



HAL
open science

Diet of ancient and middle Neolithic populations in the northwest of Mediterranean. Anthropological and isotopic studies.

Gwenaëlle Le Bras-Goude

► **To cite this version:**

Gwenaëlle Le Bras-Goude. Diet of ancient and middle Neolithic populations in the northwest of Mediterranean. Anthropological and isotopic studies.. *Archaedyn 7 millennia of territorial dynamics Settlement pattern, production and trades from Neolithic to Middle Ages*, Jun 2008, Dijon, France. halshs-00415978

HAL Id: halshs-00415978

<https://shs.hal.science/halshs-00415978v1>

Submitted on 11 Sep 2009

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

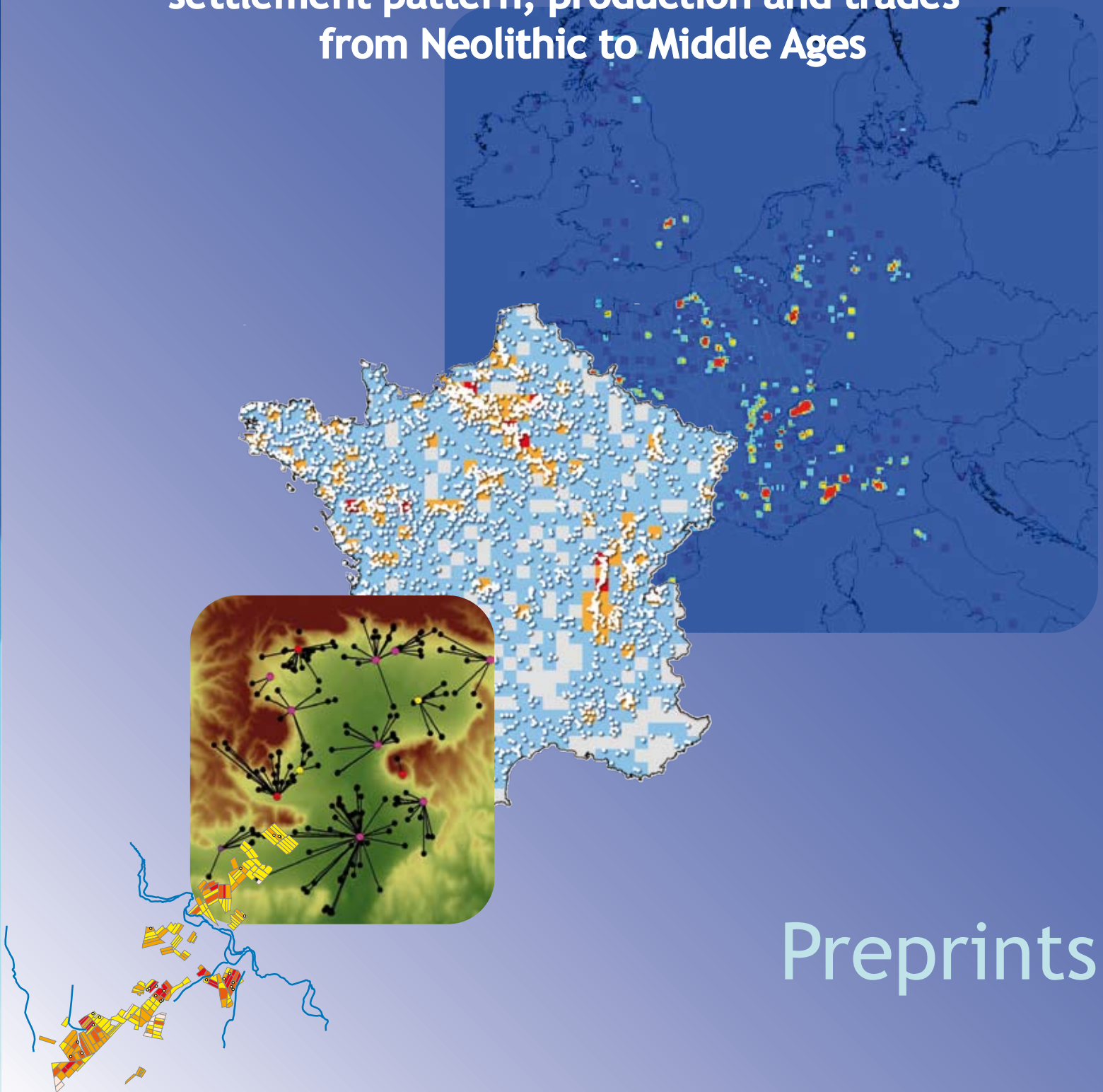
L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

