UDK 903'1(450.36+497.4)"633/63":330.342.11
Documenta Praehistorica XXXII (2005)

The ethnography of the Cyclops: Neolithic pastoralists in the eastern Adriatic*

Dimitrij Mlekuž
Department of Archaeology, Faculty of Arts, University of Ljubljana, SI
dimitrij.mlekuz@guest.arnes.si

ABSTRACT – *Paper discusses archaeological data of the emergence and development of pastoralism on the Eastern Adriatic coast from social perspective. Formation of pastoralism is placed in the context of social changes within indigenous hunter-gathering communities. Incorporation of sheep into households brought the change in social relations of production and caused fragmentation of communities into independent, mobile households, which did not form complex social structures.*

IZVLEČEK – *V prispevku preučujem arheološke zapise o nastanku in razvoju pašništva na vzhodnojadranski obali skozi socialno perspektivo. Začetek pašništva postavljam v kontekst družbenih sprememb lovskonabiralniških skupnosti. Vključitev ovac v gospodnistva je povzročila spremembo družbenih odnosov proizvodnje in vodila k razpadu skupin na neodvisna, mobilna godpodinjstva, ki niso sestavljala kompleksinih socialnih struktur.*

KEY WORDS – *pastoralism; Mesolithic; Neolithic; eastern Adriatic*

INTRODUCTION

This paper is an attempt to write a long-term ethnography of communities in the eastern Adriatic, covering a time span approaching 5000 years. My principal aim is to explore the development and structure of pastoralism on the east Adriatic coast from a social perspective. However, the main focus is on the very short period of transformation of hunter-gatherers into pastoralists. I argue that this transformation was a revolutionary change among indigenous groups which brought a new set of social relations, a different way of life and a different perception of landscape. Thus communities akin to Homer's Cyclops emerged: small, mobile, autarchic households, with their daily life focused on herding sheep and goats.

CONTINUITY OR CHANGE: THE MESOLITHIC-NEOLITHIC TRANSITION ON THE EASTERN ADRIATIC COAST

If archaeological data used in the construction of meaningful statements about the past are perceived through a cloud of theory, then we should be extremely careful when choosing the concepts we use to understand the archaeological record. One such problematic concepts often used uncritically is that the of Neolithic. Julian Thomas (*1993*) has demonstrated in his deconstruction of 'the Neolithic' that, although the precise meaning of the concept has changed, it has always been represented as a totality, an entity that can be analysed as a coherent whole. He suggests a different understanding of the word:

...we have to consider not a thing *but a* field *composed of sometimes interlocking and sometimes unrelated social practices and traditions, elaborated by numerous relays and resistances. Over time some of them decline in their importance, and others emerge (for example, megaliths), while the whole is continually geographically variable. The Neolithic has to be broken down, and recognized as something fragmented and dispersed, localised in its effects, with no overall direction or intention behind it (Thomas 1993.390).*

This is the path I to pursue in this brief review of the archaeological record from the eastern Adriatic.

* This paper is based on PhD thesis, defended at the Department of Archaeology, Faculty of Arts, University of Ljubljana. I would like to thank Dr. Mihael Budja who supervised and guided my PhD dissertation.

I will try to demonstrate that there were different pathways which led to the mosaic of different social practices grouped under 'the Neolithic'. They may have many in common, but they also diverge in fundamental ways.

Continuity or 'gap'?

Several Mediterranean Holocene stratigraphic sequences show a hiatus between the Mesolithic and Neolithic occupations of at least several centuries if not several millennia. This 'gap' is often used as evidence of demographic depopulation – even extinction – of indigenous groups and as favouriing a demic diffusion model:

Thus it is possible to conclude that when the Neolithization of the Adriatic coastline took place the Holocene hunter-gatherers totally disappeared. All the above-mentioned data seem to support the Neolithic expansion hypothesis proposed by Ammerman and Cavalli-Sforza (Biagi and Starnini 1999. 12).

In this perspective the role of Mesolithic communities in the process of Neolithisation in the eastern Adriatic is marginalised, minimal and passive.

However, I want to argue that the concept of a 'gap' is highly problematic, and not supported by evidence. Firstly, Mesolithic settlement patterns should not be interpreted in a reductionist manner, as the proponents of the 'gap' theory do. A Mesolithic settlement pattern is not just a distribution of points in space, points that can be studied in isolation and without reference to the wider context. Instead, a settlement pattern is a remnant of wider economic, demographic and social structures. The long-term reproduction – social and demographic – of such structures is reflected in a stable settlement pattern. In this perspective the Mesolithic record becomes a densely or loosely connected network spanning large areas:

Much of the Balkan Peninsula is covered by extensive forager breeding networks, most of which were large, except in exceptionally rich environments such as the Iron Gates Gorge of the Danube. These networks were the mechanism by which physical and social reproduction were maintained, and stimulated widespread, if low-density exchange of exotic materials and/or finished artefacts (Wobst 1974; 1976; Chapman 1990) [Chapman 1994.143].

Thus 'gaps' in the stratigraphic or radiocarbon sequences of a particular site do not necessarily reflect demographic breaks and depopulations, but may be the result of changed mobility patterns or site use. Gaps, especially if they appear synchronously over a wider area, may be considered as evidence of shifts in settlement pattern. But as long as there is some evidence of human occupation in a region, then some form of demographic and social regional continuity is plausible.

Current distributions of Mesolithic sites are biased due to the rise of sea levels during the Holocene, and the Mesolithic settlement pattern is biased in favour of upland caves throughout the Dinarides, while there is a selective field survey bias in favour of lowland, open-air Neolithic sites (*Chapman 1994. 133*).

However, there are clear concentrations of Mesolithic sites along the eastern Adriatic coast, with evidence of regional continuity. The occupation of the Triestine Karst caves ends abruptly at the end of the early Mesolithic. There are caves with evidence of both Mesolithic and Neolithic occupation, but the hiatus between the 'Mesolithic' and 'Neolithic' occupations of Edera is about 1100 years. However, trapezoidal microliths have been found in contexts from Edera/Stenašca, Benussi/Pejca na Sedlu, Azzura/Pečina na Leskovcu, Tartaruga, Trincea, Monrupino, Zingari/Ciganska jama, Lonza, VG 4246 (*Montagnari Kokelj 1993*) and Mala Triglavca (*Leben 1988; Turk et al. 2004*). The stratigraphic sequence from Benussi has been as from approximately 9400 to 7900 cal BP. This date overlaps at double standard deviation with radiocarbon dates from 'Neolithic' contexts from Edera (context 3a), Podmol pri Kastelcu (layer 13),[1] and Pupićina in Istria. However, the only 'Neolithic' feature of these contexts is large number of domesticates and – in the case of Edera – pottery. Nevertheless, domesticates (sheep or goats) were also identified in a 'Mesolithic' context at Grotta Benussi (*Riedel 1975*). And although we do not have evidence for radiocarbon continuity, it is clear that there is evidence for regional Mesolithic-Neolithic continuity in the Triestine Karst.

A similar situation exists in Istria. Although there is abundant evidence of human occupation in the late

1 6610±40 BP (Poz-8053) and 6640±50 BP (Poz-8054).

Pleistocene and early Holocene, there are almost no late Mesolithic sites (*Malez 1979; Malez et al. 1979; Malez 1987; Miracle et al. 2000*). The radio-carbon gap between 'Mesolithic' and 'Neolithic' in Pupićina is about 1800 years (*Miracle 1997*). In Pupićina (and also in Edera) are Mesolithic and Neolithic layers separated by an erosional surface. On the other hand, we have a very radiocarbon date (7400 cal BP)[2] from the Mesolithic context in Podsojna peć (*Malez 1987*). This date is ealier than the 'Neolithic' date from Pupićina and the lowland site at Vižula, which proves the co-existence of 'Neolithic' and 'Mesolithic' communities in Istria.

There are many sites with evidence of both Mesolithic and Neolithic occupation in Dalmatia and the Kvarner Islands, Vela jama on Lošinj (*Malez 1979; Čečuk 1982*), Jamina Sredi on Cres Island (*Mirosavljević 1971; Čečuk 1982*), Vaganačka pečina on Mt. Velebit (*Forenbaher and Vranjican 1985*), Vogranska peč on Island Krk, Kopačina špilja on Brač, an open-air site at Lopari on on the island of Rab (*Malez 1979*), Ledenice (*Batović 1973*), Podumči (*Malez 1979*), Glavičica, Okrugla, Gospodska and Pečina u Brini (*Malez 1979*), and Vela spila on the island of Korčula (*Čečuk and Radić 2001; Bočuk and Radić 2002*). Those sites located on the Islands and in the Karst hinterland and, an intensive survey of the Ravni kotari lowlands in Northern Dalmatia yielded no Mesolithic sites (*Chapman et al. 1996*).

Similar situation can be found in the south, with number of caves in carstic hinterland in Montenegro, such as Crvena stijena (*Benac 1975*), Odmut (*Srejović 1974; Marković 1985; Kozłowski et al. 1994*), Medena stijena (*Mihajlović 1996*), Mališina stjena, Trebaćki krš (*Mihajlović and Dimitrijević 1999*) and Zelena pećina (*Benac 1958*) in Hercegovina.

On the other hand, clear evidence for stratigraphic and radiocarbon continuity is available from some sites. The clearest example comes from a shell midden site at Sidari on Korfu Island (*Sordinas 1969*). The shell midden was deposited during the Mesolithic. The earliest 'Neolithic' horizon contains abundant monochrome pottery, stone tools in the 'Mesolithic' tradition, and sheep and goat bones. There is no stratigraphic break between the latest Mesolithic and the earliest Neolithic horizon. However, a horizon with impressed ware, is separated by a sterile layer. Another example is Odmut cave in Montenegro (*Srejović 1974; Kozłowski et al. 1994*), which shows a continuity of occupation from the earliest to the latest Mesolithic.[3] Similar evidence for continuity comes from Konispol cave in Albania, with evidence of continuous occupation of the cave during the Mesolithic/Neolithic transition, although there is approximately a 100 year gap between the earliest Neolithic and the latest Mesolithic radiocarbon dates (*Russell 1998; Schuldenrein 1998*).

