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New data on Late Pleistocene small vertebrates from northern France

Nouvelles données sur deux assemblages microfauniques du Pléistocène supérieur du Nord de la France

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ABSTRACT

Quaternary small vertebrate assemblages from northern France, and more generally from northwestern Europe, are poorly recognized, and studied less than those from more southern, Mediterranean areas. However, important sites of human occupation are often found in these northern areas, with significant issues related to the occupation of these sites by Neanderthals and previous humans, as well as faunal dynamics under climatic pressure. In this paper, we present preliminary results from the study of small vertebrate assemblages from two Late Pleistocene sites of northern France: Mutzig (Alsace) and Le Rozel (Normandy). Both are ancient rock-shelters that have been excavated recently and have yielded evidence of Neanderthal occupation, but in very different contexts: Le Rozel is located in a coastal area of northwestern France contemporaneous with a temperate period, while Mutzig is located at the foot of the Vosges mountains in northeastern France and was occupied during a cold period. Consequently, even if these two sites are chronologically close to each other, differences in faunal composition are observed and discussed in relation to the geographic, climatic and biochronological context, in comparing the results from small vertebrates with those from other disciplines (numerical dating, large mammals).

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RÉSUMÉ

Les assemblages microfauniques du Nord de la France, et plus généralement du Nord-Ouest de l'Europe, sont encore peu étudiés par rapport aux zones plus méridionales, notamment en région méditerranéenne. Cependant, plusieurs sites d'occupation humaine

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paléolithiques importants ont été découverts dans ces régions septentrionales, posant d'intéressantes questions sur l'occupation de la région par les Néandertaliens et par les groupes humains plus anciens, ainsi que sur la dynamique des communautés fauniques sous pression climatique. Dans le présent article, nous exposons les premiers résultats issus de l'étude d'assemblages microfauniques inédits provenant de deux sites du Nord de la France datés du Pléistocène supérieur : Mutzig (Alsace) et Le Rozel (Normandie). Tous deux sont d'anciens abris sous roche ayant fait l'objet de fouilles archéologiques récentes et ayant livré des vestiges d'occupations néandertaliennes, mais dans des contextes très différents. En effet, Le Rozel est un site côtier du Nord-Ouest de la France en contexte tempéré, alors que Mutzig a une position plus continentale, au pied des Vosges, dans le Nord-Est de la France, et est contemporain d'une période froide. En conséquence, bien que ces deux sites soient chronologiquement proches, des différences de composition faunique ont été observées et sont ici discutées en lien avec le contexte géographique, climatique et biochronologique, en comparant les résultats issus de l'étude des microvertébrés avec ceux issus des autres disciplines (datations numériques, grands mammifères).

1. Introduction

Northwestern Europe has yielded important Middle and Late Pleistocene archaeological sites with significant issues related to Neanderthal occupations and faunal dynamics under climatic pressure (Auguste, 2009). Unfortunately, small vertebrate assemblages from these septentrional areas remain poorly recognized, and studied less than those from more southern, Mediterranean areas, preventing an understanding of the environmental context of human occupations in these regions. The paper aims to address this issue by presenting new data from small vertebrate assemblages from two Late Pleistocene sites of northern France: Mutzig (Alsace) and Le Rozel (Normandy), which have been integrated in a broader, regional context.

2. Presentation of the study sites

2.1. Mutzig

Mutzig, located in northeastern France (Figs. 1 and 2), represents an exceptional site for the understanding of the Middle Palaeolithic in the upper Rhine region. The archaeological site of Mutzig is an ancient rock-shelter (now collapsed) located at 340 m ASL at the foot of the Mutzigberg rock mass composed of sandstone, near the Bruche river. The site was discovered in 1992 during construction work in the garden of a house. The site was covered by sandstone rocks, which would have played a key role in the preservation of the archaeological material, protecting it from erosion. Several excavations were undertaken between 1992 and 1996 by J. Sainty (Sainty, 1992, 1993a), and since 2009 by J. Detrey and T. Hauck (2009–2012) and then H. Koehler (since 2013). Several periods of Neanderthal occupation have been identified and yielded Mousterian industries, small and large faunal remains, some of them displaying burning and butchery evidences. OSL dates yielded an age dating to the end of MIS 5 for UE 7a, 8, 9 (Detrey and Hauck, 2011; Koehler et al., 2013; Preusser et al., in prep.). ESR-U/Th dating is in progress (J.-J. Bahain, MNHN). The "old collection" of large mammal remains (i.e. Sainty's excavations, called Mutzig 1, 2, 7 and 8; Sainty, 1993a, 1993b) are represented by several species: *Rangifer tarandus*, *Bison priscus*, small bovid (cf. *Rupicapra rupicapra*?), *Equus* sp., *Cervus elaphus*, *Megaloceros giganteus*, *Capreolus capreolus*, *Mammuthus primigenius*, *Canis lupus*, *Vulpes vulpes*, *Ursus* sp., a small carnivore (Auguste, 2012; Patou-Mathis, 1993). The large fauna coming from the recent 2010–2014 excavations (in association with the small vertebrates) are a little different from the old corpus: *Rangifer tarandus*, *Bison priscus*, small bovid (cf. *Rupicapra rupicapra*?), *Equus* sp., *Coelodonta antiquitatis*, *Mammuthus primigenius*, *Canis lupus*, cf. *Alopex lagopus*, *Ursus* cf. *arctos*.
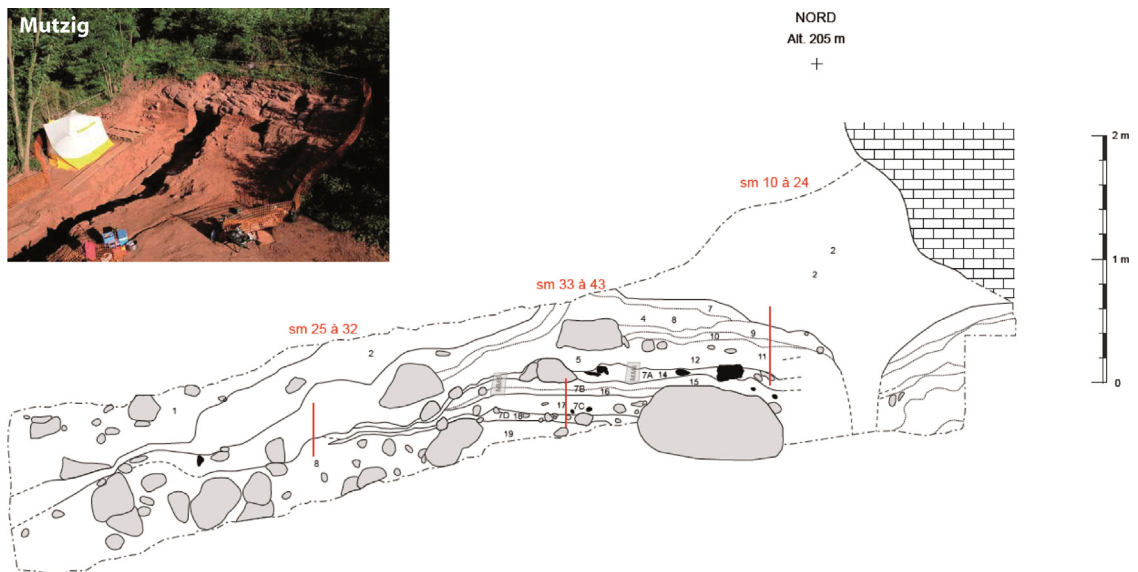
2.2. Le Rozel