ACI "Spaces and territories" 2005-2007
Final conference - Dijon, 23-25 june 2008

ARCHAEDYN

7 millennia of territorial dynamics

**settlement pattern, production and trades
from Neolithic to Middle Ages**



Preprints

Pre-proceedings directed by

Cristina GANDINI (*UMR 8546 AOROC, ENS Ulm Paris*)

François FAVORY*

Laure NUNINGER*

Organisation committee

Cristina GANDINI,

Laure SALIGNY***

Laëtitia BASSEREAU**

Jean-Marc BOURGEON***

Brigitte COLAS**

Marion LANDRÉ****

Isabelle MOURET****

Sophie BUI****

Sylvie COSTILLE-VAREY*

Nathalie PUILLET*

Scientific committee co-chairs

François FAVORY*

Claude MORDANT**

Laure NUNINGER*

* *UMR 6249 ChronoEnvironnement*

** *UMR 5594 ARTeHIS*

*** *MSH Dijon UMS 2739*

**** *MSH C. N. Ledoux, Besançon USR 3124*

ACI « Spaces and territories » 2005-2007

Contract ET 28

**Spatial dynamics of settlement and natural resources :
toward an integrated analysis over the long term
from Prehistory to Middle Ages**

Final Conference – University of Burgundy, Dijon, 23-25 June 2008

ARCHÆDYN

7 millennia of territorial dynamics

*settlement pattern, production and trades
from Neolithic to Middle Ages*

Preprints

REMERCIEMENTS

Le collectif Archædyn remercie les institutions qui ont bien voulu accepter d'accueillir les réunions de son groupe de pilotage, de ses séminaires, de ses ateliers et son colloque final.

Groupe de pilotage :

Université Paris IV Sorbonne, Paris
INHA, Paris
UMR 8546 ENS Ulm-CNRS, Paris

Tables rondes :

DRAC Franche-Comté, Besançon
ZRC SAZU, Ljubljana (Slovénie)
MSH Clermont-Ferrand

Ateliers :

INHA, Paris
MMSH Aix-en-Provence
UMR 5594 - ArteHis Dijon
MSHE Besançon
MSH Clermont Ferrand
MSH Tours
UMR 6130 CEPAM, Sophia Antipolis

Colloque final :

Université de Bourgogne

Le collectif Archædyn tient également à remercier individuellement tous les personnels chercheurs et administratifs qui ont fortement contribué à l'organisation de toutes ces rencontres et assurer le recrutement des vacataires.

Sylvie COSTILLE-VAREY, Nathalie PUILLET *UMR 6249, Besançon*
Monique SEGURA *UMR 6173, Tours*
Laëtitia BASSEREAU, Brigitte COLAS *UMR 5594, Dijon*
Isabelle MOURET, Marion LANDRE, Soizic VIAOUËT, Sophie BUI *USR 3124, Besançon*
Jean-Marc BOURGEON *UMS 2739, Dijon*
Sasa CAVAL, IAPS ZRC SAZU *Ljubljana*
Béatrice FIXOIS *UMR 7041 Nanterre*
Martine JOLY, M. MASSE, M^{me} FERNOUX *Univ. Paris IV / INHA, Paris*

Pour le colloque final, les organisateurs remercient également chaleureusement :

- les personnels de l'Université et du Crous de Bourgogne pour leur soutien logistique et administratif et les vacataires recrutés pour cette manifestation ;
- la ville de Dijon pour la réception du 23 juin ;
- Patricia ALEXANDRE pour les traductions en anglais et les relectures des textes anglais de l'équipe ArchæDyn, réalisée dans des délais extrêmement courts ;
- Bertrand TURINA pour la mise en page des pré-actes, également réalisée dans des conditions extrêmes ;
- Christian VERNOU, conservateur du Musée archéologique et ses collaborateurs pour l'organisation de la soirée inaugurale du colloque ;
- L'ensemble vocal « Le Laostic » et son chef de chœur, François TAINURIER ainsi que la paroisse Saint Bénigne qui a bien voulu accueillir leur concert.