Another issue that has to be considered in the discussion of Mesolithic/Neolithic continuity is evidence

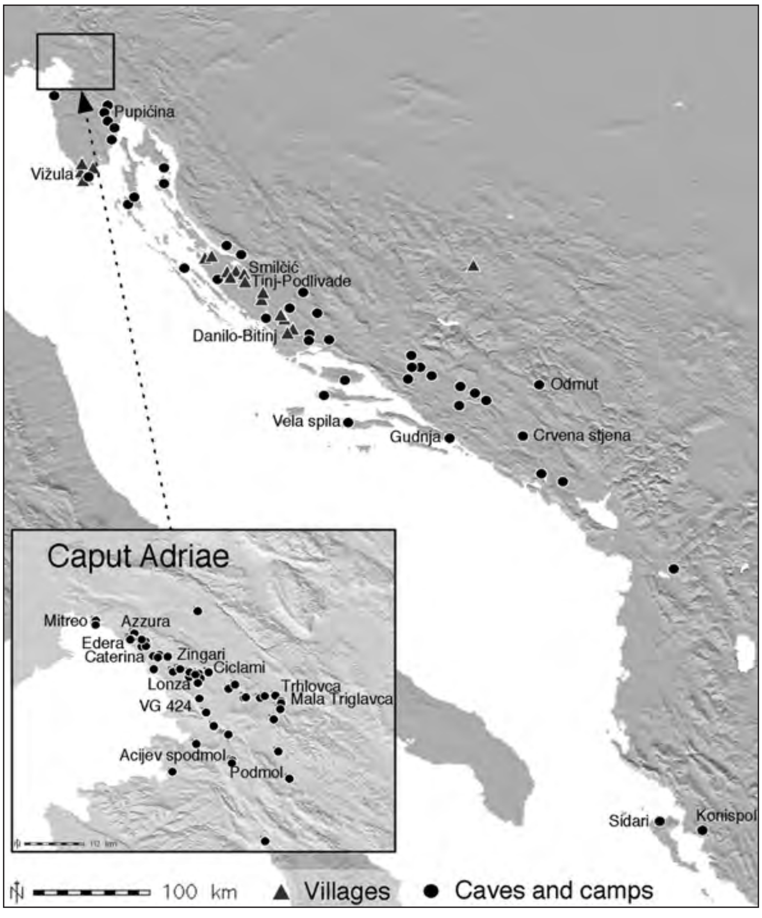

Fig. 1. Some of the sites and places discussed in the text.

2 6400±95 BP (Z–198).

3 This sequence, excavated in the 'seventies, is not without problems. If the new interpretation by Kowzlowski et al. (1994) is correct, there is a 300 year gap between the Mesolithic and Neolithic layers. On the other hand, the bones of domesticated goat were identified in late Mesolithic contexts.

of erosional surfaces between Neolithic and Mesolithic layers. This feature separates two different types of sedimentation, reworked loess and wood ash deposits typical of Mesolithic occupation, and layered heaps of ashes and charcoal typical of the Neolithic use of the caves. Erosional surfaces were noted at many sites, including Edera, Caterina, Azzura, Zingari and Lonza (*Boschian and Montagnari Kokelj 2000*) and Pupićina (*Miracle 1997*). Processes that formed erosional surfaces removed evidence of the latest Mesolithic occupation. This can be clearly seen in the case of Grotta Lonza, where the Mesolithic layer, cut by the eroded surface, is filled with a layer containing pottery (*Meluzzi et al. 1984*). In Grotta Azzura intact Mesolithic layers were found in a test trench in the front of the cave; the test trench inside the cave contained only traces of Castelnovian layers (*Cremonesi et al. 1984*). Erosional discontinuities may demonstrate intensive anthropogenous modifications of cave interiors, which happened at least once, at the beginning of Neolithic, and which destroyed evidence of late Mesolithic occupation. This interruption also marks a completely different use of caves: from gatherings of people in the 'Mesolithic' to animal shelters or stables in the 'Neolithic'. This can explain the presence of Castelnovian microliths in Neolithic deposits (*Montagnari Kokelj 1993.75*) and the presence of 'anomalous' radiocarbon dates and inversion in radiocarbon sequences.

Further eveidence which speaks against the 'gap' are the finds of domestic animals in Mesolithic contexts along the Adriatic coast. These collections are considered as highly problematic and were attributed to the various 'taphonomic filters' (*Guilaine 1993; Zilhão 1993; Rowley-Conwy 1995; 2003*). However, they were never subjected to any serious analysis and often actively dismissed as 'intrusions'. This attitude towards these finds is clearly more informative about authors' assumptions about what the 'Neolithic' is than the actual archaeological record. These finds on the Eastern Adriatic coast are too numerous (Tab. 1) to be simply dissmised. Instead of treating them as – in the best case – anomalies, I want to include them in the discussion, as another evidence of active role of indigenous groups in adopting new innovations. Instead as simplistic indicators of 'avabillity phase' (*Zvelebil 1986; 1995; 2001*), can these animals be viewed as active agents, which played an important role in prestige competitions within and among Mesolithic groups (*Mlekuž 2003*) and become the medium for the reproduction of new social relations of production. I will develop this argument below.

Site	Context	Date	Ovicaprid NISP	References
Grotta Azzura	4	Mesolithic	12	Cremonesi et al. 1984; Wilkens 1991
Grotta Benussi	5 4 3	8380±70 BP R–1045 7620±150 BP R–1044 7050±60 BP R–1043	5 8 9	Riedel 1975
Podmol pri Kastelcu	13	6610±40 BP Poz–8053 6640±50 BP Poz–8054	6	Turk et al. 1992
Pod Črmukljo		Mesolithic	1	Pohar 1986
Vaganačka pečina	1	Mesolithic	??	Forenbaher and Vranjican 1985
Crvena stijena	VI	Mesolithic	??	Malez 1975
Odmut	I	9135±80 BP Si–2228 8590±100 BP Si–2224 7790±70 BP Si–2226 7080±85 BP Si–2227	??	Srejović 1974
Vela spila	VII/1998	Mesolithic	6	Kužir et al. 2005
Šandalja	B/g, B/s	Mesolithic?	??	Brajković 2000
Pupićina peć	L19–21	6600±240 BP Z–2575	11	Miracle 1997
Grotta dell'Edera	3a	6700±130 BP GX–19569 6620±60 BP GrA–19912 6510±70 BP GrN–27229 6480±40 BP GrN–25474 6390±60 BP GrN–19820	53	Boschin and Riedel 2000

Tab. 1. Finds of ovicaprines in Mesolithic contexts of Eastern Adriatic.

The final set of evidence which challenges the demographic gap comes from the modern gene pool, especially Y-chromosome haplogroups. The population of the south-eastern Adriatic islands of Brač, Hvar and Korčula has the highest frequencies reported in Europe to date (54–66%) of haplogroup I, which originates before the last glacial maximum. High frequencies of haplogroup I imply demographic stability since the last Glacial Maximum in the Western Balkans and directly refutes migration or demic diffusion models. Haplogroups J, G and E which can be related to the spread of farming, characterise a minor proportion (12.5%) of Croatian paternal lineages (*Barać et al. 2003*).

What, then, is Neolithic?

The recognition of the Neolithic on the eastern Adriatic coast traditionally relies on the presence of pottery. However, even from this reductionist perspective we have exclusive interpretations. Batović was the first to emphasise the Mesolithic/Neolithic continuity and the internal development of the east Adriatic Neolithic. In his model, indigenous groups adopted pottery through exchange and adoption, whereas domesticates and farming caught up later and were fully integrated only at the end of the early Neolithic (*Batović 1966; 1979*). A similar position was adopted by Ruth Tringham (*1971*), who makes a strong case for continuity from Late Mesolithic to impressed ware based on the continuity of lithic technology and the association of wild fauna with impressed ware (Crvena stjena, Jama na Sredi and Vogranska peć).

Other authors gave importance to the colonisation processes. Johannes Müller (*1994*) demonstrated the importance of the Adriatic bridge for the diffussion of pottery styles from Apulia. Chapman and Müller (*1990*) detected a directional trend in the distribution of radiocarbon dates consistent with the local diffusion of the Neolithic way of life from Apulia, southern Dalmatia to the Kvarner Islands and Istria. In their scenario, the Triestine Karst remained a hunters' refugee zone well into the 6th millennium BC, when indigenous groups in Montenegro hinterland hunted goats derived from coastal farmers.

Although there are some isolated finds of impresso pottery in the Triestine karst, Lawrence Barfield (*Barfield 1971; Montagnari Kokelj 1998*) defined middle Neolithic 'Vlaška group' as the first Neolithic culture in the area. It emerged as a result of contacts of indigenous hunter-gatherers with the eastern Adriatic middle Neolithic cultures Danilo and Kakanj. Forenbaher and Miracle (*2005*) have recently elaborated Chapman and Müller's model and suggested a two-stage model for the spread of farming along the eastern Adriatic coast based on the first appearance of pottery. The initial stage was a very rapid migration into southern Dalmatia, associated with cave sites, where the second stage was a slower agro-pastoral expansion associated with open-air and cave sites along the northern coast. The mountainous hinterland formed an agricultural frontier zone, where farming was adopted piecemeal by indigenous groups. They base their argument on pottery only and treat the east Adriatic Neolithic as an unified object. However, Chapman and Müller (*1990*) clearly demonstrated that an integrated Neolithic package – domesticated plants and animals, pottery and polished stone tools – can be identified only at open-air sites.

The Neolithic on the eastern Adriatic coast is not a homogenous and totalising entity. It has different forms, which are the results of different processes, which led to the adoption of novel resources.

I believe that a key to the transition to farming on the eastern Adriatic coast is hidden in the structural dichotomy of settlement patterns (*Müller 1994.62*). The Neolithic settlement pattern is dual and complementary. Its first components were open-air settlements located in lowland, seasonally flooded areas suitable for early agriculture. They usually yield evidence of architecture, large quantities of pottery, and domesticated plants and animals. They are 'flat', with no evidence of older occupation of the area. They can be interpreted as villages, no different from early Thessalanian or early Central Balkan Neolithic sites.

Cave sites are in sharp contrast to open-air sites, located in mountainous areas, away from lowlands suitable for cultivation. They are marked by low densities of pottery and animal bones, the majority of which are ovicaprines. Cave sites are usually 'deep' with long occupational histories, often extending into the Palaeolithic. These can be interpreted as seasonal hunting or herding camps. There are differences the in density of pottery on the range of magnitude.

I believe that the dichotomy between caves and villages is deeper, and reflects not only the the different processes which led to the eastern Adriatic 'Neolithic'. What is Neolithic on the eastern Adriatic coast, and how can it be recognised? I have tried to demonstrate that the concepts of Mesolithic and Neolithic are too fuzzy to have any heuristic or interpretative use. Many authors have tried to avoid this by adopting the simplistic and reductionist position that Neolithic is a total phenomenon which can be identified by only one component of the 'Neolithic package'. My position is different. I want to argue that what we call 'Neolithic' on the eastern Adriatic coast is not a total phenomenon, but a mosaic of different social practices. The mosaic of contexts, with different components of the 'Neolithic package', do not yield evidence of 'One Neolithic' but is a reflection of the various social practices that existed along the eastern Adriatic coast. There is no single 'Neolithisation' of the Eastern Adriatic, but "several related but different processes, spanning several millenia and following distinctive regional and local trajectories" (*Halstead 1996b.306*).

