	?	?			
<i>Arvicanthis niloticus</i>	+	?	?		?	
<i>Myomys daltoni</i>	+		+			
<i>Nannomys</i> sp.		+	?			
<i>Gerbillus</i> sp.	+	?	?		?	?
<i>G. campestris</i>	+	?	?	+	+	?
<i>G. nanus</i>	+	?	?		?	?
<i>G. tarabuli</i>	+	?	?		?	?
<i>Desmodillus</i> <i>braueri</i>		+		+	+	
<i>Jaculus jaculus</i>		+		+	+	+
<i>Massoutiera mzabi</i>			+			
<i>Euxerus erythropus</i>					+	
<i>Hystrix cristata</i>						+
<i>Lepus</i> sp.					+	+
<i>Crocidura lusitania</i>		+				
<i>C. pasha</i>		+				
<i>C. somalica</i>		+				
<i>Asellia tridens</i>		+		+	+	
<i>Rhinopoma hardwickii</i>		+		+	+	

Table 2

Means of inventory for each small mammal species encountered.
"?" means that the determination only by this mean is ambiguous.

one is composed of Saharan or Saharo-Sahelian species, like the Trident Leaf-nosed bat *Asellia tridens*, gerbils (genus *Gerbillus*), the jerboa (*Jaculus jaculus*) or the gundi (*Massoutiera mzabi*). The second one groups typically Sahelian to Sudano-Sahelian species like *Arvicanthis niloticus*, *Myomys daltoni*, *Desmodillus braueri*, *Taterillus* sp. (AG SIDIYÈNE, unpubl. data, specimen n°1991-1033 in MNHN, Paris), *Hystrix cristata* or *Xerus erythropus*. This is confirmed when looking at medium-sized and larger mammals, with e.g.

Erythrocebus patas and *Mellivora capensis* on the one hand, *Gazella dorcas*, *Ammotragus lervia*, *Vulpes zerda* on the other hand (AG SIDIYÈNE and TRANIER, 1990; KINGDON, 1997; this study). Similarly, bird (S. MOULIN, unpubl. data) and plant species (AG SIDIYÈNE, 1996) show the same trend.

At the end, some of the taxa encountered showed great adaptive capacities and to be very opportunistic. In particular, commensalism may be an especially efficient survival strategy in this harsh environment. From a general point of view, our observations lead to the conclusion that the Adrar des Iforas massif constitutes a Sahelian refuge in the middle of the Sahara desert. Its rather high altitude reaching 850 metres may have contributed to make it a real climatic and ecological island during the last Southward progression of the desert which started around 6.000 bp. That would explain the cohabitation between desert species and Sudano-Sahelian ones (AG SIDIYÈNE and TRANIER, 1990): the Malian Adrar could have been colonised by the latter for example during the last interglacial episode (around 9.000 bp). It would then have acted as an “ecological trap” during the last Southward progression of the Sahara. This kind of pattern has already been emphasized about the fauna of the neighbouring Aïr massif in Niger (POILECOT, 1996), another Saharan massif belonging to the same geological complex. Molecular analyses would be of great interest for evaluating the genetic divergence between individuals from the Adrar des Iforas and conspecifics from Sahel, and then for dating the different events of colonisation. On that basis, and as it may be the same pattern in the other Saharan massifs (e.g. Aïr, POILECOT, 1996), biogeographical studies should allow to propose a global scenario for the history of Central Sahara faunas.

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Appendix

Review of the species of mammals from Adrar des Iforas (for the last century).

Species	Status	References
<i>Hippotragus equinus</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Damaliscus lunatus</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Giraffa camelopardalis</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Alcelaphus buselaphus</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Gazella dorcas</i>	Endangered	Ag Sidiyène and Tranier 1990 Le Berre 1990 This study
<i>Gazella rufifrons</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Gazella dama</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Addax nasomaculatus</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Ammotragus lervia</i>	Endangered	Ag Sidiyène and Tranier 1990 Le Berre 1990 This study
<i>Oryx dammah</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Phacochoerus aethiopicus</i>	Extinct	Chudeau 1920 Ag Sidiyène and Tranier 1990
<i>Orycteropus afer</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Erythrocebus patas</i>	Endangered	Ag Sidiyène and Tranier 1990 This study
<i>Panthera leo</i>	Extinct	Chudeau 1920 Ag Sidiyène and Tranier 1990
<i>Panthera pardus</i>	Extinct	Ag Sidiyène and Tranier 1990
<i>Lycaon pictus</i>	Extinct	Sayer 1977 Ag Sidiyène and Tranier 1990
<i>Vulpes zerda</i>	Insufficiently known	Ag Sidiyène and Tranier 1990 This study Le Berre 1990
<i>Vulpes pallida</i>	Insufficiently known	Ag Sidiyène and Tranier 1990 This study
<i>Vulpes rueppelli</i>	Presence suspected	Ag Sidiyène and Tranier 1990
<i>Canis aureus</i>	Insufficiently known	Ag Sidiyène and Tranier 1990 This study Le Berre 1990