ACKNOWLEDGMENTS

The ArchaeDyn collective thanks the institutions which have kindly agreed to receive the meetings of his supervisory committee, seminars, workshops and final conference.

Supervisory committee:

Université Paris IV Sorbonne, Paris
 INHA, Paris
 UMR 8546 ENS Ulm-CNRS, Paris

Round-tables:

DRAC Franche-Comté, Besançon
 ZRC SAZU, Ljubljana (Slovenia)
 MSH Clermont-Ferrand

Workshops:

INHA, Paris
 MMSH Aix-en-Provence
 UMR 5594 - ArteHis Dijon
 MSHE Besançon
 MSH Clermont-Ferrand
 MSH Tours
 UMR 6130 CEPAM, Sophia Antipolis

Final conference:

University of Bourgogne

The Archaeodyn collective would also like individually to thank all the researchers and administrative staff who greatly contributed to the organisation of all these meetings and to assure the recruitment of the temp staff.

Sylvie COSTILLE-VAREY, Nathalie PUILLET *UMR 6249, Besançon*
 Monique SEGURA *UMR 6173, Tours*
 Laëtitia BASSEREAU, Brigitte COLAS *UMR 5594, Dijon*
 Isabelle MOURET, Marion LANDRE, Soizic VIAOÛËT, Sophie BUI *USR 3124, Besançon*
 Jean-Marc BOURGEON *UMS 2739, Dijon*
 Sasa CAVAL, IAPS ZRC SAZU *Ljubljana*
 Béatrice FIXOIS *UMR 7041 Nanterre*
 Martine JOLY, M. MASSE, M^{me} FERNOUX *Univ. Paris IV / INHA, Paris*

Regarding the final conference, the organizers also warmly thank :

- the University staff and the Crous of Burgundy for their logistical and administrative support and recruited temps for this event ;
- the city of Dijon for the reception of the June 23 ;
- Patricia ALEXANDRE for english translations and corrections of the texts of the ArchaeDyn's team which have been done according to extremely short delays ;
- Bertrand TURINA for the layout of the preprints which have been done according to extreme conditions too ;
- Christian VERNOU, Curator of the archaeological Museum and his collaborators for the organisation of the inaugural evening of the conference ;
- The vocal ensemble "Laostic" and his choral leader, François TAINURIER as well as the Saint Bénigne parish who agreed to host their concert.

SOMMAIRE CONTENTS

- 2 Scientific committee
- 2 Steering committee
- 3 Partners
- 6 Presentation ArchaeDyn
- 8 Archaeodyn's members
- 13 Acknowledgments
- 15 Program
- 18 Presentation concert Laostic

19 Articles

- 21 Introduction

23 **Session 1 “Methods and tools of spatial analysis” (workgroup 4)**

Communications orales Oral communications

- 25 *L. SALIGNY, L. NUNINGER, K. OSTIR, N. POIRIER, E. FOVET, C. GANDINI, E. GAUTHIER, Z. KOK ALJ, F. TOLLE with the collaboration of the ArchaeDyn team*
Models and tools for territorial dynamic studies
- 45 *DUCKE Benjamin, KROEFGES Peter C.*
Managing complexity the simple way: examples from GIS modelling of human behaviour.
- 55 *KOHLER Timothy*
Agent-Based Modeling and its Application to Prehispanic Settlement Ecodynamics in the Central Mesa Verde Region: Testing Optimality in Site Location in the Archaeological Record.
- 63 *HILPERT Johanna, ZIMMERMANN Andreas*
Estimations of population densities from the Neolithic up to the 19th century: methods and results.
- 71 *ZIMMERMANN Andreas, HILPERT Johanna*
Interpretive dimensions and variability of population densities

79 **Session 2 “Catchment areas, terroirs and community lands” (workgroup 1)**

Communications orales Oral communications

- 81 *POIRIER Nicolas, GEORGES-LEROY Murielle, TOLLE Florian, FOVET Elise*
The spatio-temporal dynamic of agricultural areas, from Antiquity to modern period (ArchaeDyn Project)
- 95 *BARGE Olivier, CASTEL Corinne*
Subsistence, sustainability and population at Tell Al-Rawda: a 3rd Millennium BC town in the Syrian steppe/ Autosuffisance alimentaire et population à Tell Al-Rawda: une ville du troisieme millenaire dans la steppe syrienne
- 107 *BINTLIFF John*
Catchments, settlement chambers and demography: case studies and general theory in the Greek landscape from prehistory to early modern times.