Located on the western coast of the Cotentin (Manche, Fig. 1), to the North of the Surtainville beach, the Rozel ancient rock-shelter was revealed by coastal erosion. The site is part of a dune formation formed by the wind during the early stages of the last glaciation and 'trapped' in an old creek opening in a rocky cliff composed of schist crossed by quartz veins (Cliquet et al., 2014; Scuvée and Verague, 1984, 1988; Fig. 3). The site was discovered by Y. Roupin in 1967, and was then the subject of excavations in 1969 and 1970 by F. Scuvée (Scuvée and Verague, 1984). New excavations directed by D. Cliquet are ongoing since 2012. Investigations conducted on the sedimentary deposits and on the lithic and bone material suggest that the site was occupied by Neanderthals at least twice (two occupation soils; Van Vliet-Lanoë et al., 2006; Fig. 2). OSL dating on the "*Grande dune*" levels have yielded ages corresponding to the middle or end of MIS 5: around 107–87 ka according to Folz (2000) and 115–102 ka according to Van Vliet-Lanoë et al. (2006). Le Rozel is a major Middle Palaeolithic site in northern France, due to the exceptional preservation of anthropic structures (hearths), bone material (large and small vertebrates), insect remains, Neanderthal footprint, and the originality of its lithic industries (Cliquet, 2012; Cliquet et al., 2014; Scuvée and Verague, 1984; Van Vliet-Lanoë et al., 2006). Unfortunately, the coastal
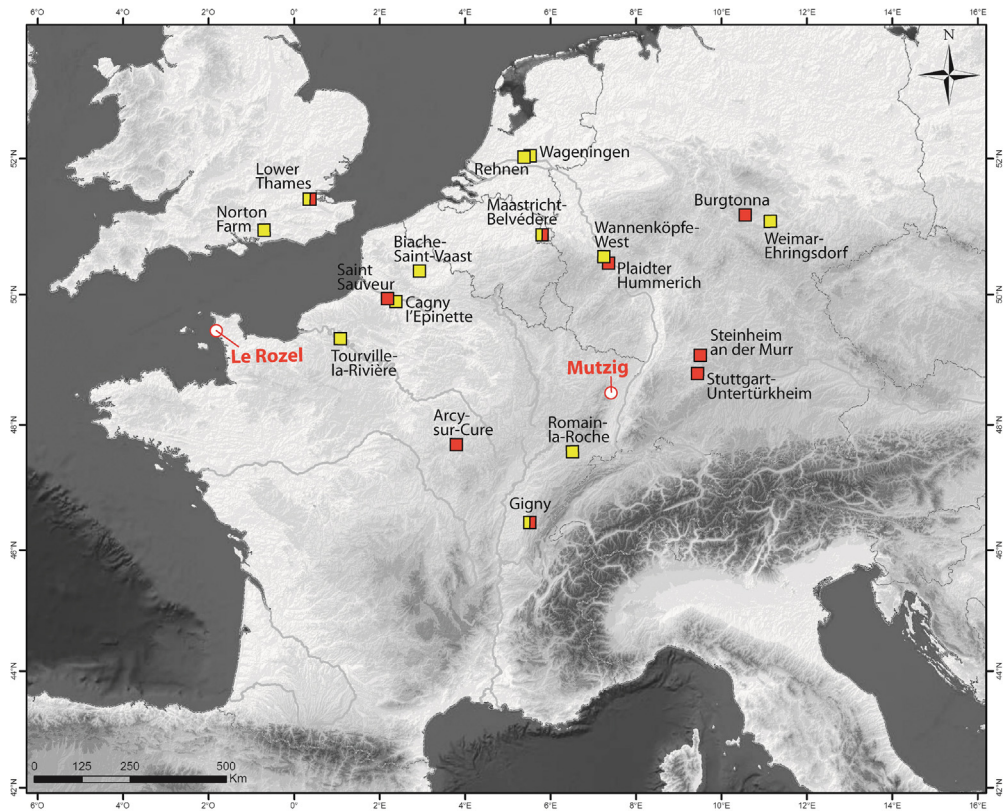
Fig. 1. Location of the two study sites, Mutzig and Le Rozel, and the main northwestern European Saalian (late Middle Pleistocene, in yellow) and Weichselien (early Late Pleistocene, in red) sites having yielded small vertebrate remains.

Fig. 1. Localisation géographique des deux sites d'étude, Mutzig et Le Rozel, et des principaux sites saaliens (fin du Pléistocène moyen, en jaune) et weichséliens (début du Pléistocène supérieur, en rouge) d'Europe du Nord-Ouest ayant livré des restes de microvertébrés.

Fig. 2. Mutzig: view of the site (in 2010) and stratigraphy (Koehler et al., 2014).
Fig. 2. Mutzig : vue du site (en 2010) et stratigraphie (Koehler et al., 2014).
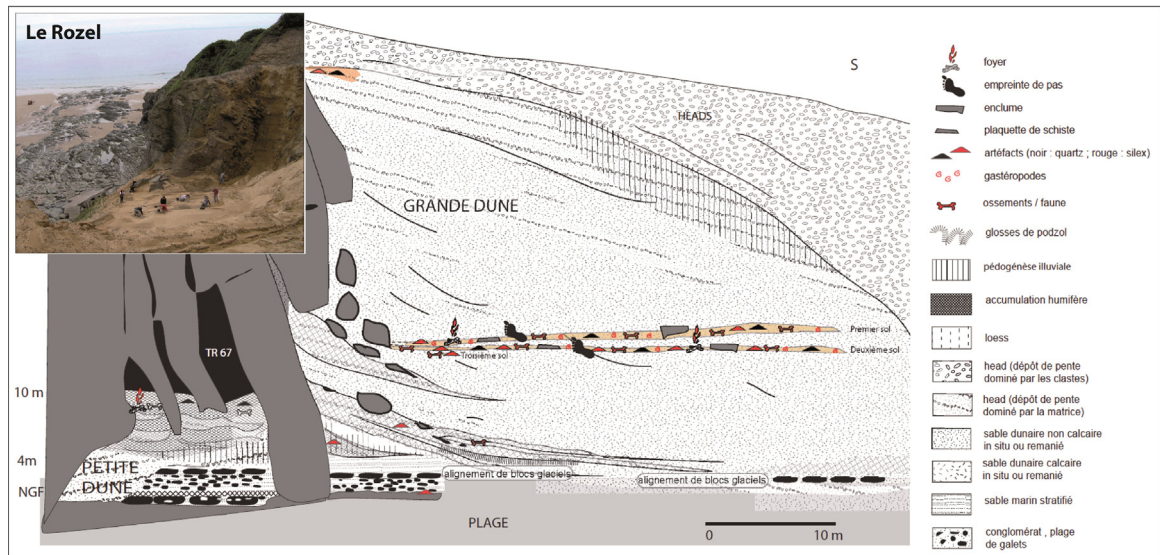
Fig. 3. Le Rozel: view of the site (in 2012) and stratigraphy (Cliquet et al., 2014).
Fig. 3. Le Rozel : vue du site (en 2012) et stratigraphie (Cliquet et al., 2014).

location means erosional processes threatening the sites future survival. As for Mutzig, the large mammal fauna from the old excavations of Le Rozel is a little bit different from that of the recent ones. Old excavations have yielded remains of *Bos primigenius*, *Equus* sp., *Cervus elaphus*, *Megaloceros giganteus*, *Odobenus rosmarus*, a small carnivore (Auguste *in* Van Vliet-Lanoë et al., 2006). Large mammals from recent excavations are represented by cf. *Palaeoloxodon antiquus*, cf. *Stephanorhinus hemitoechus*, *Bos primigenius*, *Equus* sp., *Cervus elaphus*, *Capreolus capreolus*, *Oryctolagus cuniculus*.

3. Material and methods

3.1. Mutzig samples

A total of 17 samples coming from UE 2, 5, 6 and 7c were studied. Each level was considered separately, and samples lacking stratigraphic context were counted but excluded from the analyses. All the sediment samples were water-sieved at 1 mm mesh. A sieving test was carried out on two samples at a smaller mesh (0.5 mm), but no more material was found in the 0.5–1 mm fraction. One sample corresponds to a bucket of ∼ 8 L of sediments, leading to a total volume of sediments of around 0.136 m^3 for 17 samples. A total of 341 identifiable remains of small vertebrates were extracted from these studied samples. The small vertebrate bone concentration at Mutzig is thus around 2507 identifiable remains/m^3.

3.2. Le Rozel samples

A total of 91 samples from the first occupation soil and from the yellow fine sand immediately above and below this occupation soil were studied. Consequently, all samples were grouped together as a whole, however samples lacking stratigraphic context were counted but excluded

from the analyses. All the sediment samples were dry-sieved at 0.5 mm mesh and then sorted to extract more than 700 identifiable remains of small vertebrates. One sample corresponds to a bucket of ∼ 10 L of sediments, leading to a total volume of sediments of around 0.910 m^3 for 91 samples. The small vertebrate bone concentration at Le Rozel is thus around 875 identifiable remains/m^3.

3.3. Methods of study

Species identifications were based on direct comparisons with osteological collections at the *Museum national d'Histoire naturelle* (MNHN, Paris), and on illustrations, morphological and biometric criteria from literature (e.g. Abbassi et al., 1998; Bailon, 1999; Callou, 1997; Chaline, 1972, 1974, 1988; Chaline and Mein, 1979; Cuenca-Bescos, 2003; Desclaux, 1992; Escudé et al., 2008a, 2008b; Hanquet, 2011; Heinrich, 1987; Kalthoff et al., 2007; van Kolfschoten, 1990, 1992; Maul et al., 2000; Nadachowski, 1982; Paunescu, 2001; Tuffreau et al., 1995). Only small terrestrial vertebrates were considered and although bird and fish remains were counted, they were not considered in this study. Identifications and taphonomic observations were performed under binocular microscope. Pictures were taken using a microscope equipped with a digital camera at the Department of Prehistory of the MNHN and at the Morphometry platform of the MNHN. Rodent teeth were measured from digital pictures using TpsDig2 software. Data on the ecology and distribution of species comes from literature (e.g. Aulagnier et al., 2008; Desclaux, 1992; Hanquet, 2011; Jeannet, 2010a; http://www.iucnredlist.org/). For palaeoecological reconstructions, we used classical indices such as Climatogram (based on the relative frequencies of species (MNI), each species belonging only to one ecological group), Taxonomic Habitat Index (based on the presence/absence of species and their occurrence in several types of habitats,

regardless of their relative proportions, avoiding potential taphonomic biases) and Cenogram (considering both large and small mammals according to their weight, the structure of a mammalian community depending on the type of landscape and climatic conditions).