We can observe at least two trajectories of 'Neolithisation' along the eastern Adriatic coast, and a number of different 'Mesolithics' and 'Neolithics'. The first trajectory can be described as a process of the integration of external innovations within the established social practices of indigenous hunter-gatherers. This trajectory begins with the formation of Mesolithic social (exchange and kinship) networks. These networks enabled the social and demographic reproduction of hunter-gatherers over a wider area, and were a medium for the dispersal of prestige items and exotic animals well beyond the 'agricultural frontier'. Consequently, in some late Mesolithic contexts in the eastern Adriatic the first domesticates appear. These finds are rare, and in some cases the evidence is most unconvincing, but they became more common and numerous in some very late Mesolithic contexts, such as Sidari on Corfu, or Grotta dell'Edera/Stenašca in the Triestine Karst. Firstly, undecorated or monochrome pottery appears. Presence of impressed ware pottery is often the only diagnostic elements for the first 'Neolithic' contexts, as some context contain remains of only or predominately wild fauna and lithic tools made in a 'Mesolithic' tradition. However, domestic animals, especially ovicaprines, are usually the main component of faunal assemblages. This demonstrates that the process of adoption of innovations was not unilinear and homogenous, but elaborated by numerous relays and resistances. However, the main change visible in the archaeological record is the new use of caves. If they were gathering of people in 'Mesolithic', sedimentation of ash from burnt animal dung, show that caves were now used as shelters for domestic animals.

A different, but related trajectory of Neolithisation begins around 7600 cal BP with the establishment of open-air sites located in areas suitable for cultivation, and containing an integrated 'Neolithic package'. These communities practiced an agro-pastoral way of life very similar to other early Neolithic village communities in Greece or the Central Balkans. Open-air settlements appear almost synchronously along the Adriatic coast around 7600 cal BP. This process is similar to the spread of cardial ware in the Western Mediterranean:

... at a level of resolution allowed by radiocarbon dating, the spread of Cardial farmers and shepherds could be described as a punctuated event, not the outcome of a slow, regular, east-west spread from one contiguous area to the next (Zilhão 1997. 21).

In analogy to the processes in the western Mediterranean the emergence of open-air sites can be attributed to the leapfrog colonisation (*Zvelebil and Lillie 2000.62*) of farming groups, which targeted niches suitable for early farming – especially the floodplains in Ravni Kotari, Zagora and Red Istria.

However, pottery and domesticates emerged before the establishment of farming villages. East Adriatic hunter-gatherers participated in exchange and demographic networks.

I believe that the advent of the Neolithic on the eastern Adriatic coast should be seen through a perspective of continuity and change. Continuity of social reproduction on the east Adriatic coast can be seen in the ways that exogenous innovations (pottery, domesticates) were absorbed by indigenous population and used as tools in the existing social system. I believe that it is extremely simplistic to understand these changes as a result of population change. Instead, I will focus on the mechanisms of internal social dynamics which led to changes in the archaeological record that are traditionally classified as 'Neolithic'.

BEYOND SUBSISTENCE: MODES OF PRODUCTION

My discussion of social dynamics which lead from hunting and gathering to pastoralism will be structured around the concept of mode of production, a focal analytical tool in Marxist analyses of political economy. Maurice Godelier (*1977*) defines mode of production as a "combination – which is capable of reproducing itself – of productive forces and specific social relations of production which determine the structure and form of the process of production and the circulation of material goods within a historically determined society".

The productive forces include the means of production (raw materials, land, tools, and machines) and the organization of production (labour power). The forces of production determine the possibilities and the constraints of the productive process, but the specific patterns of allocation and stratification are determined by the social relations of production (*Godelier 1977.36*). These social relations determine the economic use that is made of the environment, the division of productive labour, the forms of appropriation and distribution of the social product, and the value of the surplus in relation to the costs of reproduction and the utilization of the surplus (*Friedman 1974.446*).

Ambiguities in Marx's own formulations have allowed economic and technological determinist interpretations of the relationships between productive forces and the social relations of production. But it should be noted that the distinction between infrastructure and superstructure is not between institutions; it is a distinction between different functions within a single institution (*Godelier 1978; 1980*).

Godelier redefined infrastructure to encompass the processes that produce not only the material preconditions of social life, but all its pre-conditions – including e.g. kinship, which anthropologists had long claimed to have a status similar to a Marxist infrastructure. Godelier (*1978*) thus suggested that in early, pre-class societies, kinship relations are also relations of production and distribution and they are the dominant and determinant relations of production. The determination of the main organization of production at the infrastructural level of kinship is one way of facing the dilemma presented in preindustrial societies to Marxist analyses, namely between the decisive role accorded by the theory to economic forces and the fact that the dominant economic relations are in quality superstructural e.g kinship relationships (*Terray 1969; Godelier 1972*). Thus kinship, chieftainship and even ritual order appear as economic forces (*Sahlins 1972.102*).

An essential premise of Marxism is that humans are motivated by self-interest and motivated to accumulate power in order to extend that self-interest. People's interests become antagonistic to others' since they are involved in social relations for the production of materials and food, and for the reproduction of the social institutions which articulate that production. Marx and Engels defined two domains where contradictions can appear. The first is the inter-relationship between forces and relations of production. The second kind of contradictions exists between the appropriation and consumption of the surplus and the social organization of its production. If "the history of all hitherto existing societies is the history of class struggle" (*Marx and Engels 1968.35*), how can these concepts be applied to pre-capitalist societies?

Domestic mode of production

Marshall Sahlins (*1972*) identified a mode of production in foraging, simple farming or pastoralist societies. The principal relations of productions in the "domestic mode of production"[1] are those within the household. The division of labour by gender is the dominant form; marriage therefore establishes a generalised economic group. Production is motivated by the subsistence needs of the household (production for use) and therefore harbours an anti-surplus principle. However, the household unit is never completely self-sufficient, but given the emphasis on use values and livelihood, production is set low and, consequently, resources are often under-used.

Sahlins recognised two sets of contradictions inherent in the domestic mode of production. The first contradiction is the structural opposition between the forces and relations of production, where domestic control becomes an impediment to the development of productive means. This contradiction is reduced by the 'horizontal' contradiction between the household economy and the society at large, the domestic system and the greater institutions in which it is inscribed. The household is never entirely submerged in the larger community, nor are domestic ties ever free from conflicts from wider kin relationships. Sahlins believe that this conflict is masked by an uncritical ideology of reciprocity (*Sahlins 1972.124*). These two contradictions determine the transformational vectors of the domestic mode of production.

The 'centripetal' vector has roots in the first contradiction and leads to an intensification of production, where the demands of descent groups, marital alliances of different structures, or even interpersonal kin networks of different patterns encourage or even demand surplus domestic labour. But the formal solidarity of the kinship structure can be transmitted to its political aspect. As the kinship structure is politicised, especially when it is centralised in its ruling chiefs, the household economy is mobilised in a larger social cause. Political life can be a stimulus to production which generates surpluses. However, Sahlins notes that material flow in simple societies tends to be away from accumulation towards insufficiency. This often takes the form of consumption – competitive feasts – where is masked by generalized reciproci-competitive battles between individuals – accumulators – trade of goods is masked behind the ideological facade of generalized reciprocity. Feasts serve to promote ideology This vector leads to emergence of 'big-man' societies.

On the other hand we have a 'centrifugal' force, which leads to weaker kinship relationships and the economic isolation of individual households. Sahlins believes that realisation of this contradiction entails economic collapse, where there is not enough surplus to sustain relations of reciprocal sociability, and results in separate proprietary interests, which is overcome through an ideology of generalised reciprocity. However, it is in times of crises that the ideological screen of reciprocity is removed and proprietary interests become explicit.

I will tackle this transformation of the domestic mode of production in the following section, following the model proposed by Tim Ingold (*1980*) based on his fieldwork among Arctic reindeer pastoralists.

From hunting to pastoralism

The transition from hunting and gathering to pastoralism is more than merely the incorporation of new resources into hunter-gatherer societies, but a qualitative infrastructural change. The source of this discontinuity comes from new social relations of production (*Ingold 1980.94*).

Hunting and gathering is based on a principle of undivided access to productive resources (or sharing)[4], both land and animals. However, this right does not extend to the consumption of the products, which serve rather to disguise obligatory sharing as prestige-conferring generosity (*Ingold 1980.161*). In the hunter-gatherer mode of production, social relations of productions are reproduced in the interval between the kill and consumption of animals. The accumulation of material wealth within the social relations of production is not possible, as dead animals can not reproduce. Hunter-gatherers developed a series of social and ideological practices to encourage the distribution of game and the reproduction of the ideological principle of sharing. Successful individuals may subvert this ideological principle to accumulate prestige. However, the individual possession of dead animals in a hunting society exists only in the domain of ideology, and does not reflect an underlying principle of divided access.

The incorporation of tame animals in a human household, where animals gain the status of quasi-persons is the first pre-condition for pastoralism. Tame animals are ubiquitous in hunter-gatherer societies, where they have the role of pets, hunting assistants (dogs), transport animals or decoys (reindeer). They are members of households and subject to the same rules as human members.

Pastoral property relations become explicit when the status of animals changes from agents of production to sources of food. It is also a change in animals' status from quasi-persons to resources.

Sharing out – the distribution of food – reaches its widest extent in times of extreme shortage (*Ingold 1980.152*). This is in direct opposite to Sahlins (*1972. 123–48*) view, but the principle that 'no one starves unless all are starving' which Evans Prichard (*1951. 132*) observed among Nuer is even more valid for the hunter-gatherers. But this can only be achieved at the expense of the deterioration of intra-domestic relations. The ultimate realisation of this extreme is marked by changes in the status of members of the household, their conversion into food, whose consumption is limited to the household. This applies more usually – although not exclusively – to domestic animals. Pastoralism thus begins with the negation of social relations within the household, where the status of animals is reduced from quasi-persons to food (*Ingold 1980.150–61*).

Animals in the pastoral mode of production become means of reproducing the social relations of pastoral production. Reproduction and the multiplication of domestic animals make possible the accumulation of wealth (*Ingold 1980.144*). The slaughter of domestic animals frees people from obligations of sharing that apply in the case of hunted animals. Social fragmentation into autonomous, self-sufficient domestic units is therefore not the cause, but the effect of drawing on domestic herds for subsistence. Thus auto-

4 Ingold (*1986*) emphasised two structurally different forms of sharing. *Sharing out* is a act of distributing resources, whereas *sharing in* is a principle of undivided access to resources, which inheres in hunter-gatherer social relations and practices.

nomy in the realm of property characteristic of the pastoral household derives from a domestic division of labour, and ultimately forms the structure of the human family itself (*Ingold 1980.151*). The rationality of accumulation follows the fragmentation of economic responsibility, for whereas hunters derive a collective security through the ideology of sharing, pastoralists ensure themselves against catastrophes by maximizing their herds (*Ingold 1980.89*).

In Ingold's model, animals must be capable of functioning both as labour and its subject-matter in order to support a direct transformation from hunting to pastoralism. This includes reindeer, which are often used as draught animals or hunting decoys in hunter-gatherer groups, but excludes sheep and goats, which cannot be employed as transport animals. It is therefore scarcity of prey that encourages owners of domestic herds to draw off from their domestic herds.

But on the eastern Adriatic coast the animals involved in transition from hunting and gathering to pastoralism were obviously ovicaprines, goats and sheep. Are there any other trajectories of transformation from hunting-gathering to pastoralism?