Species	Status	References
<i>Canis adustus</i>	Insufficiently known	Ag Sidiyène and Tranier 1990
<i>Hyaena hyaena</i>	Insufficiently known	Blanguernon 1955 (In Le Berre 1990) Ag Sidiyène and Tranier 1990 This study
<i>Crocuta crocuta</i>	Extinct	Chudeau 1920 Ag Sidiyène and Tranier 1990
<i>Acinonyx jubatus</i>	Endangered	Sayer 1977 Ag Sidiyène and Tranier 1990
<i>Felis sylvestris libyca</i>	Insufficiently known	Ag Sidiyène and Tranier 1990
<i>Caracal caracal</i>	Endangered	Ag Sidiyène and Tranier 1990
<i>Felis serval</i>	Insufficiently known	Ag Sidiyène and Tranier 1990
<i>Ictonyx striatus</i>	Presence suspected	Ag Sidiyène and Tranier 1990
<i>Poecilictis libyca</i>	Presence suspected	Le Berre 1990 Ag Sidiyène and Tranier 1990
<i>Mellivora capensis</i>	Abundant	Happold 1984 (In Le Berre 1990) Ag Sidiyène and Tranier 1990 This study
<i>Procavia capensis</i>	Insufficiently known	Seurat 1934
<i>Rhinopoma hardwickei</i>	Insufficiently known	This study
<i>Nycteris thebaica</i>	Insufficiently known	Ag Sidiyène and Tranier 1990
<i>Asellia tridens</i>	Insufficiently known	Ag Sidiyène and Tranier 1990 This study
<i>Nycticeius schlieffenii</i>	Insufficiently known	Ag Sidiyène and Tranier 1990
<i>Crocidura lusitanica</i>	Insufficiently known	Ag Sidiyène 1989 Ag Sidiyène and Tranier 1990 This study
<i>Crocidura somalica</i>	Insufficiently known	Hutterer <i>et al.</i> 1992 This study
<i>Crocidura pasha</i>	Insufficiently known	This study
Hedgehog (undetermined)	Insufficiently known	This study
<i>Arvicanthis niloticus</i>	Abundant	Ag Sidiyène 1989 This study
<i>Myomys daltoni</i>	Insufficiently known	This study
<i>Acomys airensis</i>	Abundant	This study
<i>Mus nannomys</i> sp.	Insufficiently known	This study
<i>Gerbillus gerbillus</i>	Insufficiently known	Petter 1961 Ag Sidiyène and Tranier 1990

Species	Status	References
<i>Gerbillus campestris</i>	Abundant	Petter 1961 This study
<i>Gerbillus nanus</i>	Abundant	Petter 1961 This study
<i>Gerbillus tarabuli</i>	Abundant	This study
<i>Gerbillus</i> sp.(cf. <i>pyramidum</i> ?)	Abundant	(Petter 1961?) (Ag Sidiyène and Tranier 1990?) This study
<i>Desmodilliscus braueri</i>	Insufficiently known	This study
<i>Taterillus</i> sp.	Presence suspected	Ag Sidiyène unpublished
<i>Psammomys obesus</i>	Presence suspected	Petter 1961
<i>Pachyuromys duprasi</i>	Presence suspected	Ag Sidiyène and Tranier 1990
<i>Meriones crassus</i>	Presence suspected	Petter 1961 Ag Sidiyène and Tranier 1990
<i>Massoutiera mzabi</i>	Insufficiently known	Ag Sidiyène and Tranier 1990 Le Berre 1990 This study
<i>Jaculus jaculus</i>	Abundant	Misonne 1986 (In Le Berre 1990) Ag Sidiyène and Tranier 1990 This study
<i>Xerus erythropus</i>	Abundant	Ag Sidiyène 1989 Ag Sidiyène and Tranier 1990 This study
<i>Hystrix cristata</i>	Insufficiently known	Chudeau 1920 This study
<i>Lepus</i> sp. (cf. <i>capensis</i>)	Abundant	This study (Le Berre 1990)