4. Results

4.1. Identified species

4.1.1. Mutzig

A total of 341 identifiable remains allowed the identification of around 11 taxa in UE 2, 5, 6, 7c (Table 1, Fig. 4), while Chaline (1993) only identified 4 species for UE 2, 3, 4, 5 and 6 during previous excavations in 90's (*Arvicola terrestris*, *Microtus gregalis*, *M. oeconomus*, *M. arvalis* and unidentified birds and fishes).

Mole elements (3 mandibles and 2 humeri) found at Mutzig are not distinguishable from the modern *Talpa europaea*.

One isolated upper incisor is similar in size and morphology to those of modern specimens of Leporidae, notably *Oryctolagus* (smaller than *Lepus*), and is clearly distinct from the smallest elements belonging to *Ochotona*. These latter (several mandibles, maxillaries and isolated teeth) are very similar to the modern *Ochotona pusilla*, but too rare and fragmented for a certain specific attribution.

Only one maxillary (carrying *in situ* teeth) belonging to *Spermophilus* was found at Mutzig. Its relatively small size means it is closer to modern *S. citellus* than to the larger *S. major* and *S. superciliosus*. However, the tooth morphology differs slightly from *S. citellus* and is closer to that described

for Middle Pleistocene *S.* gr. *major* (Desclaux, 1992). Further material is required to refine the specific attribution.

The size of the Cricetidae elements found at Mutzig (3 mandibles with *in situ* teeth) is slightly smaller than the known variability of *Allocricetus bursae*, and is closer to that of *Cricetulus migratorius*. However, the tooth morphology of Mutzig specimens is very close to *A. bursae*. Again, further material is required, and we tentatively attribute the Mutzig specimens to *Allocricetus/Cricetulus* sp.

One mandible of *Lagurus lagurus* was recovered in UE 5. *In situ* m1 and m2 are notably characterized by an absence of cement in the re-entrant angles. The m1 from Mutzig shows markedly alternate T6 and T7, but globally the size and morphology of these remains correspond to *L. lagurus* (e.g. Chaline, 1972; Cordy, 1980; Nadachowski, 1982; Paunescu, 2001; Rekovets and Nadachowski, 1995).

Arvicola remains belong to the *terrestris* group, and both "*terrestris*" form, also named "*amphibius*" (symmetric anterior loop, confluent T4 and T5) and "*sapidus*" form (asymetric anterior loop, T4 and T5 alternating) are represented at Mutzig (as most of the material is broken, precise quantification of relative frequencies is difficult). The few data obtained on SDQ (~ 104.1) and m1 length (~ 4.2 mm) show an intermediate position between the *mosbachensis/cantiana* group and the modern *terrestris* group. But considering the scarcity of measurable specimens (only 2 m1 for the moment), these results should be treated with caution. Moreover, Escudé et al. (2008a, 2008b) have shown that, in certain cases, the use of SDQ and m1 length as biochronological indicators is not reliable, notably because biases in SDQ measurements are frequent, and altitude and geographic origin (western/eastern Europe) have to be considered.

Table 1
Faunal list of the small vertebrate species from Mutzig.
Tableau 1
Liste des espèces de petits vertébrés de Mutzig.

Taxa	UE 2		UE 5		UE 5–6		UE 6		UE 7c		Not in strati.	Total	
	NDR	MNI	NDR	MNI	NDR	MNI	NDR	MNI	NDR	MNI	NDR	NDR	MNI
Soricomorpha												**5**	**4**
Talpa europaea	–	–	3	3	2	1	–	–	–	–	–	5	4
Lagomorpha												**36**	**13**
Ochotona cf. *pusilla*	1	1	20	5	2	1	2	1	1	1	–	26	9
Leporidae indet.	1	1	–	–	–	–	–	–	–	–	–	1	1
Lagomorpha indet.	1	1	8	2	–	–	–	–	–	–	–	9	3
Rodentia												**291**	**63**
Spermophilus sp.	–	–	1	1	–	–	–	–	–	–	–	1	1
Allocricetus/Cricetulus sp.	–	–	2	1	–	–	1	1	–	–	–	3	2
Lagurus lagurus	–	–	1	1	–	–	–	–	–	–	–	1	1
Arvicola gr. *terrestris*	1		3	1	–	–	1	1	3	1	–	8	4
Microtus gregalis	–	–	10	7	–	–	–	–	1	1	–	11	8
Microtus oeconomus/malei	–	–	5	3	–	–	1	1	3	1	–	9	5
Microtus arvalis/agrestis	–	–	6	3	–	–	1	1	–	–	–	7	4
Microtus sp.	–	–	9	3	–	–	1	1	1	1	–	11	5
Arvicolinae indet.	2	1	12	5	–	–	4	2	3	1	–	21	9
Rodentia indet.	5	2	135	15	10	2	34	3	33	2	2	219	24
Amphibia												**9**	**4**
Rana cf. *temporaria*	–	–	1	1	–	–	–	–	2	1	–	3	2
Anura indet.	–	–	2	1	–	–	–	–	4	1	–	6	2
Total studied	11		218		14		45		51		2	341	84
Birds indet.	–	–	–		1		1		–		–	**2**	
Total with birds	11		218		15		46		51		2	343	

NDR: number of determinable remains; MNI: minimum number of individuals. Each level was considered separately, but samples not found in stratigraphy were not considered for the calculation of the MNI.
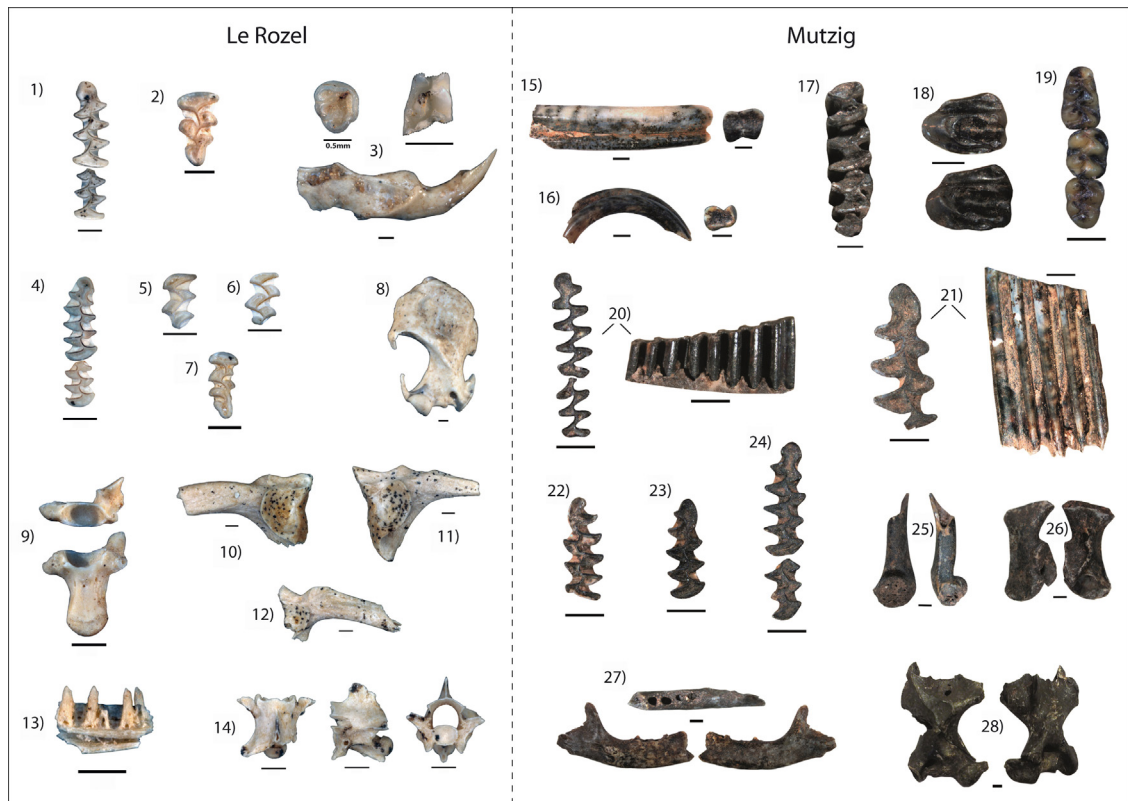
Fig. 4. Some examples of microvertebrate remains from Le Rozel (1–14) and Mutzig (15–28): 1) *Arvicola* gr. *terrestris* (left m1m2), 2) *Arvicola* gr. *terrestris* (left M3), 3) *Apodemus* sp. (left M2, left m1, right mandible), 4) *Microtus arvalis* (right m1m2), 5) *M. arvalis* (left M2), 6) *M. agrestis* (left M2), 7) *M. agrestis/arvalis* (left M3), 8) *Talpa europaea* (humerus), 9) Legless Sauria cf. *Anguis* (tronc vertebra), 10) *Bufo* cf. *bufo* (ilion), 11) *Bufo* cf. *calamita* (ilion), 12) *Rana* cf. *temporaria* (ilion), 13) Small Lacertidae (dentary), 14) Colubrinae cf. *Natrix* sp. (tronc vertebra), 15) Leporidae indet. (left upper incisor), 16) *Ochotona* sp. (right upper incisor), 17) *Ochotona* cf. *pusilla* (left p4m1m2m3), 18) *Spermophilus* sp. (left M1M2), 19) *Allocricetus/Cricetulus* sp. (right m1m2m3), 20) *Lagurus lagurus* (left m1m2), 21) *Arvicola* gr. *terrestris* (right m1), 22) *Microtus gregalis* (left m1), 23) *Microtus oeconomus/malei* (right m1), 24) *Microtus agrestis/arvalis* (right m1m2), 25) Anoura indet. (humerus), 26) *Rana* cf. *temporaria* (scapula), 27) *T. europaea* (left mandible), 28) *T. europaea* (humerus). Scale = 1 mm.