I believe that pressures on households to begin transforming their animal members into food might be found in the context of prestige politics (*Hayden 1990; Dietler 2001; Hayden 2001; Hayden 2003*). Exotic domestic animals – sheep and goats – may become available through hunter-gatherer exchange networks. They are included in the households of successful middlemen who control exchange networks (*Bender 1978; Bender 1981*). The demand for surplus and exotic foodstuffs in competitive battles among prestige-aspiring individuals may result in a chain of events as in Ingold's scenario. Wealthy accumulators would use their own exotic animals to attract followers. Those animals – although shared out – are beyond the obligations of sharing that apply in the case of hunted animals. When they begin to reproduce in hunter-gathering societies they also reproduce new relations of production. This opens the way to the accumulation of wealth, and leads to the fragmentation of economic responsibility. Animals, formerly used to promote social cohesion and integration, at the point when they become a source of food actually reverse this process and lead to the fragmentation of society into autonomous households.

Carnivorous vs. milch pastoralism

The accumulation of the herds as the exclusive property of particular households is a for the condition of emergence of what Ingold calls 'carnivorous pastoralism'. Carnivorous pastoralism is no more effective than hunting. In the long term it is often less effective because of the age structure of herds being biased towards older animals, high concentrations of animals on pastures, and increasing vulnerability to diseases. Carnivorous pastoralism can not be seen as intensification of hunting, but as a mode of production with the complete autonomy of the household in the sphere of its property characteristics (*Ingold 1980.87*).

Carnivorous pastoralism is a small stock economy, with no possibility of conversion to large stock (*Ingold 1980.178*). Small stock is usually exploited for meat; although milked on occasion, it is not specialised for this purpose. The have very high rates of increase – up to ten times greater than that of cattle – but they are particularly vulnerable to epidemics (*Dahl and Hjort 1976*). With no alternative form of security avalaible, a household is forced to accumulate herds by minimalising their off-take. Carnivorous pastoralism thus combines a restriction of household size with a tendency toward the maximal concentration of animals. Households in carnivorous pastoralism avoid reciprocal obligations beyond the household: "the successful pastoralist hoards rather than hosts" (*Paine 1971.167*). This leads to what Barth calls a "very careful life". Hospitality is definitely not a feature of carnivorous pastoralism.

Sheep and goats are gregarious by nature and may not require too much labour. On the other hand, large stock require more management, which places constraints on the number of animals that can be maintained by a single household. Resource extraction from milch animals constitutes an essential part of their everyday care, which means greater labour demand, whereas extraction from meat animals coincides with the end of care. The milch pastoralist's wealth in large stock is therefore equal to the abundance of labour force, women and children. Thus the availability of labour sets a limit on herd size.

This enables alternative forms of security to emerge. The main strategy is the circulation or redistribution of stock among households. Wealthy owners whose holdings exceed the maximum manageable size will find it mutually advantageous to loan or give some animals to other households. Conversely, if someone man is short of animals, they may seek gifts or loans from the better-off (*Dahl and Hjort 1976.136–37*). Animals produce milk for the household where they are situated, irrespective of who owns a particular animal; however, the owner retains control over the slaughter of an animal and over its offspring.

Alternatively, complementary types of animals allows poorer households to exploit the high reproductive potential of small stock to build their herds and then exchange them for larger stock (*Dahl and Hjort 1976.230–34*). While in a carnivorous pastoral economy a herd is the exclusive property of the household, households in milch pastoralism spread their interests by distributing animals as gifts and loans to a range of stock-associates. Milch herds typically consists of animals from a number of separate owners under the management of a single household. This establishes a network of social relations between households which are reflected in herds. Animals become symbols of social cohesion (*cf. Evans-Pritchard 1940*).

Another difference between carnivorous and milch pastoralism lies in the different status of animals. While animals in carnivorous pastoralism become resources, the staus of animals in milch pastoralism is not unlike that of tame animals in hunter-gatherer societies. Milk animals *produce* milk and are therefore agents of labour rather of its subject. In terms of social relations between animals and people and between people with respect to animals, milch pastoralim has nothing in common with the exploitation of domestic herds for meat. Carnivorous and milch pastoralism are not related modes of production (*Ingold 1980.200*).

ETHNOGRAPHIC MEAT ON ARCHAEOLOGICAL BONES?

Distinguishing different types of pastoralism on the basis of social relations between animals and people and between people with respect to animals is extremely important when discussing ethnographic data as an analogy for past pastoral systems. Could the exceptionally rich ethngraphic data on various pastoral strategies from the Dinarides and the eastern Adriatic coast shed any light on the structure and development of Neolithic pastoralism? My suggestion is that the ethnographic and historical data on traditional subsistence strategies should be approached with caution.

There is a variety of different pastoral systems recorded in the Dinarides and the eastern Adriatic (*Dedijer 1916; Leban 1950; Umek 1956; Cvijić 1966; Marković 1971; 1980; Smerdel 1989; Vinščak 1989; Smerdel 1999*). The most common form of pastoralism was integrated into arable farming. Farmers kept domestic herds as sources of milk, wool, manure and meat. Herds served as a form of 'animal capital', as buffers against failed harvests and political crises. There are different levels of dependence on livestock, from farmers who kept only a few sheep to sedentary pastoralists who combined the herding of relatively large flocks with the cultivation of grain for domestic consumption. However, most herds were small and diversified, average flocks on the Triestine Karst being no larger than 15 animals combined of sheep, goats, cattle and horses/mules. This number was larger in Čičarija, where herds reached 80 animals, most of them sheep and goats (*Vilfan 1957*). Mobility was restricted to the confines of the local community or to the top of the local mountains; flocks grazed on communal land, marginal for cultivation. Specialised forms of transhumant pastoralism and nomadic pastoralism were practised almost exclusively by the Vlachs, who exploited a no-mans-land between the Ottoman and Venetian states, supplied both sides with animal products (*Wace and Thompson 1914; Marković 1971; 1980*).

Probably the most important lesson we can learn from the study of traditional pastoralism is that modern practices should not be seen as fossil strategies from the distant past, and timeless responses to seasonal climatic extremes, but as dynamic responses to extremely complex natural, historical and economic processes. Instead, I take the position of 'radical defamiliarisation' of Neolithic subsistence practices. I believe that Neolithic pastoralism was something quite different from anything we can experience now (or a few decades ago) in the eastern Adriatic. Structurally equivalent ethnographic analogies for Neolithic economies should therefore be sought elsewhere. I suggest two examples which can shed a light on Neolithic pastoralism: the north American Navajo Indians, and the Cyclops from Homer's Odysseus.

The Odyssey can be read as an ethnographic text describing the pastoral society of 'the lawless and inhuman' Cyclops (*Odyssey IX*). The Cyclops are pastoralists, herders of sheep and goat flocks. They do not cultivate land, eat bread or respect gods. Their main animal product seemproduct seems to be milk, as Polyphemus' daily schedule includes milking, separating lambs from lactating ewes and dairying. This way of life was so remote to the Greeks that the Cyclops cannot be classified as human; instead, they are portrayed as monsters.

However, the social institutions described in Odyssey are closer to those of carnivorous pastoralism. Cyclop society is fragmented into autarchic households which are economically and politically independent: 'They have no laws nor assemblies of the people, but live in caves on the tops of high mountains; each is lord and master in his family, and they take no account of their neighbours' (*Odyssey IX. 112–115*). Weak coalitions are formed only in times of conflict; this is obvious from the other Cyclops' reluctant response to Polyphemus' call for help when blinded by Odysseus. One of the most striking features of carnivorous pastoralism is the absence of any formal rules of hospitality. This is, of course, a consequence of the fragmentation of economic responsibility, which can be obtained only by maximising herds. The lack – or rather, the opposite – of hospitality is shown at its most extreme when Polyphemus kills and eats Odysseus' six companions, and not a single goat or sheep from his herd.

The detailed descriptions of the organisation of space and herding techniques are revealing. Cyclops live in caves, which also serve as folds for their flocks. The description of these caves is surprisingly similar to the cave-pens which are still used as shelters for flocks in Dalmatia. The cave space is structured by folds which serve to separate ewes from lambs and rams. Flocks consist of goats and sheep and are taken to pasture every morning. In the evening they are returned to the cave, where they are milked

The descriptions of herding practices in The Odyssey are precise and seem to document existing practices experienced by the author(s) at the time the epic was created. However, there is obviously an older layer in the epic, describing social institutions and ways of life (the absence of agriculture, specialised carnivorous pastoralism, and the social relations typical of this mode of production) which was seen as both fascinating and strange to the Aegean society of the early first millenium BC. The Cyclops in the Odyssey can therefore be seen as evidence for existence of a specialised, almost 'pure' carnivorous pastoralism somewhere on the fringes of the Aegean world.

A fascinating insight into the introduction of pastoralism to hunter-gatherers, and their subsequent transformations can be gained from accounts of the colonisation of the American Southwest by the Spanish. Before the adoption of pastoralism the Navajo were hunter-gatherers and small-scale farmers. As a consequence of an increased reliance on agriculture, the Navajo became more sedentary and tied to their maize fields. Sheep were brought to the Southwest by the Spaniards in the 1600s. Exactly when the Navajo began herding sheep rather than taking them for food is unknown, but reports indicate that herding had begun by the early eighteen century. A process of structural change in Navajo society began soon after 1700, and within only a matter of decades they had become a full blown pastoral society. Domestic herds caused the fragmentation of extended families into independent households, and increased mobility (*Bailey 1980*).

Before the 20th century Navajo households practised subsistence pastoralism combined with small-scale cultivation of maize fields. Herds and maize were used for direct consumption, not for trade, and most households owned no more than the minimum numbers needed for direct consumption, which is estimated to be around 250 sheep per household (*Kelley and Whitley 1989.49*).

Navajo herding practices were extremely simple, as rams were not separated from the herd. Combined with the extreme reproductive potential of *churro* sheep, this allowed herds to increase faster (*Kelley and Whitley 1989.90*). Because of large herds and pressure on pastures, various patterns of mobility emerged. Most households practised vertical transhumance, with up to three residences over an annual cycle, although other systems of nomadic mobility were devised:

The people moved around most of the time, herding their sheep from place to place. The people travelled mostly on horseback; when moving with the sheep, we used horses to carry our belongings. The main reason for moving around like that was to look for new grazing ground and water for the sheep and horses. We never stayed at one place very long; we would spend a few days here, and then move on to some another location (Frisbie and MacAllester 1978.29–31).

Of course, the Navajo can not serve as direct analogy for the emergence of pastoralsim in the eastern Adriatic; however, it can provide insight into the consequences of changed social relations of production caused by the adoption of herding. This change fragmented extended families into autonomous households; it increased mobility, and modified settlement patterns.

Both examples can be useful in adding 'meat to bones' of, but the 'bones' – structure and development –

of Neolithic pastoralism should be built from the ground up, based on the fragmentary archaeological data.