Posters

- 119 *AUSSEL Sandra, GOGUEY Dominique, PAUTRAT Yves, SALIGNY Laure, CHARMOT A., MORDANT Claude, NUNINGER Laure*
Spatial analysis of archaeological sites in the Châtillonnais forests (Côte-d’Or, France).
- 127 *FOVET Elise, POIRIER Nicolas*
Characterization of Agrarian Resources for Archaeological Applications (ArchaeDyn Project).
- 133 *LE BRAS-GOUDE Gwenaëlle*
Diet of ancient and middle Neolithic populations in the northwest of Mediterranean. Anthropological and isotopic studies

139 Session 3 “Settlement patterns, networks and territories” (workgroup 2)*Communications orales* Oral communications

- 141 *Frédérique BERTONCELLO, Elise FOVET, Cristina GANDINI, Frédéric TRÉMENT, Laure NUNINGER with the collaboration of the members of Workgroup 2*
The spatio-temporal dynamics of settlement patterns from 800 BC to 800 AD in Central and Southern Gaul: models for an interregional comparison over the long term
- 155 *BURILLO Francisco, ARENAS Jesús, PICAZO Jesús, ORTEGA Julián, POLO Clemente, VILLAGORDO Carolina, LÓPEZ Raul, SAIZ Esperanza*
The uncorrupting mountain. Historical dynamics in the Iberian Mountain Range from 5.500 B.C. to 1.800 A.D.
- 167 *POSLUSCHNY Axel*
GIS as a means to investigate «Princely Sites», Space and Environs. New ways to answer old questions.
- 175 *VAN DEN BOSSCHE Benjamin, MARCIGNY Cyril*
Changing settlement patterns in the Normandy countryside.

Posters

- 187 *KOROBOV Dmitry*
Using ArcGIS Spatial Analyst for the investigation of the system of habitation in the Kislovodsk basin (South of Russia).
- 193 *NOUVEL Pierre, BARRAL Philippe*
Rural settlement dynamic during Iron Age in Central Gaul: the excavation and fieldwalking data head to head

195 Session 4 . “Diffusion of raw materials and manufactured objects” (workgroup 3)*Communications orales* Oral communications

- 197 *GAUTHIER Estelle, WELLER Olivier, NUNINGER Laure et avec la collaboration de : GABILLOT Maréva, QUILLIEC Bénédicte, PETREQUIN Pierre*
Models for the study of the consumption and the circulation of resources and products in France and Western Europe during the Neolithic and the Bronze Age (ArchaeDyn project)
- 211 *CORNIQUET Claire*
Mobility and circulation of knowledge among potters of the Arewa (South-Western Niger): impact of the frameworks of practice on the spatial distribution of ceramics' techniques.

Posters

- 221 *FISCHER Viktoria*
Pin consumption on the shores of lake Neuchâtel (Switzerland) during the palafittic Late Bronze Age.
- 225 *WELLER Olivier, BRIGAND Robin, NUNINGER Laure*
Spatial analysis of the Salt Spring exploitation in Moldavian Pre-Carpathic Prehistory (Romania).

233 Session 5 . Synthèse/Open synthetic session*Communication orale* Oral communication

- 235 *FAVORY François, NUNINGER Laure*
Bilan général du programme triennal ArchaeDyn/synthesis of ArchaeDyn project ArchaeDyn 2005-2007 : ambitions, achievements and accomplishments

DIET OF ANCIENT AND MIDDLE NEOLITHIC POPULATIONS IN THE NORTHWEST OF MEDITERRANEAN. ANTHROPOLOGICAL AND ISOTOPIC STUDIES.

Gwenaëlle LE BRAS-GOUDE (1,2)

1-Laboratoire d'Anthropologie UMR 5199 PACEA
Université Bordeaux 1, Avenue des Facultés
33405 Talence cedex, France
2-INRAP Méditerranée
561 rue Etienne Lenoir, KM Delta
30000 Nimes, France
hygee2@wanadoo.fr

ABSTRACT:

The aim of this communication is to characterize the individual and then the group diet of first Neolithic populations, and the ecosystem in which these populations drawn their resources. Isotopic analysis ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) was performed on one hundred human remains from early and Middle Neolithic sites in South of France and Liguria, and associated animal bones. Results indicate among others things that the difference observed may indicate an evolution of dietary choices through this period.