Fig. 4. Quelques exemples de restes microfauniques du Rozel (1–14) et de Mutzig (15–28) : 1) *Arvicola* gr. *terrestris*, (m1m2 gauches), 2) *Arvicola* gr. *terrestris* (M3 gauche), 3) *Apodemus* sp. (M2 gauche, m1 gauche, mandibule droite), 4) *Microtus arvalis* (m1m2 droites), 5) *M. arvalis* (M2 gauche), 6) *M. agrestis* (M2 gauche), 7) *M. agrestis/arvalis* (M3 gauche), 8) *Talpa europaea* (humérus), 9) orvet cf. *Anguis* (vertèbre thoracique), 10) *Bufo* cf. *bufo* (ilion), 11) *Bufo* cf. *calamita* (ilion), 12) *Rana* cf. *temporaria* (ilion), 13) petit Lacertidae (dentaire), 14) Colubrinae cf. *Natrix* sp. (vertèbre thoracique), 15) Leporidae indet. (incisive supérieure gauche), 16) *Ochotona* sp. (incisive supérieure droite), 17) *Ochotona* cf. *pusilla* (p4m1m2m3 gauches), 18) *Spermophilus* sp. (M1M2 gauches), 19) *Allocricetus/Cricetulus* sp. (m1m2m3 droites), 20) *Lagurus lagurus* (m1m2 gauches), 21) *Arvicola* gr. *Terrestris* (m1 droite), 22) *Microtus gregalis* (m1 gauche), 23) *Microtus oeconomus/malei* (m1 droite), 24) *Microtus agrestis/arvalis* (m1m2 droites), 25) Anoura indet. (humérus), 26) *Rana* cf. *temporaria* (scapula), 27) *T. europaea* (mandibule gauche), 28) *T. europaea* (humérus). Échelle = 1 mm.

Microtus remains from Mutzig (numerous mandibles, maxillaries and teeth) belong to several species: *M. gregalis*, *M. oeconomus/malei* group and *M. arvalis/agrestis* group. Concerning *M. gregalis*, the size of Mutzig specimens fall into the global variability of the species, and both "*gregaloides*" form (quite absent T6, developed T7 confluent with anterior loop, deep LRA5) and "*gregalo-arvaloides*" form (LRA5 less marked, T7 more reduced, sometimes appearance of T6) appear to be represented. *M. oeconomus* and *M. malei* have a very similar molar morphology, with a high intra-specific variability, making precise identifications difficult within this group. However, at Mutzig, most of the specimens are closer to *M. oeconomus* (T6 almost absent and T7 moderately developed), while some others appear to be closer to *M. malei* (T6, BRA4 and LRA5 more pronounced). *M. arvalis* and *M. agrestis* also have a similar molar morphology, with a high intra-specific variability. The most efficient discriminating characteristics on molars are localized on the anterior part of m1 and the posterior part of M2 (e.g. Chaline, 1974; Chaline, and Mein 1979; Nadachowski, 1982; Paunescu, 2001), but these are often difficult to apply in the case of badly preserved fossil material, especially when intermediate forms are present. Nevertheless, most of the Mutzig material is closer to the "*arvalis*" form on the basis of molar morphology (T6 and T7 of similar size, mostly opposite and confluent, anterior loop rounded and mostly symmetric, BRA4 and LRA5 well developed but BRA4-LRA5 distance relatively large), despite a relatively high mean size closer to the "*agrestis*" form. More abundant material is required to have a good estimation of the relative frequencies of each morpho-group, and geometric morphometrics may be performed on molars in order to refine the species attributions (Escudé et al., 2013; Killick, 2012).

Table 2
Faunal list of the small vertebrate species from Le Rozel.
Tableau 2
Liste des espèces de petits vertébrés du Rozel.

Taxa	Just above soil 1	Soil 1	Just below soil 1	Variegated sand	Red sand	Infilling sand	Not in strati.	Total	
	NDR	NDR	NDR	NDR	NDR	NDR	NDR	NDR	MNI
Soricomorpha								**3**	**1**
Talpa europaea	2	–	–	–	–	–	1	3	1
Rodentia								**488**	**28**
Apodemus sp.	1	1	–	–	–	1	–	3	1
Arvicola gr. *terrestris*	53	18	–	–	–	6	–	77	7
Microtus arvalis/agrestis	13	9	–	–	–	22	–	44	5
Rodentia indet.	171	69	4	3	1	106	10	364	15
Anura								**187**	**27**
Rana cf. *temporaria*	2	1	–	10	–	168	1	182	25
Bufo cf. *bufo*	–	–	–	–	–	4	–	4	1
Bufo cf. *calamita*	–	–	–	–	–	1	–	1	1
Squamata								**24**	**5**
Natrix sp.	–	–	–	–	–	6	–	6	1
Colubrinae indet.	6	–	–	–	–	1	–	7	1
Legless Sauria cf. *Anguis*	2	–	–	–	–	–	–	2	1
Small Lacertidae	–	–	–	–	–	9	–	9	2
Total studied	250	98	4	13	1	324	12	702	61
Birds indet.	14	7	–	5	2	–	1	**28**	
Fish indet.	–	1	–	–	–	–	–	**1**	
Total with birds and fishes	264	106	4	18	3	324	13	731	

NDR: number of determinable remains; MNI: minimum number of individuals. All samples were considered as a whole, however those not found in stratigraphy were not considered for the calculation of the MNI.

Amphibian remains are all attributed to Anurans. Only 1 scapula, 1 ilion and 1 tibio-fibula could have been attributed to *Rana* cf. *temporaria*. The remaining material (3 humeri, 1 vertebra, 1 urostyle, 1 metapodial) was too fragmentary or lacked discriminating characteristics preventing specific attribution.

4.1.2. Le Rozel

A total of 702 identifiable remains were studied and 11 taxa were identified (Table 2, Fig. 4). Most of the material is composed of rodents, but some samples yielded large amount of frog remains.

Mole elements (1 femur and 2 humeri) found at Le Rozel are non-distinguishable in size or morphology from the modern *Talpa europaea*.

The woodmouse *Apodemus* is represented by one mandible (without *in situ* molars), one maxillary (with *in situ* M2) and an isolated m1. Unfortunately, the bad state of preservation and the lack of discriminating characters prevent more precise attributions.

Arvicolinae represent the majority of the material, and are only represented by two groups: *Arvicola* gr. *terrestris*, and *Microtus arvalis/agrestis*. *Arvicola* remains clearly belong to the modern *terrestris* group and not to the older *mosbachensis/cantiana* group. The measurement of around 10 m1 showed that mean m1 length ($\sim$ 3.95 mm) and SDQ ($\sim$ 98.9) were slightly lower than at Mutzig. As previously stated, *M. arvalis* and *M. agrestis* have a similar molar morphology, and even if we can usually distinguish them thanks to size and conformation criteria, the material here is too sparse to be statistically reliable. However, at Le Rozel both forms were recognized thanks to the good preservation of some M2, displaying a small T5 in *M. agrestis*, which is absent in *M. arvalis* (Fig. 4).

Three species of amphibians are represented at Le Rozel: *Rana* cf. *temporaria*, *Bufo* cf. *bufo* and *Bufo* cf. *calamita*. Identifications were mainly based on ilion, scapula, humerus and urostyle.

Several squamates remains were also found, belonging to a legless lizard (2 vertebrae, cf. *Anguis fragilis*?), a small Lacertidae (several vertebrae and dentaries) and Colubrinae snakes (several vertebrae and ribs), including *Natrix* sp. (6 vertebrae).