PIECING THE BONES TOGETHER: NEOLITHIC PASTORALISM

The principal questions that interest me in building the 'skeleton' of the Neolithic pastoralsim in the eastern Adriatic are those related to the scale and specialisation of hunting and pastoral economies in a long-term perspective, the seasonality of practices in a landscape, patterns of exploitation of animal products and the structure of settlement patterns.

Faunal Assemblages

The subject of analysis are 97 faunal assemblages from more or less well defined stratigraphic contexts[5] from 21 sites in the eastern Adriatic and *Caput Adriae* (the assemblages used in the analysis can be accessed on the *Documenta Praehistorica* homepage: http://arheologija.ff.uni-lj.si/documenta/v32mlekuz_sup.html). Data was collected from available published reports. An obvious problem with such diverse sources is the comparability of sampling strategies (use of sieving etc.), applied analytical methods, and the level of detail available in the reports. Only mammal remains were used in the analysis, since information about other resources is either incomplete or lacking. All assemblages were screened for obvious inconsistencies and some adjustments have been made to the bone counts derived from the original reports in order to enhance comparability among sites. Where necessary, worked bone and shed antlers were not included in the counts used in the analysis. In general, the categories used comprise the number of bone fragments identified to species level. Some modification was required in the case of bones such as *Sus* sp. and *Bos* sp. Most 'Neolithic' assemblages contain representatives of both wild and domestic forms of cattle and pig. Many also contain bones which, due to high fragmentation and intermediate size, can only be identified to genus level. In order to increase the comparability of assemblages, bones identified as *Bos* sp. and *Sus* sp. were counted as *Bos taurus* and *Sus domesticus* in 'Neolithic' and 'transitional' assemblages (phases 1, 2, 3,

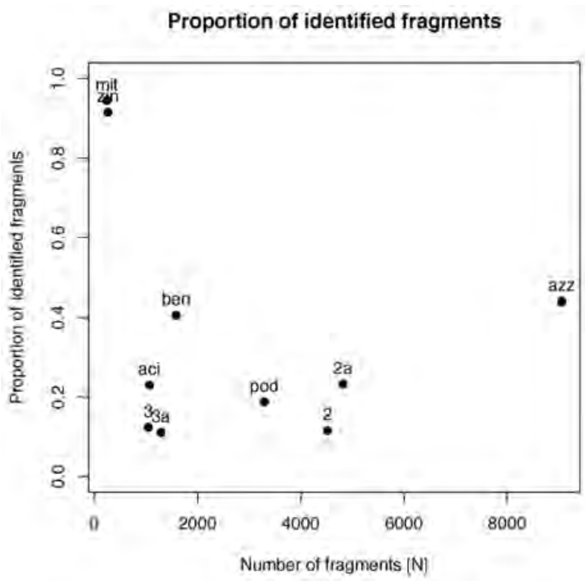

Fig. 2. Proportion of identified fragments versus sample size for sites: Grotta dell'Mitreo/Mitrej (*Petrucci 1997.100*); Grotta degli Zingari/Ciganska jama (*Bon 1996.127*); Grotta Benussi/Pejca na Sedlu (*Riedel 1975.128*); Acijev spodmol (*Turk et al. 1992b.34*); Podmol pri Kastelcu (*Turk et al. 1992a.71*); Grotta Azzura/Pečina na Leskovcu (*Cremonesi et al. 1984.28*); Grotta dell'Edera/Stenašca, layers 3a, 3,2a, 2 (*Boschin and Riedel 2000.Tab. 3*).

4; see below) and as *Bos primigenius* and *Sus scrofa* in 'Mesolithic' assemblages (phase 0, Fig. 3). For the same reason, bones identified as *Ovis aries*, *Capra hircus* and '*Ovis* or *Capra*' were grouped together as ovicaprines.

The assemblages discussed here are not the simple result of *châines opératoires*[6] streaming through the sites; they are reworked by a series of taphonomic filters, which transformed them in many ways. A comparison of proportions of identified fragments and assemblage sample sizes (Fig. 2) can reveal taphonomic traces related to the collection, recording and publication of assemblages. The percentage of identified fragments is usually well below 50%, except in Grotta dell'Mitreo/Mitrej and Grotta degli Zingari/Ciganska jama, both with low sample sizes. It is obvious that in these two cases the excavators chose to collect and record only identifiable fragments. Assemblages from other sites seem less modified by collection and recording strategies, although there are considerable differences. However, there is no correlation between percentages of iden-

5 See Tomaž Fabec's (*2003*) critical analysis of stratigraphic contexts from *Caput Adriae*.

6 I believe that the *châine opératoire* or operational sequence (*Leroi-Gourhan 1988*) approach to the study of animal remains in the landscape can be extremely fruitful. Instead on paying attention on the the static assemblages found in the sites, operational sequences focus attention on the dynamic processes of selection, transport, consumption and deposition within the landscape and in the social and cultural perspective.

tified fragments and sample sizes, neither can differences be attributed to the identification skills of individual analysts (Grotta Azzura/Pečina na Leskovcu (45% of identified fragments) was analyzed by B. Wilkens, whereas A. Riedel analyzed Grotta Benussi/Pejca na Sedlu (45%) and Grotta dell'Edera/Stenašca (10–25%)). It might be significant that both 'Mesolithic' sites (Grotta Azzura/Pečina na Leskovcu and Grotta Benussi/Pejca na Sedlu) have the highest percentage of identified fragments, whereas the percentage for 'Neolithic' sites is much lower. This may reflect structural changes in taphonomic processes which correlate with the Mesolithic-Neolithic transition and may be connected to changes of activities performed on the sites.

Faunal assemblages were grouped into four chronological phases (Fig. 3) in order to understand changes in animal use. However, loose stratigraphic control over contexts, a general lack of radiocarbon data, and difficulties connected with traditional chronologies based on pottery and lithic typology mean that this chronological sequence has only heuristic value, and does not pretend to challenge established local chronologies.

Phase 0 consists of assemblages from contexts identified as 'Mesolithic' on the base of lithic typology and absence of pottery. Phase 0 faunal assemblages consist exclusively of wild animals. Phase 1 includes 'transitional' assemblages, with a mix of traditional 'Mesolithic' elements (the presence of a Castelnovien tool-kit) and 'Neolithic' elements such as domesticates and pottery. Phases from context attributed to the 'Vlaška group' on the basis of pottery typology are grouped in phase 2. Phase 3 assemblages derive from loosely defined 'late Neolithic' contexts. Assemblages from phase 4 are from 'late Eneolithic/early Bronze Age' contexts defined by the presence of 'Ljubljana culture' pottery.

Phase	Edera	Mitreo	Ciclami	Azzura	Gigante	Zingari	Tartaruga	Benussi	Mala Triglavca	Trhlovca	Podmol	Acijev spodmol	Pupićina	Pod Črmukljo	Šebrn Abri
4		A3,5					6		3	C D E	D C E				
3	2	AB4 AB5,6	6		*		7		4 5 6 7	F	G H I [illegible]	E			
2	2a	AB6,8	7 8			5			8 9	G H	K L M	F			
1	3 3a			P 1 - 5				3 4 5			18		19-22		
0				6 - 16-17				6	*				23-24 25-27 38-30	*	3a 3b 3c 3d

Fig. 3. Chronological divission of assemblages into five phases.

Sums of available radiocarbon dates (Fig. 4) display all the problems connected with phasing. Phases are chronologically fuzzy and overlapping, sometimes even significantly (phases 2 and 3). However, the distribution of radiocarbon dates does display a general pattern of succession.

Specialisation and diversification

Faunal assemblages display considerable differences in terms of their general structure, as well as in the relative contribution of major taxa. One way of investigating these differences is through an analysis of assemblage diversity. A faunal assemblage dominated by one species would suggest the potential for large-scale specialised herding, whereas a mixed assemblage suggests the reverse: diversified and small scale herding.

Specialisation refers to concentration on one or a very limited range of species. The economic rationale may be to focus on animals with greater productivity in local environments or on animals with specific desired yields. Thus in the context of carnivorous pastoralism it may be desirable to focus on small stock which have extremely high reproductive capacities and allow rapid accumulations of herds. Specialisation is often a risky strategy, since all stock may be affected by localised disease or disaster. However, the relative expense of maintaining exclusively one kind of stock may be expected to decrease with a large number of animals, primarily due to the organisation of labour, which is aimed at the rather predictable requirements of only one species (*Glass 1991.32; Halstead 1996a.24*).

Specialisation is a common response of subsistence agriculturalists to the introduction of a market economy. For this reason it has generally been regarded as representing a late development, facilitated mainly by the establishment of inter-regional economic systems integrated into a world market. However, carnivorous pastoralism is often based on only one species, for example reindeer in the case of Siberian peoples (*Paine 1971; Ingold 1980*), or sheep and goats in the case of the Navajo (*Bailey 1980*) or Basseri (*Barth 1961*). It can even be said that it is specialisation, which does not enable conversion of stock and therefore alternative forms of security, which drives households towards the accumulation of herds and the fragmentation of economic responsibility (*Ingold 1980*).

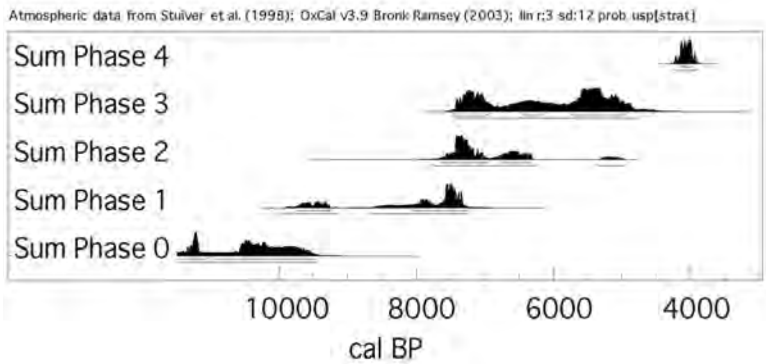

Fig. 4. Sums of radiocarbon dates for chronological phases. Radiocarbon dates used can be found on the Documenta Praehistorica homepage: http://arheologija.ff.uni-lj.si/documenta/v32mlekuz_sup.html

Diversification refers to a strategy in which multiple kinds of animals are kept, and are usually managed for different products. There are many advantages to be gained from the diversification of stock-holding. Since different animals graze on complementary plants, their combination permits a more effective utilisation of land. They are attacked by different diseases and parasites, so a diversified herd is less vulnerable to loss of due to diseases. Diversification may help to even out irregularities in the food supply, for in pastoral species oestrum, duration of gestation, and lactation periods vary. Moreover, the presence of different stock within pastoral economy creates the possibility of conversion from one to another through exchange (*Dahl and Hjort 1976.223–30*).

Measuring diversity

Diversity, as used here, is a measure of variability in the composition of an assemblage. It is comprised of two components: richness and evenness. Richness refers to the number of taxa in an assemblage; evenness describes the relative proportion of each taxon in an assemblage (*Grayson 1984; Kintigh 1984; 1989; McCartney and Glass 1990*). Evenness is measured with Shannon-Wiener information statistics (H) divided by the maximum value for observed richness (H_{max}). Division by H_{max} removes the effect of richness and normalises evenness into the 0, 1 interval.