KEY WORDS : Neolithic, Diet, Mediterranean, Isotope, Palaeobehaviour

1. Introduction

At the end of the 7th millennium BC, social and economic changes occurred in the Northwestern Mediterranean linked with the introduction of Neolithic material culture into the region. A key change was the introduction of new methods of food production, particularly animal husbandry and agricultural techniques, as evidenced by archaeological, archaeozoological and archaeobotanic studies. These studies show that, in this geographical area, the diet of Early Neolithic populations is based on domestic (meat and milk of caprinae) and wild (e.g. marine molluscs) resources thought this of Middle Neolithic humans is predominantly based on domestic (vegetal and animal) one. Moreover, the social organisation of the middle Neolithic populations seems to be more organized into a hierarchy. The aim of this study is to bring complementary data about the individual and then the group diet of these populations. For this investigation, stable isotope ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) method has been used, on human bone collagen and associated animal bones. This article synthesizes a set of results acquired during a Ph.D. about the foodstuff of northwestern Mediterranean Neolithic human groups (GOUDE, 2007).

2. Material and method

Eleven archaeological sites were studied in which hundreds of human bones and more of faunal remains were sampled. These sites are placed in various environments (close to the sea, more inland, close to montains) between Liguria (Italy) and french Pyrenees. Chronologically they spread between the middle of VIth and middle of IVth millennium BC during the Ancient (Cardial, Fontbrégoua and VBQ cultures) and Middle Neolithic (Montbolo and Chasséen cultures) periods. For most of these sites, archaeological and archaeozoological information are available as anthropological (e.g. age, sex, stature) and funeral practices data. Although the sites come from a wide region, all the Ancient Neolithic humans studied come from cave sites in Liguria and Provence. Besides, the sites dated to the Middle Neolithic come from open air sites in Languedoc and Pyrenees area.

Stable isotope method has been used for this study, because it provides direct dietary information on the protein sources in human diets, including the relative amounts of marine vs. terrestrial and animal vs. plant protein in diets (AMBROSE, NORR, 1993; DE NIRO, EPSTEIN, 1978; SCHOENINGER *et al.*, 1983). The carbon and nitrogen isotope ratios ($^{13}\text{C}/^{12}\text{C}$: $\delta^{13}\text{C}$ and $^{15}\text{N}/^{14}\text{N}$: $\delta^{15}\text{N}$) are specific in plants

according to photosynthesis, environment and intrinsic parameters (PARK, EPSTEIN, 1960). The differences of isotope ratios in plants proteins are reflected in consumer's tissues synthesized with diet proteins (as bone collagen), with an increase in heavy isotope along the trophic web. The difference of isotope ratios in bone collagen between individuals from two successive trophic levels is +0,0 to +1,0 ‰ for $\delta^{13}\text{C}$ and +3,0 to +5,0 ‰ for $\delta^{15}\text{N}$ (DENIRO, EPSTEIN, 1978; 1981; MINAGAWA, WADA, 1984). Thus, this method provides direct dietary information on the protein consumed, including the relative amounts of marine vs. terrestrial and animal vs. plant protein in diets. Moreover, the analysis of faunal remains is necessary to target known trophic level in the ecosystem studied for each site and then to suggest a relevant interpretation of data.

The bone collagen was extracted according to the Longin's protocol adapted particularly by Brown and colleague (LONGIN, 1971; BROWN *et al.*, 1988; MORLAN *et al.*, 1990; NELSON *et al.*, 1986). The carbon and nitrogen contents and isotopic ratios are measured in 0.5 mg of freeze-dried collagen by IRMS (Isotope Ratio Mass Spectrometry, Thermo Finnigan Delta Plus XP) associated to an elemental analyzing (Flash EA System). The accuracy is 0.1 ‰ for both elements. Extraction and analysis were performed in the Department of Human Evolution (Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany).