4.2. Taphonomic observations

4.2.1. Mutzig

The Mutzig material is highly fragmented and displays weathering traces (cracking and desquamation of bones and tooth enamel), with probable impact of several phenomena such as frost, wind, desiccation, etc. We have observed few traces of trampling and root marks, some soil corrosion traces, as well as numerous extended black traces attributed to manganese oxides. All skeletal elements are represented in the whole material, however, some differences in anatomical representation exist between the levels (Fig. 5a). In UE 5, and perhaps UE 7, all skeletal elements are represented, and the profiles are close to what can be observed in modern owl accumulations (Andrews, 1990), indicating possible accumulation by avian predators. The material displays few traces of digestion that are only visible on a few post-cranial remains, whereas vole teeth are generally easily subjected to gastric acid attack, even of low intensity. This indicates the intervention of an owl with very low taphonomic impact, such as a nocturnal avian predators which digestion is generally less corrosive relative to diurnal raptors (Andrews, 1990; Mayhew, 1977), or another origin which remains to be determined
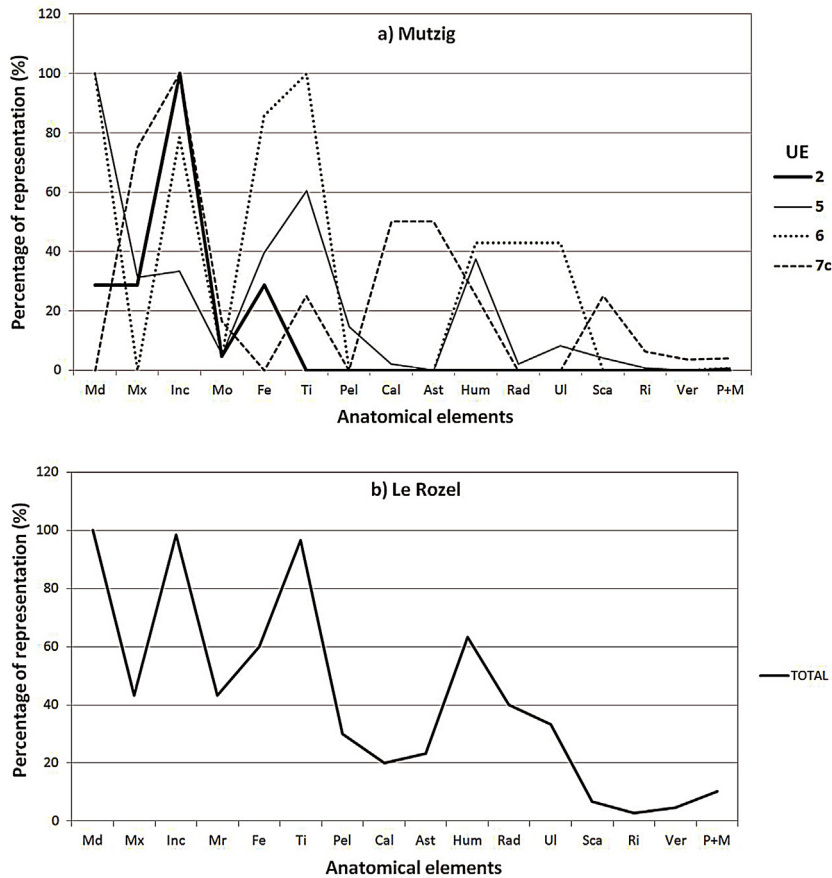
Fig. 5. Profiles of anatomical representation of the different studied levels of Mutzig (a) and Le Rozel (b).
Fig. 5. Profils de représentation anatomique des différents niveaux étudiés de Mutzig (a) et du Rozel (b).

(natural death?). In UE 6, we observe the presence of elements belonging to Voorhies categories III to V, and there is a lack of the smallest, less dense and more easily 'transportable' elements (see Behrensmeyer, 1975; Cheme Arriaga et al., 2012; Dodson, 1973; Fernandez-Jalvo and Andrews, 2003; Korth, 1979; Voorhies, 1969), indicating a probable water dispersal of low to medium energy (water stream?) which is in agreement with the hypothesis of disturbed slope deposits in this level (Koehler et al., 2013). No rounding or polishing by water is observed, excluding an extended stay in a dynamic flow. Alternatively there may have been a vertical migration of some bones from UE 6 to UE 7, as these two levels show opposite profiles (Fig. 5a). Further analysis is required. In UE 2, it appears that a "sorting bias" occurred during excavations towards larger (femora) or more recognizable (mandibles, maxillaries, incisors) elements. These elements belong to different Voorhies categories, and thus do not reflect any sorting of bones by wind or water flow. This level also yielded the least material, which could also bias the results. Consequently, UE 2 was not considered for palaeoecological analyses. The levels deemed best for palaeoecological analyses are UE 5, and UE 6 and 7 in a lesser extent.

4.2.2. Le Rozel

The bones are relatively well preserved despite breakage, and display very few signs of weathering and no polishing by water or wind. Corrosion has impacted a large part of the material, as it is for manganese oxides, but with a low intensity. There may also be a "sorting bias", as the samples sorted by the first author her-self yielded much larger proportion of material than the other samples. However, this bias only concerns small elements (such as phalanges), which are always under-represented in modern and fossil assemblages (Andrews, 1990). Thus, the under-representation of Voorhies category I–II elements, corresponding to the smallest, less dense and more easily 'transportable' elements (Fig. 5b) can be related either to a sorting bias, or to a wind and/or water dispersal. In addition, some bone accumulations that looked like fossilized owl pellets were found *in situ* during excavations. However, only few, uncertain, digestion traces were observed on the studied material, with the origin of the accumulations remaining unknown yet (predation? natural death? *in situ* or from another place with secondary transport?) and deserve further studies on both isolated remains and "palaeo-pellets".

On the basis of the taphonomic considerations for both sites, the following preliminary biochronological and palaeoecological results are tentative.

4.3. Biochronological interpretations

4.3.1. Mutzig

Chaline (1993) previously estimated the age of Mutzig assemblages at the beginning of the last "Middle Glacial" (MIS 3), around 60-30 ka. But recent OSL dates place UE 7a, 8, 9 at the end of MIS 5 (Detrey and Hauck, 2011; Koehler et al., 2013; Preusser et al., in prep.). Large mammals from recent excavations are in agreement with an age at the beginning of the Weichselian Glacial, especially with a large horse very close to caballine forms identified in sites dating to cold periods of the Early Weichselian. But this is not so obvious for the old excavations, which have yielded a large horse indicating the possibility of the existence of deposits dating to the end of the Middle Pleistocene. Small vertebrates would corroborate these data from radiometric dating and large faunas. Indeed, our study has shown that the micromammal association is mostly "modern", with a probable persistence of *Allocricetus*, a Middle Pleistocene relictual species. In addition, *Lagurus lagurus* is relatively rare in French Quaternary sites, and appears to have immigrated in western Europe at two different periods: at the end of the Middle Pleistocene (Saalian, in association with *Dicrostonyx*), and at the beginning of the Late Pleistocene (Early Weichselian) (e.g. Chaline, 1972; Chaline and Monnier, 1976; Cordy, 1980; Marquet et al., 1998; Nadachowski, 1982; Rekovets and Nadachowski, 1995; Paunescu, 2001). The rare *Arvicola* teeth measurements place Mutzig at the end of the Middle Pleistocene (Saalian) or the beginning of the Late Pleistocene (Weichselian).

4.3.2. Le Rozel

The microfauna from Le Rozel is a typical Late Pleistocene association. Contrary to Mutzig, no Middle Pleistocene relictual species was observed, and all the species still exist in western Europe today (*T. europaea*, *Apodemus*, *A.* gr. *terrestris*, *M. arvalis/agrestis*, *R. temporaria*, *B. bufo*, *B. calamita*, *Natrix*, *Anguis*). Thus the small mammal assemblage, as well as *Arvicola* measurements, suggest an interstadial phase of the Weichselian period (MIS 5d-a). These results are in agreement with the OSL dates from the site (Early Weichselian, ~ 107–87 ka; Folz, 2000).

4.4. Palaeoenvironmental reconstructions

4.4.1. Mutzig

Some of the species found at Mutzig still occur in western Europe today (*T. europaea*, *M. arvalis/agrestis*, *A. terrestris*), while others occur presently farther east, in Central Europe and/or Asia (*Ochotona*, *Spermophilus*, *L. lagurus*, *M. gregalis*, *M. oeconomus*). The latter species generally live in cold continental steppes today, and *Ochotona*, *M. gregalis* and *L. lagurus* are often found together in Quaternary deposits from western Europe dating to cold and arid periods. *M. oeconomus* is found in riparian habitats of the boreal zone, while *Ochotona pusilla* is a strictly steppe

species, occurring notably in "tundra-steppe" periglacial environments. *M. arvalis* and *M. agrestis* are meadow species inhabiting a broad range of environmental settings. The occurrence of *A. terrestris*, *M. oeconomus* and amphibians also indicates the presence of wetlands and/or water ponds. In addition, the presence of *Talpa* indicates the absence of permafrost and infers that the freezing of the ground was seasonal. Palaeoecological data (Figs. 6 and 8), notably Climatograms and Taxonomic Habitat Indices, indicate a cold continental arid climate, with an open landscape mostly composed of arid steppes alternating with humid areas, tundra and boreal forests. However, "true" tundra indicators (such as *Dicrostonyx* or *Lemmus*) are absent. The cenogram (combining large and small mammals) indicates an open and quite arid landscape (Montuire and Desclaux, 1997). Observations from each level show that although the climate is always cold continental, some differences emerge: UE 5 shows a higher proportion of continental arid steppes, while UE 7c shows better representation of sub-arctic environments (tundra and boreal forests), and UE 6 appears intermediate. It thus seems that the climate in UE 7c was colder than in UE 5, but these preliminary observations are yet to be confirmed. We note the absence of typical species of temperate forests (such as *Apodemus*, *Clethrionomys glareolus*, arboreal species of the squirrel and dormice families) and Mediterranean habitats, but also of cold-arctic areas ("true" lemmings such as *Dicrostonyx* or *Lemmus*), indicating that the microfauna from the studied levels of Mutzig (UE 5, 6, 7c) corresponds to a cold–arid climate but not a strictly pleniglacial period (transition period? taphonomy?), while the results from the large mammals indicate a typical "Mammoth Steppe" during a pleniglacial period (with the presence of woolly rhino, woolly mammoth, horse, reindeer, steppe bison, isatis, wolf and perhaps chamois).