Measures of richness and evenness have been shown to depend greatly on sample size. Both rgression and simulation methods have been proposed to control for the effect of sample size (*Grayson 1984; Kintigh 1984; 1989; McCartney and Glass 1990*). While sample size can be important information in itself (see below), variability in sample sizes among sites presents one of the most obvious difficulties in comparing faunal assemblages. The huge variability in sample sizes for analyzed assemblages, which range from a few to a few thousand fragments, and relatively poor control over the taphonomic histories of published assemblages makes it critical to consider sample-size effects.

The effect of sample size on diversity is evaluated using a Monte Carlo simulation (*McCartney and Glass 1990*). This involves constructing a background population of species frequencies from a group of assemblages. This hypothetical parent population is then randomly sampled a set number of times at various sample sizes. Mean values and confidence intervals are calculated for each sample size. Each individual assemblage can be compared to this range, and the likelihood that it derives from a background population can be evaluated. In this study, the background population was constructed using a variation of Kintigh's procedures described in (*McCartney and Glass 1990*).[7]

The program generates expected values and 95% confidence intervals for richness and evenness. Separate simulations were run for each case. Throughout the analyses faunal assemblages were quantified using numbers of identifiable specimens (NISP). Other measures (e.g. minimum number of elements, MNE) give a more reliable estimate of abundance, especially in contexts where fragmentation is variable between species and/or identifiably of bones varies significantly between taxa (*Miracle 1996*). However, variable levels of detail in published assemblages allowed only the use of NISP, which was the common denominator for all publications. The null hypothesis for each simulation is that all assemblages derive from the same background population.

7 This procedure was implemented in a software program which can be accessed on the Documenta Praehistorica homepage: http://arheologija.ff.uni-lj.si/documenta/v32mlekuz_sup.html

Faunal assemblage diversity

In the first simulation, *Caput Adriae* assemblages were compared against all eastern Adriatic assemblages (Fig. 5). This simulation is aimed at detecting general trends in the diversity of assemblages and examining the effect of sample size on the diversity of assemblages.

The simulation of the effect of the sample size on taxonomic richness in mammal assemblages shows an approximate logarithmic relationship between richness and sample size.

The slope of the line representing the mean expected evenness decreases slightly with the higher sample size. The width of the 95% confidence interval decreases with larger sample sizes, showing that somewhat greater degrees of random variability are to be expected at lower sample sizes than at large ones. The scatter of points showing actual values of faunal assemblages very roughly reflects these same characteristics. They fall in a relatively steeply sloping linear band, which is much broader at small sample sizes. The points do not all fall within the limits defined by a 95% confidence interval for each simulated point. Therefore the null hypothesis can be rejected: the assemblages are not derived from a single parent population. The majority of assemblages displays greater evenness than the hypothetical population; they are therefore more diversified than expected. But almost all assemblages with sample sizes greater than 300 fragments have lower than expected evenness. This may be due to the effect of sample size, or may reflect deeper structural properties of animal economies in the eastern Adriatic. It is apparent that assemblages from the region tend to have larger sample sizes and lower evenness, and can be found in the lower left portion of the graphs; some assemblages tend to cluster with *Caput Adriae* assemblages.

The result of the analysis suggests that sample size is a major factor structuring differences in richness and evenness. It also indicates that the assemblages cannot be assumed to come from a single population, or at least not from one resembling the hypothetical population. It is apparent that most *Caput Adriae* assemblages tend to be characterised by small sample sizes and high diversity. Larger assemblages tend to be more specialised, which is consistent with the observation that faunal assemblages dominated by one species would suggest a potential for large-scale, specialised herding.

The second batch of simulations was run on data from selected sites. The main issues pursued here are related to temporal changes in assemblage diversity.

Mala Triglavca and Trhlovca are two contemporaneously occupied caves, with very small assemblages (Fig. 7). A relationship between sample size and richness is expected, except for a cluster of assemblages from Mala Triglavca which have lower richness than expected. The evenness values of assemblages from Mala Triglavca display a sharp threshold in phase 2, from very specialised to relatively diversified assemblages in phases 3 and 4. Assemblages from Trhlovca are apparently more diversified than expected during phases 2, 3 and 4.

The case analysed is Grotta dell'Mitreo/Mitrej, a cave with relatively small assemblages which span from the Neolithic to the Bronze Age (Fig. 8). There is a distinctive cluster of assemblages with much lower richness than expected; most of those assemblages are early and less diverse than expected. The earliest assemblages (AB6, A5, B5, phase 2) tend to be less diverse, and the latest (A4, phase 3; A3, phase 4) are more diverse than expected. This pattern is less pronounced with larger samples (excavations by *Centro di Antichitá Altoadriatiche*; (*De Piero Steffèe 1978*)). However, at Grotta dell'Mitreo/Mitrej there is an apparent trend toward increased diversity of faunal assemblages during the Neolithic (phases 2, 3 and 4).

Grotta dell'Edera/Stenašca assemblages are relative large and span the 'transitional' period (layers 3a and 3; phase 1) and the 'Neolithic' (layer 2a, phase 2

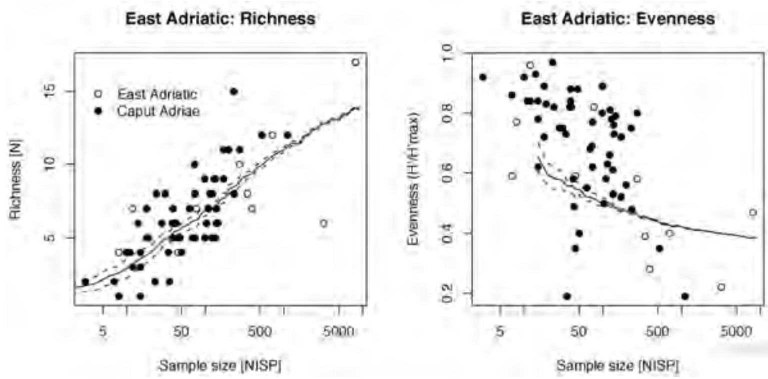

Fig. 5. Result of richness and evenness simulation for assemblages from eastern Adriatic.

and layer 2, phase 3). Although there is an expected relationship between sample size and richness, there is a dramatic change in the evenness of assemblages from less diverse than expected assemblages in phase 1 to less diverse than expected in phases 2 and 3 (Fig. 9). This change is also marked by the pronounced step in sample sizes, where the latter samples are larger by an order of magnitude.

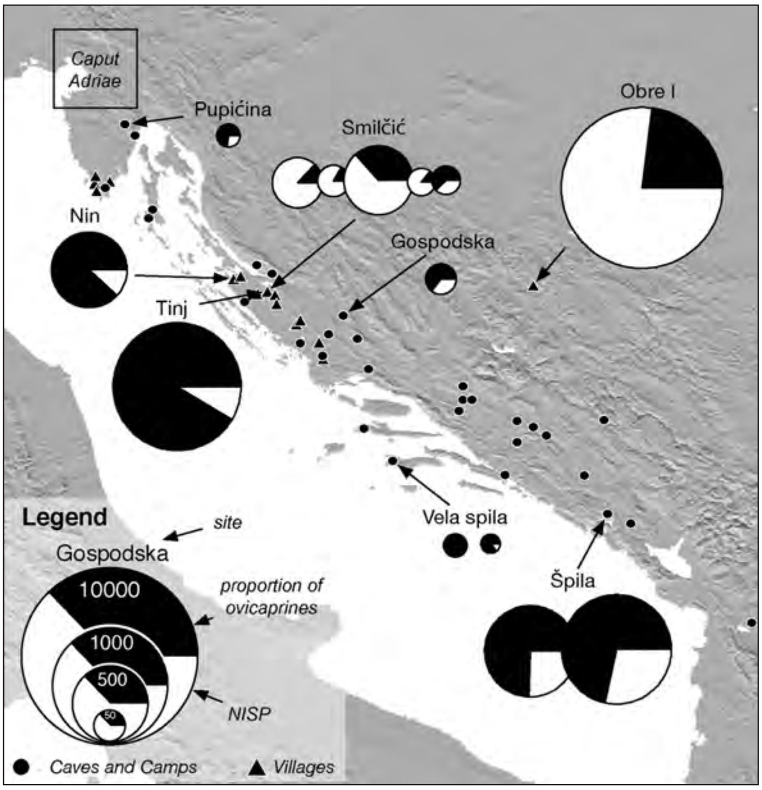

Fig. 6. Assemblages from the Eastern Adriatic. Note the large differences in assemblage sizes.

Selected cases from the *Caput Adriae* demonstrate that there are different trajectories of assemblage composition. In Mitreo/Mitrej there is an obvious trend for more diverse assemblages during the Neolithic and Eneolithic (phases 2, 3 and 4). On the other hand, there is a dramatic decrease in diversity from the transitional period to the Neolithic in Edera/Stenašca, where assemblage diversities remain low. Selected examples tend to demonstrate different temporal changes in the diversity of faunal assemblages. Is there a general trend? In Figure 10, a histogram of evenness values was produced for assemblages from different phases. All phase 1 assemblages can be found in the left-hand portion of the histogram, indicating the absence of highly specialised assemblages. These appear in phase 2; however, highly diversified assemblages still exist, and tend to be more numerous in phase 3, which is marked also by the disappearance of the? most specialised assemblages. Only highly diversified assemblages can be found in phase 4.

At this point it is evident that phase 2 is marked by the appearance of very specialised animal management systems, which co-existed with more diverse ones. In phases 3 and 4 a trend towards diverse assemblage compositions can be observed. I will try to explain this trend with an analysis of composition of assemblages and of the main animal products.

Assemblage composition

Since sheep and goats tend to be the largest component of faunal assemblages, I will analyse their role in structuring assemblage diversity. Figure 11 is a histogram of the proportion of sheep and goat in assemblages from different phases. In most of phase 1 assemblages sheep and goats tend to be a minor component, usually comprising less then 40% of the assemblage. In phase 2 a bimodal distribution can be observed. There are some assemblages with relative low proportions of sheep and goat, and a large number of assemblages with high proportions of ovicaprines. Almost no assemblages with moderate proportions of ovicaprines can be found. This changes in phase 3, where we can observe a normal distribution of proportions of sheep and goat, with most of assemblages composed of

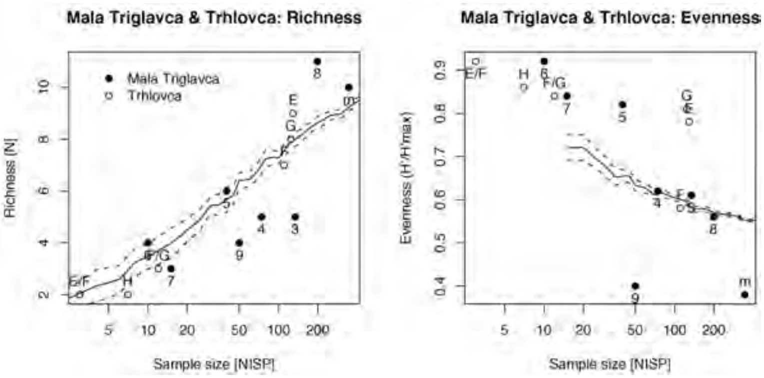

Fig. 7. Result of richness and evenness simulation for assemblages from Mala Triglavca and Trhlovca.