3. Results and discussion

After checking out the preservation of extracted collagen, 70 humans¹ (27 for Ancient Neolithic and 43 for Middle Neolithic) and 91 faunal remains (54 for Ancient Neolithic and 37 for Middle Neolithic) are available and are included into the discussion (DENIRO, 1985; BOCHERENS *et al.*, 2005a; 2005b). For Ancient Neolithic period, human isotopic results² range from -21.1 ‰ to -19.4 ‰ (-20.0 ± 0.4 ‰) for $\delta^{13}\text{C}$ and from 6.2 ‰ to 10.3 ‰ (8.9 ± 1.0 ‰) for $\delta^{15}\text{N}$ and faunal isotopic results range from -22.4 ‰ to -19.1 ‰ (-20.4 ± 0.7 ‰) for $\delta^{13}\text{C}$ and from 1.7 ‰ to 7.3 ‰ (4.8 ± 1.2 ‰) for $\delta^{15}\text{N}$. For Middle Neolithic period human isotopic results range from -20.8 ‰ to -19.2 ‰ (-19.8 ± 0.4 ‰) for $\delta^{13}\text{C}$ and from 4.7 ‰ to 12.1 ‰ (9.0 ± 1.2 ‰) for $\delta^{15}\text{N}$ and faunal isotopic results range from -21.1 ‰ to -17.9 ‰ (-20.0 ± 0.8 ‰) for $\delta^{13}\text{C}$ and from 4.4 ‰ to 7.5 ‰ (5.9 ± 0.9 ‰) for $\delta^{15}\text{N}$.

These results highlight two main features. Despite the relatively close proximity to the sea, there was no evidence of any significant consumption of marine foods, at once the first steps of neolithization fixed up in this region. Indeed, the expected $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values for a marine resources consumer are higher than these recorded in the Neolithic population in south of France and Liguria (CHISHOLM *et al.*, 1982; SCHOENINGER *et al.*, 1983; SCHOENINGER, DENIRO, 1984; RICHARDS, HEDGES, 1991; SCHULTING *et al.*, 2007). The main part of the protein comes from terrestrial environment and specifically from animals (meat and dairy products), and thanks to archaeozoological data, we know that most of these animal products are acquired in the sheep and goat breeding stock (HELMER, VIGNE, 2004; HELMER *et al.*, 2005; VIGNE, 2007). Moreover, ranges of $\delta^{13}\text{C}$ of humans in both periods are similar; on the contrary range of $\delta^{15}\text{N}$ of humans is higher during the Middle Neolithic (7.4 ‰) than during the Ancient Neolithic (4.0 ‰) and the $\Delta\delta^{13}\text{C}_{\text{human-fauna}}$ and $\Delta\delta^{15}\text{N}_{\text{human-fauna}}$ are higher in Ancient Neolithic (4.1 ‰) than in Middle Neolithic period (3.1 ‰). These results suggest, first, that the consumption of animal proteins is more important during the Ancient Neolithic period, and second, that the diversity of diet is wider during the Middle Neolithic than the previous one. It may indicate an evolution of dietary choices through the first times of the Neolithic in the northwestern Mediterranean which could be in connection with the expansion of agricultural practices and perhaps migration (acquisition of food in different environments) during Middle Neolithic in Languedoc-Pyrenees region.

Stable isotope method allows the use of mathematical pattern (specifically in ecological fields) to estimate the proportion of specific animal protein in diet (e.g. PHILLIPS, 2001; PHILLIPS, KOCH, 2002; DRUCKER, HENRY-GAMBIER, 2005). But, in this study, the results were not included in this type of pattern for many reasons, particularly because isotopic values are not enough distinguished between animal species, and data from animals from different ecosystems are not available. Moreover, stable isotope method (C and N in collagen) is not currently suited to the establishment of a model linked to occupied territories during Neolithic periods in this area, among other things, because of lack of data (human and animal and also vegetal ones).

1. Individuals older than 3 years ago, to avoid the record of breastfeeding isotopic signal.

2. In consequence of their specificity (isotopic signature close to these of human), dogs are excluded of the discussion here.

Acknowledgments

This work was possible thanks to J.-J. Hublin, M. Richards, S. Bösel, A. Weiske and G. Taylor (Dpt. of Human Evolution, Max Planck Institute of Evolutionary Anthropology, Leipzig), C. Couture-Veschambre and the lab. of Anthropology (UMR 5199 PACEA, Bordeaux), M. Balasse (UMR 5197 MNHN, Paris), E. Herrscher (UMR 6578, Marseille), the persons in charge of Museums and SRA from PACA, Languedoc and Liguria regions, the archaeologists and archaeozoologists of each sites. Financial support was granted by CNRS and Aquitaine region, the Max Planck Institute and by INRAP.