4.4.2. Le Rozel

Palaeoecological indices based on Le Rozel micromammals (Figs. 7 and 8) record a different palaeoenvironmental signal than that of Mutzig. At Le Rozel there is a higher representation of humid meadows and temperate environments, including deciduous forests. However, despite the presence of *Apodemus*, we observe the absence of other species characteristic of temperate forests (such as *Clethrionomys glareolus*, arboreal species of the squirrel and dormice families) and Mediterranean habitats. However, it should be noted that arboreal sciurids are generally scarce in the Quaternary localities of Western Europe.

The presence of several species of amphibians indicates the presence of soft water ponds near the site. The cenogram indicates a semi-open humid environment. The presence of some species, such as the woodmouse and the roe deer, infers the presence of wooded areas. At the beginning of the Weichselian period, sea level was similar to that of today and the site was located in a small cove opening in a rocky cliff. The littoral location could explain the relatively poor rodent/shrew diversity at Le Rozel despite favorable climatic conditions. The small vertebrates indicate that the environment was temperate and relatively humid with wooded areas, meadows and water ponds. This is in agreement with large fauna that infers a
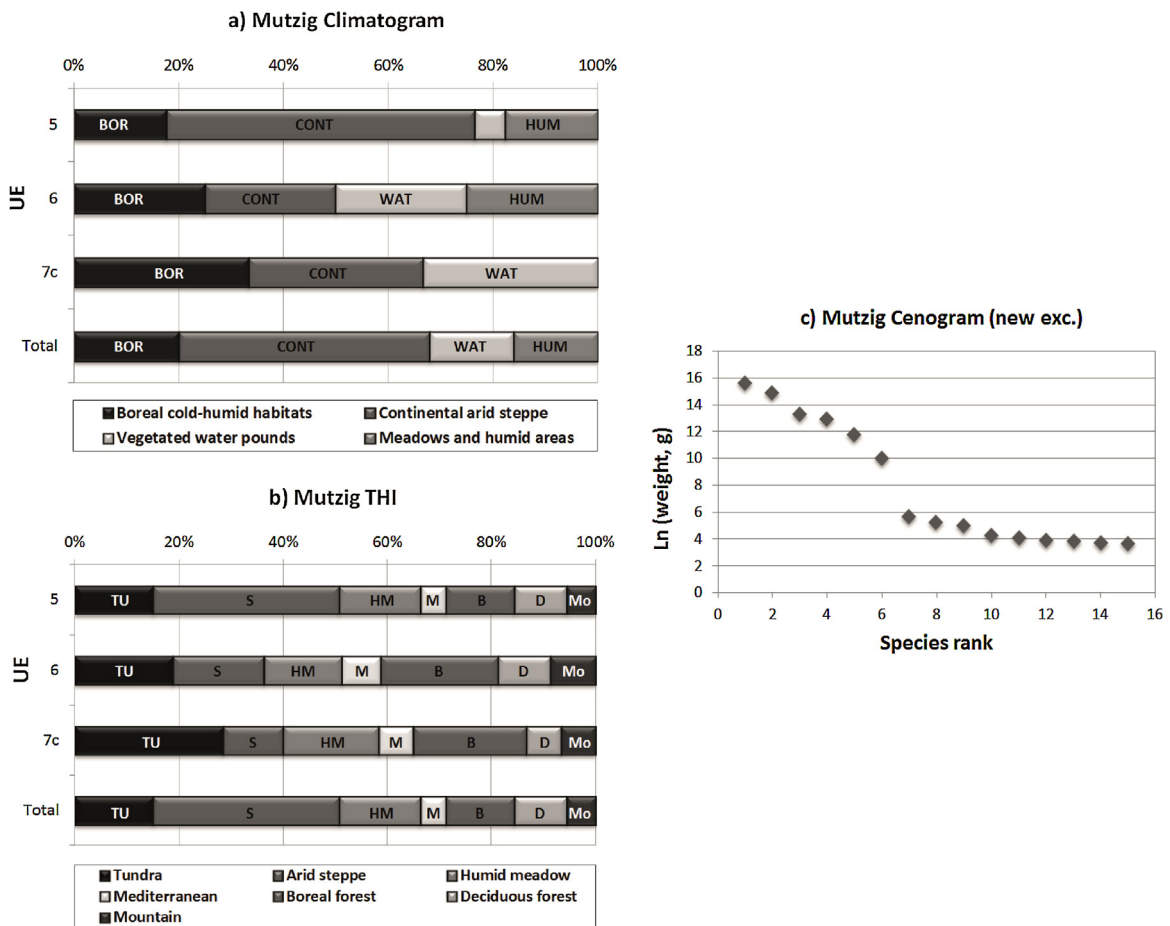
Fig. 6. Graphic representation of ecological indices based on Mutzig faunas: a) climatogram; b) taxonomic habitat index; c) cenogram (data from new excavations only).

Fig. 6. Représentation graphique des indices écologiques d'après les faunes de Mutzig : a) climatogramme ; b) indice taxonomique d'habitat ; c) cénogramme (données des nouvelles fouilles seulement).

landscape dominated by temperate semi-wooded meadows, with a dominance of red deers, roe deers, aurochs and horses. Although the presence of walrus (*Odobenus* cf. *rosmarus*) has been recorded at the Rozel in the old collection (Auguste *in* Van Vliet-Lanoë et al., 2006), this cold adapted marine mammal can be found at these latitudes today, and is not necessary an indicator of a cold period.

4.4.3. Additional remark

Despite some taphonomic disturbances, it appears that the biochronological and palaeoenvironmental information obtained from the study of the small vertebrate assemblages from Mutzig and Le Rozel agrees with the results from the large mammals and sedimentology. Although there is a bias in anatomical representation, it appears that the faunal representation is relatively well preserved, and despite some disturbances within some levels, there is little mixing between stratigraphic levels. However, further analyses are required to confirm this hypothesis.

5. Regional comparisons

From a general point of view, there are significant regional differences between faunal compositions as well as biometrics of some rodents (*Arvicola*). It is therefore important to compare the sites to those contemporary in northwestern Europe, and to avoid comparisons with eastern and Mediterranean sites. We have thus compared the microfaunal assemblages from Mutzig and Le Rozel with several Saalian (MIS 9-6) and Weichselian (MIS 5d-a) sites from northwestern Europe that yielded small vertebrate remains (Fig. 1). Sites belonging to the Eemian period (MIS 5e) were not considered, because this fully warm-humid interglacial period appears to not be recorded at Mutzig and Le Rozel.

5.1. Northern France

Sites used as examples: Cagny-l'Épinette, (Saalian; Tuffreau et al., 1995); Tourville-la-Rivière (Saalian; Cordy et al., 2003; Stoetzel, unpublished); Biache-Saint-Vaast
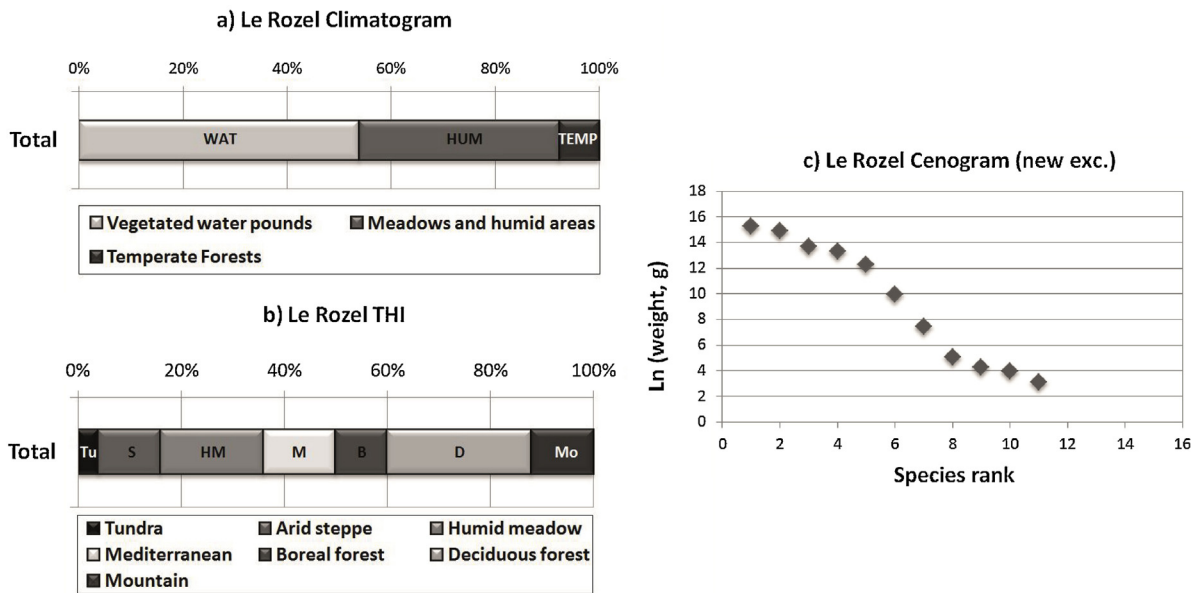
Fig. 7. Graphic representation of ecological indices based on Le Rozel faunas: a) climatogram; b) taxonomic habitat index; c) cenogram (data from new excavations only).
**Fig. 7.** Représentation graphique des indices écologiques d'après les faunes du Rozel : a) climatogramme ; b) indice taxonomique d'habitat ; c) cénogramme (données des nouvelles fouilles seulement).