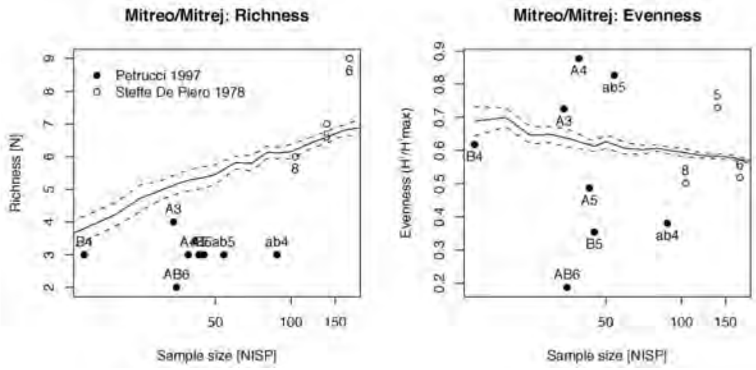

Fig. 8. Result of richness and evenness simulation for assemblages from Grotta dell'Mitreo/Mitrej.

50% of sheep and goat. A similar, but less pronounced picture can also be seen in phase 4, where there are no assemblages with high proportions of ovicaprines.

A similar picture emerges when we compare proportions of sheep and goat in the assemblages to their evenness (Fig. 12). Phase 1 assemblages tend to cluster in the upper right part of the scatter plot, with high diversity and low proportions of sheep and goat in assemblages. Assemblages with high proportions of sheep and goat and low diversity appear in phase 2. Phase 3 assemblages tend to display lower proportions of sheep and goat, and higher diversity, which becomes even more evident in phase 4.

This observation is further supported by the results of correspondence analysis[8] of faunal assemblage compositions (Fig. 12).

The first dimension, factor 1, which accounts for about 48% of variability, differentiates most clearly between categories of domestic and wild animals. Domestic animals (pig, dog, and sheep and goat) are found only on the left of the plot, while wild animals (boar, red deer and roe deer) are located on the right of the plot. Cattle, both wild and domestic, categories are located in the middle of the first dimension and overlap. This makes sense considering the difficulties in distinguishing wild and domestic species. It is clear that the ratio of wild to domestic animals is the main structuring factor for the assemblages, accounting for almost half of the variability.

The second dimension, factor 2, is more difficult to interpret. It is obvious that species which are more common in assemblages (sheep, boar, red deer) are placed in the upper section of the plot, while rarer species (carnivores, insectivores) are found in the lower portion of the graph. The situation becomes clearer if all samples with evenness lower than the hypothetical population (less diversified samples) appear in the upper part of the plot. The second dimension can therefore be interpreted as a diversification of samples.

Based on the results of correspondence analysis assemblages can be divided into three groups. The first group (A) consists of assemblages with high proportions of red deer and/or wild boar. Many assemblages from this class are less diversified than the hypothetical assemblage, and came from the context dated to phase 1 (Fig. 14). Assemblages from this class can also be found in later phases (2, 3 and 4), but these are usually more diversified than those from phase 1. Class A assemblages can be interpreted as the result of operating sequences of more or less specialised hunting.

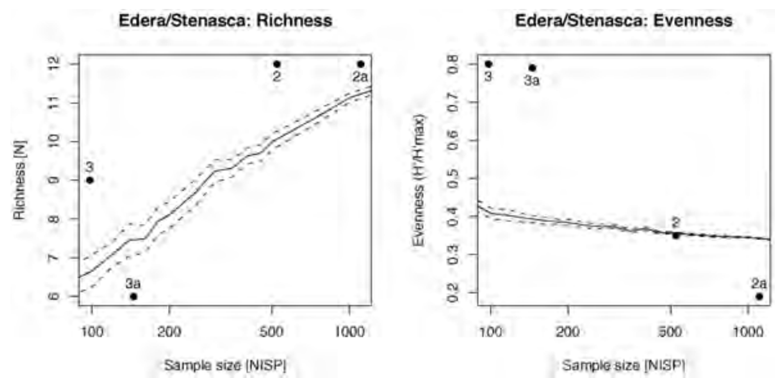

Fig. 9. Result of richness and evenness simulation for assemblages from Grotta dell'Edera/Stenašca.

8 Correspondence analysis is an exploratory technique related to principal components analysis, which finds a multi-dimensional representation of the association between the row and column categories (assemblages and species, in this case) of a two-way contingency table. This technique finds scores for the row and column categories on a small number of dimensions, which accounts for the greatest proportion of the chi square for an association between the row and column categories, just as the principal components account for maximum variation. For graphic display two or three dimensions are typically used to give a reduced rank approximation to the data (*Shennan 1988; Baxter 1994*).

The main components of assemblages from the second group (B) are sheep or goat. Most assemblages are less diversified than the hypothetical population; highly specialised assemblages can be found in phase 2; assemblages from later phases are usually more diversified. Assemblages from this group are derived from the herding of sheep and goat.

The final group (C) consists of extremely heterogeneous assemblages, with unusually large proportions of small mammals, carnivores, pigs and cattle. This class is difficult to interpret, and might represent taphonomically modified assemblages, carnivore dens or diversified assemblages derived from the herding of diversified herds or heterogeneous operational sequences operating on sites.

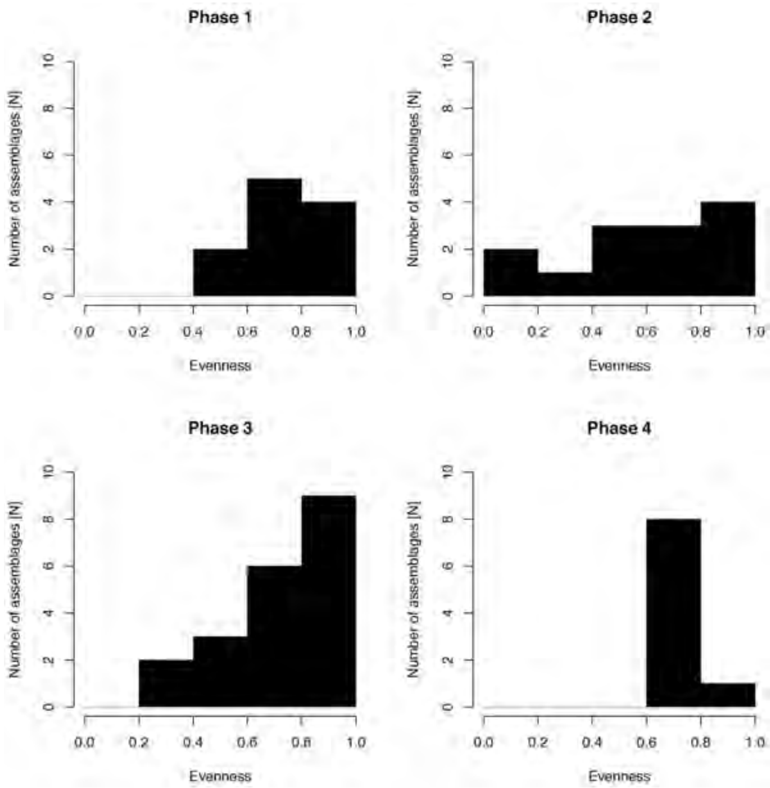

Fig. 10. Histograms of evenness scores for faunal assemblages from phases 1 to 4.

Correspondence analysis thus sheds light on the analyses of assemblage diveristy. Most phase 1 assemblages are derived from hunting activities (class A). Very specialised samples which derive from herding sheep and goat (B) appear in phase 2, along with heterogeneous, diverse samples (class C). Assemblages from all three classes can also be found in phases 3 and 4, but they tend to become less specialised. Assemblages from phase 3 and, more markedly, from phase 4 tend to cluster in the middle of the correspondence plot. This represents the homogenisation of animal management strategies toward more diversified herds with sheep, cattle and pig as the main species, but also with high proportions of wild animals.

Sample sizes as measure of intensity of activity?

The observation that sample size is a major factor structuring variability in both richness and diversity of assemblages does not mean that differences among the sites in terms of absolute sample sizes are meaningless.

I will assume here that sample size is a meaningful measure, although not without problems, of the intensity of bone deposition on the site, and it therefore reflects scales of pastoralism. Sample size can therefore offer a hint about the 'density' and intensity of actions of *châines opératoires* flowing through the site. However, it can not be overstated that the assemblages were excavated under diverse conditions over a number of decades, and analyzed by a number of investigators. Simulated excavations of a pastoral site in Kenya demonstrated that sample size can play a major role in the estimation of size and composition of the target population (*Ammerman et al. 1978; Voorips et al. 1978*). However, bias due to the intensity of sampling is an inescapable fact of archaeological work.

If we assume that deposition rates calculated for samples are representative of the whole site – which is a far-fetched assumption – then we can compare the intensity of deposition at different sites. Table 2 shows calculated deposition rates for selected sites based on assemblage sizes, volumes of sampling units, duration of occupation, and the estimated areas of the sites. Because most values are only estimates and educated guesses, values are compared by their orders of magnitude.

The assemblage from Tinj-Podlivade (*Chapman et al. 1996*) – an open-air site in Dalmatia – is characterised by a large sample size, which is due to the large sampling unit. However, the density of identified bones in a sediment is comparable to the densities calculated for sites from *Caput Adriae*. In Tinj-

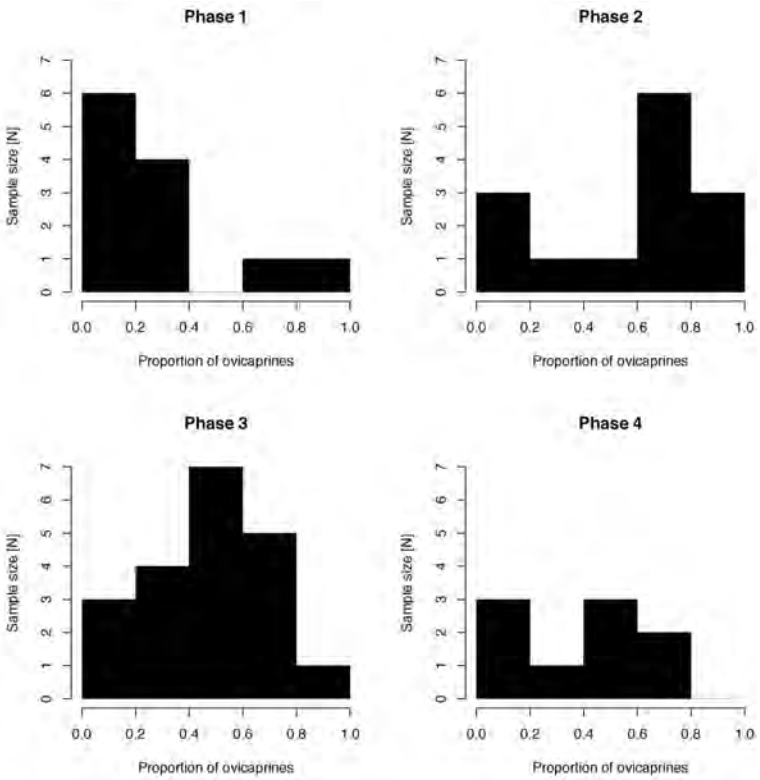

Fig. 11. Histogram of proportion of ovicaprines in assemblages from phases 1 to 4.