Bibliography

- AMBROSE, S. H., NORR, L. 1993
Ambrose, S. H., Norr, L. - Experimental evidence for the relationship of the carbon isotope ratios of whole diet and dietary protein to those of bone collagen and carbonate, in: Lambert, J. B., Grupe, G. (Eds.), *Prehistoric human bone. Archaeology at the molecular level*, Berlin, Springer-Verlag, pp. 1-37.
- BOCHERENS, *et al.*, D. 2005
Bocherens, H., Drucker, D., Billiou, D. - Etat de conservation des ossements de la grotte Chauvet (Vallon Pont-d'Arc, Ardèche, France), *Bulletin de la Société préhistorique française*, 102 : 77-87.
- BOCHERENS, H., *et al.* 2005
Bocherens, H., Drucker, D., Billiou, D., Moussa, M. - Une nouvelle approche pour évaluer l'état de conservation de l'os et du collagène pour les mesures isotopiques (datation au radiocarbone, isotopes stables du carbone et de l'azote), *L'Anthropologie*, 109 : 557-567.
- BROWN, T. A., *et al.* 1988
Brown, T. A., Nelson, D. E., Vogel, J. S., Southon, J. R. - Improved collagen extraction by modified Longin method, *Radiocarbon*, 30: 171-178.
- CHISHOLM, B. S., *et al.* 1982
Chisholm, B. S., Nelson, D. E., Schwarcz, H. P. - Stable isotope ratios as a measure of marine versus terrestrial protein in ancient diet, *Science*, 216: 1131-1132.
- DENIRO, M. J. 1985
DeNiro, M. J. - Post-mortem preservation and alteration of in vivo bone collagen isotope ratios on relation to palaeodietary reconstruction, *Nature*, 317: 806-809.
- DENIRO, M. J., EPSTEIN, S. 1978
DeNiro, M. J., Epstein, S. - Influence of diet on the distribution of carbon isotopes in animals, *Geochimica et Cosmochimica Acta*, 42: 495-506.
- DENIRO, M. J., EPSTEIN, S. 1981
DeNiro, M. J., Epstein, S. - Influence of diet on the distribution of nitrogen isotopes in animals, *Geochimica et Cosmochimica Acta*, 45: 341-351.
- DRUCKER, D., HENRY-GAMBIER, D. 2005
Drucker, D., Henry-Gambier, D. - Determination of the dietary habits of a Magdalenian woman from Saint-Germain-la-Rivière in southwestern France using stable isotopes, *Journal of Human Evolution*, 49: 19-35.
- GOUDE, G. 2007
Goude, G. - *Etude des modes de subsistance de populations néolithiques (VI^e-IV^e millénaires av. J.-C.) dans le nord-ouest de la Méditerranée. Approche par l'utilisation des isotopes stables ($\delta^{13}C$ et $\delta^{15}N$) du collagène*, Thèse de doctorat, Talence-Leipzig, Université Bordeaux 1-Université de Leipzig, 415 p.
- HELMER, D., VIGNE, J.-D. 2004
Helmer, D., Vigne, J.-D. - La gestion des cheptels de caprinés au Néolithique dans le midi de la France, in: Bodu, P., Constantin, C. (Eds.), *Approches fonctionnelles en Préhistoire : XXV^e Congrès préhistorique de France, Nanterre (24-26 novembre 2000)*, Paris, Société préhistorique française, pp. 397-407.
- HELMER, D., *et al.* 2005
Helmer, D., Gourichon, L., Sidi Maamar, H., Vigne, J.-D. - L'élevage des caprinés néolithiques dans le sud-est de la France : saisonnalité des abattages, relations entre grottes bergeries et sites de plein air, *Anthropozoologica*, 40: 167-189.
- LONGIN, R. 1971
Longin, R. - New method of collagen extraction for radiocarbon dating, *Nature*, 230: 241-242.
- MINAGAWA, M., WADA, E. 1984
Minagawa, M., Wada, E. - Stepwise enrichment of ^{15}N along food chain: further evidence and the relation between $\delta^{15}N$ and animal age, *Geochimica et Cosmochimica Acta*, 48: 1135-1140.
- MORLAN, R. E., *et al.* 1990
Morlan, R. E., Nelson, D. E., Brown, T. A., Vogel, J. S., Southon, J. R. - Accelerator mass spectrometry dates on bones from Old Crow Basin northern Yukon territory, *Canadian Journal of Archaeology*: 75-92.