(Saalian; Chaline, 1978); Saint-Sauveur (Weichselian; Antoine et al., 1995).

Similarities exist between the assemblages from Mutzig and those from Cagny-l'Épinette (Tuffreau et al., 1995), despite the older age of Cagny-l'Épinette estimated to MIS 9 thanks to chronostratigraphic position, lithic industries, large mammals and geochronology, with date around 296 ka, 318 ka, 289 ka and 291 ka (Bahain et al., 2007). Indeed, Cagny-l'Épinette yielded a "modern" microfauna assemblage lacking typical Middle Pleistocene species. The climate was fresh-temperate (*Talpa europaea*, *Sorex* sp., *Arvicola terrestris*, *Microtus oeconomus*) and mostly open (dominance of *M. arvalis/agrestis*, absence of *Clethrionomys glareolus* and Gliridae). In addition, *Arvicola* SDQ values are around 100 like at Mutzig. The recent age of microfauna

from fluviatil levels of Cagny-l'Épinette probably results from taphonomy, with many Arvicolinae elements coming from burrow contexts and, consequently, more recent than the Palaeolithic settlement.

The microfauna from Tourville-la-Rivière (Cordy et al., 2003; Stoetzel, unpublished), dating to the middle of the MIS 7 (Bahain *in* Auguste, in press), consists of *Talpa europaea*, *Arvicola cantiana-terrestris*, *Microtus arvalis/agrestis*, *M. oeconomus*; *Arvicola* SDQ values are higher than at Mutzig (~114). The landscape was mostly open and humid (grassy meadows with bushes and water ponds) and a fresh-temperate climate (transition? interstadial?) with the occurrence of moles and the absence of typical cold rodents such as *Microtus gregalis* or *Dicrostonyx torquatus*.
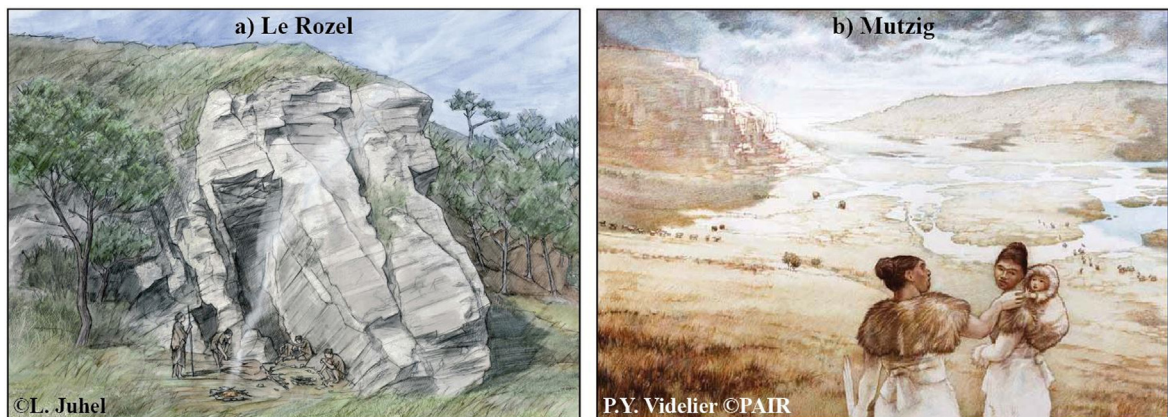
Fig. 8. Landscape reconstruction of Le Rozel (a: L. Juhel) and Mutzig (b: P.-Y. Videlier) at the Weichselian period.
Fig. 8. Reconstitution imagée des paysages autour des sites du Rozel (a : L. Juhel) et de Mutzig (b : P.-Y. Videlier) à l'époque weichsélienne.

Biache-Saint-Vaast dates to the Saalian period (around 240 ka; Auguste, 2009; Bahain et al., 2015) and has also yielded "modern" microfauna, including *Crocidura* sp., *Sorex* sp., *Microtus arvalis/agrestis*, *M. oeconomus/malei*, *M.* (*T.*) *subterraneus*, *Arvicola terrestris*, *Clethrionomys glareolus* (Chaline, 1978). The presence of Soricidae and *C. glareolus* indicates a more temperate phase (although colder than today) than at Mutzig. But a taphonomic bias probably explains the huge difference between chronostraphy, geochronology, large mammals and dating based on microfauna interpretation at Biache-Saint-Vaast.

At Saint-Sauveur, a slightly younger site dating to the Weichselian period (Antoine et al., 1995), the presence of *Talpa europaea*, cf. *Neomys* sp., *Arvicola terrestris*, *Microtus arvalis/agrestis* indicates temperate climatic conditions, intermediate between an interglacial and a glacial period (absence of cold species, presence of temperate species but absence of typical forest ones). *Arvicola* values indicate a Wechselian or Late Saalian age, as it is the case at Mutzig. But at Saint-Sauveur, the stratigraphic context, U/Th dating and large mammals (large wolf, horse similar to Late Pleistocene forms; Auguste, 1995) argue for an age around the Eemian-Weichselian transition.

Significantly, none of these sites, even the earlier ones, have yielded *Allocricetus/Cricetulus* or *Lagurus* remains, which were found at Mutzig. This could result from the fact that all these sites appear to have recorded more temperate periods than Mutzig, less favorable to the occurrence of such species characteristic of open-arid steppe environments. Alternatively, the difference in the biogeographical location of these sites, with a higher influence of the Ocean for Le Rozel and the other sites, against a clear continental location for Mutzig, may explain these differences. Indeed, some authors such as Moine (2014) have highlighted a clear separation between western coastal environments (flat and poorly vegetated domain, more humid) and the eastern continental ones (hilly domain with more diversified vegetation, more dry), with a persistence of these two domains throughout the Weichselian period.

All the mentioned sites have recorded the presence of species which do not occur anymore in northwestern Europe today (such as *M. oeconomus/malei*), and which were not found at Le Rozel. It therefore appears that Le Rozel recorded a more temperate episode than the comparison sites. However, the questions remains regarding the absence of Soricinae and typical forest rodents (*C. glareolus*, arboreal species of the squirrel and dormice families) at Le Rozel, which could result from its littoral location.

5.2. Eastern France (Jura)

Sites used as examples: Romain-la-Roche (Saalian; Bailon, 2010; Guérin et al., 2010; Jeannet, 2010b); Gigny (Saalian–Weichselian; Chaline et al., 1995; Fabre et al., 2011; Navarro et al., 2004).

Guérin et al. (2010) show that large mammals from Romain-la-Roche and ESR-U/Th dating give an age around 150–165 ka BP (MIS 6) for levels VI–VII and VIII, however, micromammals indicate a more recent age, around the MIS 5 - MIS 4 boundary (Jeannet, 2010b). Taphonomic analysis of the micromammal assemblage from Romain-la-Roche

was not carried out, meaning that faunal mixing cannot be excluded as an explanation for these differences. According to Jeannet (2010b) this site has yielded a high small vertebrate diversity, indicating a cooling of conditions towards fully pleniglacial conditions from the basis to the top of the sequence, very different to that observed at Mutzig and Le Rozel.