NELSON, D. E., *et al.* 1986

Nelson, D. E., Vogel, J. S., Southon, J. R., Brown, T. A. - Accelerator radiocarbon dating at Simon Fraser University, *Radiocarbon*, 28: 215-222.

PARK, R. B., EPSTEIN, S. 1960

Park, R. B., Epstein, S. - Carbon isotope fractionation during photosynthesis, *Geochimica et Cosmochimica Acta*, 21: 110-26.

PHILLIPS, D. L. 2001

Phillips, D. L. - Mixing models in analyses of diet using multiple stable isotopes: a critique, *Oecologia*, 127: 166-170.

PHILLIPS, D. L., KOCH, P. L. 2002

Phillips, D. L., Koch, P. L. - Incorporating concentration dependence in stable isotope mixing models, *Oecologia*, 130: 114-125.

RICHARDS, M. P., HEDGES, R. E. M. 1991

Richards, M. P., Hedges, R. E. M. - Stable isotope evidence for similarities in the types marine food used by late Mesolithic humans at sites along the Atlantic coast of Europe, *Journal of Archaeological Science*, 26: 712-722.

SCHOENINGER, M. J., DENIRO, M. J. 1984

Schoeninger, M. J., DeNiro, M. J. - Nitrogen and carbon isotopic composition of bone collagen from marine and terrestrial animals, *Geochimica et Cosmochimica Acta*, 48: 625-639.

SCHOENINGER, M. J., DE NIRO, M. J., TAUBER, H. 1983

Schoeninger, M. J., De Niro, M. J., Tauber, H. - Stable Nitrogen isotope ratios of bone collagen reflect marine and terrestrial components of prehistoric human diet, *Science*, 220: 1381-1383.

SCHULTING, R.-J., *et al.* 2007

Schulting, R. J., Blockley, S. M., Bocherens, H., Drucker, D., Richards, M. - Stable carbon and nitrogen isotope analysis on human remains from the Early Mesolithic site of La Vergne (Charente-Maritime, France), *Journal of Archaeological Science*, In Press, Corrected Proof:

VIGNE, J.-D. 2007

Vigne, J.-D. - Exploitation des animaux et néolithisation en Méditerranée nord-occidentale, *in*: Guilaine, J., Manen, C., Vigne, J.-D. (Eds.), *Pont de Roque Haute. Nouveaux regards sur la néolithisation de la France méditerranéenne*, Toulouse, Archives d'Ecologie Préhistorique, pp. 221-302.

ACI "Spaces and territories" 2005-2007 Archaedyn (contract ET28)

Spatial dynamics of settlement and natural resources :
toward an integrated analysis over the long term from Prehistory to Middle-Ages

Program's financial partners

Ministère de la Recherche et de l'Enseignement Supérieur

Centre National de la Recherche Scientifique

Program's partners

UMR 6249 Chrono-Environnement, Besançon (MSHE C. N. Ledoux)

UMR 5594 ARTeHIS, Dijon (MSH Patrimoine, Espace, Mutation)

UMR 6042 GEOLAB, Clermont Ferrand et EA 1001, CHEC (MSH)

UMR 6130 CEPAM, Nice/Sophia-Antipolis (MSH Nice)

UMR 6173 CITERES, Tours (MSH Ville et territoires)

UMR 6573 Centre Camille Jullian, Aix-en-Provence (MMSH)

UMR 7041 ArScAn, Paris X Nanterre (MAE René Ginouvès)

IAPS, ZRC-SAZU, Ljubljana (Slovénie)

Réseau ISA (Information Spatiale et Archéologie)

Conference's financial partners

Centre National de la Recherche Scientifique

Université de Bourgogne

MSH Dijon (UMS 2739)

MSHE Besançon (USR 3124)

Région Bourgogne

Région Franche-Comté

Ville de Dijon

Conference's organizers

ARTeHIS (UMR 5594)

MSH Dijon (UMS 2739)

Chrono-Environnement (UMR 6249)

MSHE Besançon (USR 3124)

in collaboration with

Université de Bourgogne

Réseau ISA (Information Spatiale et Archéologie)

Conference's sponsors

ESRI France

D3E Electronique