The site of Gigny covers a large time period, from the end of the Middle Pleistocene to the Late Pleistocene (∼145–14 ka BP), and has recorded several palaeoclimatic changes (Chaline et al., 1995; Fabre et al., 2011; Navarro et al., 2004). The most suitable levels for comparisons with Mutzig and Le Rozel are levels XXII (pre-Eemian) and XX–XVI (post-Eemian). Level XXII is characterized by a transitional climate, from warmer to more temperate conditions, with the presence of *Arvicola terrestris*, *Microtus oeconomus/malei*, *M. multiplex*, *M. agrestis*, *M. gregalis*, *Clethrionomys glareolus*, *Apodemus sylvaticus*, *Eliomys quercinus*, *Muscardinus avellanarius*, *Spermophilus superciliosus*. Levels XX to XVI–XV have recorded a progressive cooling, with the arrival of *Lagurus lagurus*, *Dicrostonyx torquatus* and *Marmota* (sparse occurrence), Cricetidae, Dipodidae, an increase of *M. gregalis* and a decrease of temperate forest taxa (Gliridae, *Apodemus*). The micromammal assemblage and *Arvicola* measurements of Mutzig are close to those of levels XX–XIXb of Gigny (*A. terrestris*, *M. oeconomus/malei*, *M. arvalis/agrestis*, *M. gregalis*, *L. lagurus*), however the presence of *M. multiplex* was recorded at Gigny and not at Mutzig. In addition, several Gigny levels have yielded *M. arvalis/agrestis, A. terrestris* and *Apodemus* remains as Le Rozel, but always associated with several other species not recorded at Le Rozel.

5.3. Neighboring countries: England, Germany and Netherlands

Sites used as examples: Norton Farm (England, Saalian; Bates et al., 2000); Lower Thames (England, Saalian–Weichselian; Sutcliffe and Kowalski, 1976); Plaidter Hummerich A (Germany, Saalian; Kalthoff et al., 2007); Wannenköpfe-West (Germany, Weichselian; Kalthoff et al., 2007); Burgtonna (Germany, Weichselian; van Kolfschoten, 2000); Steinheim an der Mur (Germany, Weichselian; van Kolfschoten, 2000); Stuttgart-Untertürkheim (Germany, Weichselian; van Kolfschoten, 2000); Maastricht-Belvédère (Netherlands, Saalian–Weichselian; van Kolfschoten, 1985, 1993).

Norton Farm, England (Bates et al., 2000), yielded only remains of *Microtus oeconomus*. However, their association with pollens, large mammals and molluscs indicate a cold-stage of the late MIS 7 or early MIS 6, too old to be correlated with Mutzig or Le Rozel. Few micromammal assemblages in the UK date to MIS 6 or early MIS 5. Most assemblages come from the Thames terraces (few from stratified cave deposits), which are of interglacial or interstadial age, because most cold-stage deposits are now submerged (Sutcliffe and Kowalski, 1976).

The German sites of Plaidter Hummerich A (Late Saalian) and Wannenköpfe-West (Eemian–Weichselian boundary) have both yielded microfauna indicating a temperate transitional climate, and an open meadow landscape with wet

areas and some wooded areas (Kalthoff et al., 2007). Le Rozel shows a high degree of similarity with Wannenköpfe-West: dominance of *Microtus arvalis/agrestis* and *Arvicola terrestris* (SDQ ∼ 98.3, m1 length ∼ 3.87 mm), presence of *Talpa europaea*, *Apodemus* and several amphibians and squamates. However, Wannenköpfe-West has also yielded Soricinae, Dipodidae, *M. multiplex* and *M. oeconomus*, indicating rather open grassland landscape with meadows along water basins and with restricted wooded areas. The authors raise an interesting point: "Thus, the studied fauna shows extremely few forms of both cold–dry and humid–warm conditions, and most taxa are generalized in their ecological preferences. This fact together with the predominance of few arvicoline species suggests transitional climatic conditions either from cold to warm or from warm to cold" (Kalthoff et al., 2007, p. 620). These data contrast with those from older Middle Pleistocene sites (such as Tönnchesberg I, Schweinskopf-Karmelenberg, Wannen) whose microfaunas are characteristic of open, cold and arid steppes (*Spermophilus*, *Cricetulus migratorius*, *Dicrostonyx gulielmi*, *Lagurus lagurus*, *Microtus gregalis*) (Kalthoff et al., 2007). Mutzig is closer to the latter sites, with the presence of *Spermophilus* sp., *Allocricetus/Cricetulus* sp., *L. lagurus* and *M. gregalis*. However, Mutzig lacks typical cold species such as "true" lemmings.

Saalian levels of Maastricht-Belvédère (3 and 4) in the Netherlands correspond to a more temperate phase than Mutzig (with notably the presence of *Erinaceus davidi*, *Talpa europaea*, several Crocidurinae and Soricinae species, *Eliomys quercinus*, *Clethrionomys glareolus*, *Arvicola cantiana/terrestris*, *Microtus arvalis/agrestis*, *Apodemus sylvaticus*, *A. maastrichtiensis*...) (van Kolfschoten, 1985, 1993). However, Maastricht-Belvédère 5 presents a colder fauna, that includes *Spermophilus* cf. *undulatus*, *Cricetulus migratorius*, *Dicrostonyx torquatus*, *Microtus oeconomus*, *M. gregalis*, but with the persistence of more temperate taxa such as *Talpa europaea* and *Arvicola cantiana/terrestris* (van Kolfschoten, 1985), which is very similar to that observed at Mutzig, despite the fact that at MB5, *Arvicola* are slightly more evolved and cold taxa are more represented.

van Kolfschoten (2000) cites several German sites documenting the Eemian-Weichselian transition. The Eemian age of most of the deposits is mainly based on the interglacial nature of flora and fauna (including the presence of Soricidae, Gliridae, woodmice, bank voles) and the evolutionary stage of *Arvicola*. Palaeontological data indicate that the environment was a mosaic landscape with both woodland and open areas, comparatively palaeobotanical data indicate an extensive forest cover. Early Weichselian faunas from Bugtonna, Stuttgart-Untertürkheim or Steinheim an der Murr are markedly different, with a higher frequency of species inhabiting cold steppes (*Ochotona pusilla*, *Spermophilus citelloides*, *Lagurus lagurus*) presenting thus similarities with Mutzig.

As observed for the sites in northern and northeastern France, faunas from Germany and the Netherlands that date to the early Late Pleistocene appear "modern" with no representation of *Allocricetus* or other Middle Pleistocene relictual species. However, *Cricetulus migratorius* appears sporadically.

5.4. Conclusions about regional comparisons

The microfauna from the Saalian sites considered here (such as Cagny-l'Épinette, Tourville-la-Rivière, Biache-Saint-Vaast, Plaidter Hummerich A, Maastricht-Belvédère 3-4, Gigny XXII) but also from Early Weichselian sites (such as Saint-Sauveur, Wannenköpfe-West) are all very similar and are composed of "modern" species, characteristic of a transitional climate, relatively temperate but cooler than today. Mania and Mania (2008) and Kalthoff et al. (2007) have previously noted that vertebrate faunas from the Late Saalian and the early Weichselian can be defined as "transitional faunas" including at the same time cold, ubiquist, thermophilous and steppic species. This is also what we observe at Mutzig and Le Rozel. Often the evolutionary stage of *Arvicola* allows the refinement of an age of an assemblage, but biometric values are generally similar for the end of the Saalian period and the beginning of the Weichselian period (van Kolfschoten, 1992). These observations do not help to refine the age attribution of our sites, especially Mutzig, which has the same "common background" as most of the other sites (*Talpa europaea*, *Arvicola terrestris*, *Microtus arvalis/agrestis*, *M. oeconomus*) and often the same biometric values for *Arvicola*. Mutzig also yielded other species, more characteristic of cold steppes (*Ochotona*, *Spermophilus M. gregalis*, *Allocricetus/Cricetulus*, *L. lagurus*). This type of assemblages is found at Maastricht-Belvédère 5 and Gigny XX–XIX (Weichselian) but with some differences in the evolutionary stage or the presence/absence of certain species. Thus Mutzig would correspond to a relatively cold-arid period, but not fully pleniglacial, of the Late Saalian or Early Weichselian, a period that is poorly documented in northwestern Europe concerning microvertebrates. Le Rozel would correspond to a more recent phase of the Early Weichselian, and to a more temperate period, but not fully interglacial, with microfauna similar to that of Wannenköpfe-West for example.

6. Conclusion and perspectives

Both Mutzig and Le Rozel yielded microfauna dating to the beginning of the Late Pleistocene, respectively from a cold-arid period and a more temperate one. However, these assemblages are not similar to other contemporaneous sites in this region. The *Arvicola* biometric data and the presence of *Allocricetus/Cricetulus* and *Lagurus* at Mutzig would indicate slightly older age (Late Saalian? Early Weichselian?) than Le Rozel (Early Weichselian). However, OSL dating disagrees with this interpretation. How interpret these contradictory results between microvertebrate associations and geochronological data? Are taphonomic biases involved? Is Mutzig really slightly older than Le Rozel? Is this linked to the palaeoclimatic context, as the species observed at Mutzig are typical of open-arid environment, while at Le Rozel the climate was more temperate? Or is there a persistence of such species in continental Europe, not occurring in coastal regions? These questions, arising from the study of the small and large vertebrates of Mutzig and Le Rozel, highlight the importance of undertaking further studies on both sites in

order to refine species identifications (notably concerning *A. terrestris/sapidus* and *M. arvalis/agrestis*), as well as taphonomic, biochronological and palaeoecological interpretations, and to include other series from northwestern Europe.

Acknowledgments

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