Podlivade the number of all deposited fragments per year is larger than from other sites by an order of magnitude. Given a site area two orders of magnitude larger, bone densities in sediment (NISP/m3) differ only by one order of magnitude, which means that bone assemblage sizes are largely determined by the size of sampling units (test trenches). However, since sampling units are usually very small (usually well below 2% of the estimated site area), deposition rates are on the same order of magnitude, and therefore the intensity of operations on dead animals was more or less equal for all sites. Thus it is site size which defines the total rate of deposition on sites: large open-air settlements from Dalmatia yielded larger assemblages, whereas small caves yielded far smaller assemblages. However, types of activities and seasonality. Deposition rates for *Caput Adriae* are comparable on the order of magnitude.

Binford and Bertram (*1977*) analysed two complementary seasonal Navajo camps inhabited by one family with a flock of approximately 350 sheep over one year. Informants reported that 37 sheep were killed over six months at a winter site. Binford and Bertram found 448 identifiable fragments, which gives an estimate of 21 MNI. Eleven sheep were killed at a summer camp, but since it was occupied longer than the winter site, the 593 fragments found comprise deposition over a course of several years, and can not be compared to animals butchered for the one summer.

The calculated deposition rate for the winter camp is slightly larger than that of the *Caput Adriae* sites, but is mainly in the same order of magnitude. Accounting taphonomic factors and small sample sizes for *Caput Adriae* assemblages, this may indicate that few animals were culled on the site in one year at sites such as Podmol pri Kastelcu and Edera/Stenašca, a situation comparable to the Navajo camps. The deposition rate for the open-air, and possibly year-round settlement at Tinj-Podlivade is an order of magnitude larger, indicating greater culling and larger scale consump-

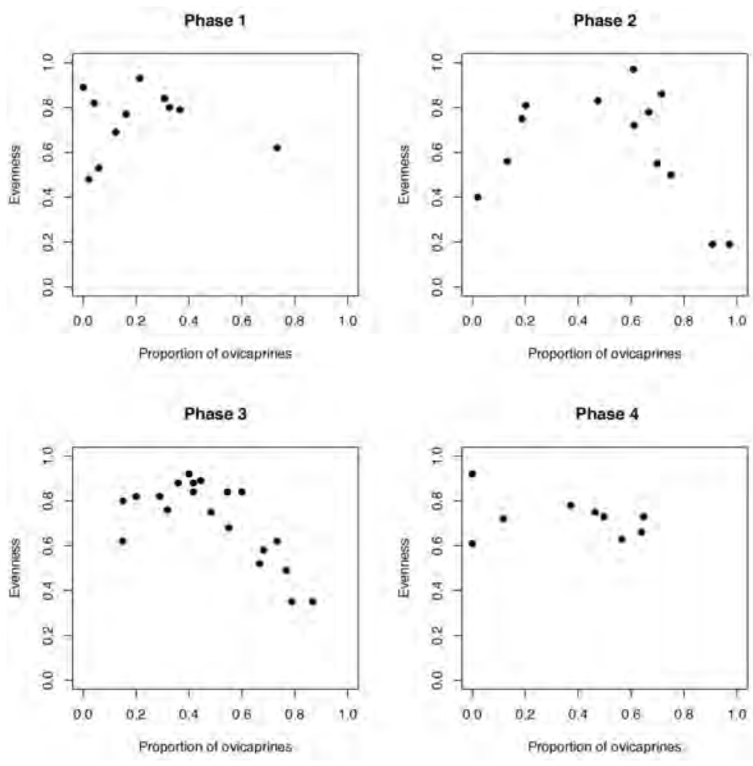

Fig. 12. Proportion of sheep vs. evenness for assemblages from phases 1 to 4.

tion than that observed at Navajo camps.

These results are consistent with the geometric densities of pottery in deposits. Müller's (*1994.Abb. 1*) calculations clearly demonstrate a much higher density of Neolithic pottery in lowland, open-air sites than that observed in caves.

Meat or milk?

The identification of herd exploitation strategies poses a number of challenges to archaeological research. The matter of which animal product was primary is not important only in the context of economics. The different labour requirements connected with milch and meat pastoralism play crucial roles in shaping the social relations of production and therefore influence every facet of life.

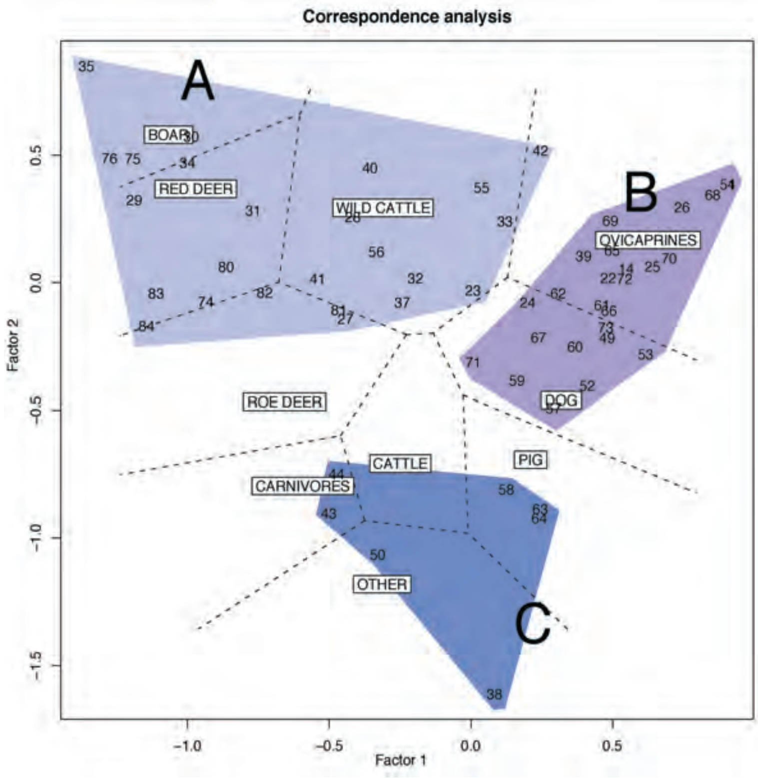

Fig. 13. Correspondence analysis of faunal assemblages.

That dairying was an innovation of the 3rd millennium BC was first proposed by Andrew Sherrat as a component of the secondary products complex (*Sherratt 1981; 1983; 1997a; 1997b; 2002; 2002*). Dairying is not a specific technology, nor is it necessarily limited to special types of livestock (*Sherratt 1997a.206*). Dairying offers by far the most efficient use of uncultivated land, and results in products that are suitable for storage (*Ingold 1980*). However, large herds optimised for dairy production are labour-intensive and economically untenable in regions without easy accessible pasture (*Dahl and Hjort 1976. 220; Halstead 1996a*). Halstead (*1996a*) argues that mixed farming strategies, where a small number of a variety of animals are kept for a mixture of products (meat, milk, wool) principally for domestic use not only seems more economically plausible in such environments, but is also evident in the considerable heterogeneity that exists in Neolithic faunal assemblages. This argument supports the idea that a specialised dairy economy could only develop toward the end of Neolithic, after substantial amounts

Site	Context	NISP [N]	Density [NISP/m^3]	Duration [years]	Deposition [NISP/m^{2}year]	Site area [m^2]	Deposition [NISP/site year]	References
Tinj-Podlivade		3212	143	850	0.13	28000	3527	Chapman et al. 1996
Podmol pri Kastelcu	13	15	15	20	0.38	250	94	Turk et al. 1992
	11	23	30	75	0.26	250	66	
	10	15	18	10	0.46	250	114	
Edera	3a	145	363	80	0.45	250	113	Boschin and Riedel 2000; Biagi 2003
	3	98	245	60	0.41	250	102	
	2a	1107	277	500	0.55	250	138	
	2	524	119	2000	0.07	250	16	
Navajo Winter camp		448		1			448	Binford and Bertram 1977

Tab. 2. Deposition rates of bones for selected eastern Adriatic sites.

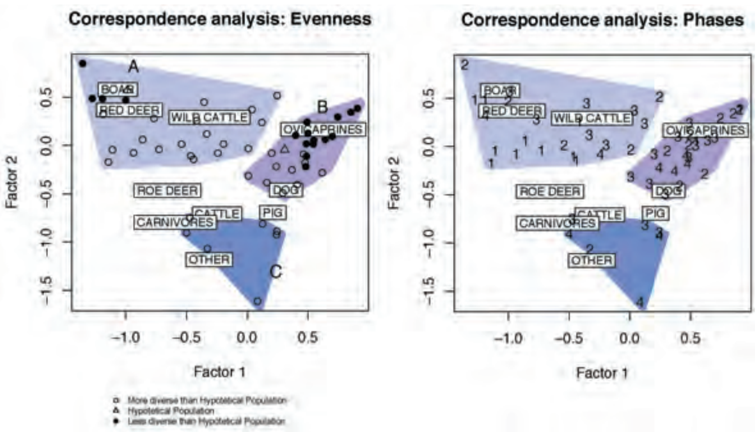

Fig. 14. Correspondence analysis of faunal assemblages with relative evenness values (left) and chronological phases (right).

of primary forest had been cleared, and fits well within the secondary products revolution.

The traditional method of detection of animal strategies is an analysis of kill-off curves. Payne (*1973*) proposed – on the basis of his ethno-archaeological research among Turkish pastoralists – a middle range theory, which links flock management strategies to kill-off curves. It is based on the assumption than an optimisation of animal products can be obtained by manipulating the sex and age structure of the herd. Ideal dairying and meat models differ in the age when males are culled. In the ideal dairying model, most animals younger than two months are culled in order to reduce competition for milk with people. With an optimal meat strategy most animals are culled after one to three years, as they achieve their maximum weight.

However, use of faunal kill-off patterns to define scale and specifics of animal husbandry has been heavily criticised. Besides problems inherent in preservation and recovery of animal bones, ancient livestock may have different productivity than modern, specially breed animals (*Halstead 1998*). High juvenile culling need not indicate a dairy economy but can be result of fodder preserving strategies. Even more, the presence of lambs may be prerequisite of early dairying in order to stimulate lactation of the sheep.

Kill-off curves from the four sites (Grotta dell'Edera/Stenašca; (*Boschin and Riedel 2000*), Grotta degli Zingari/Ciganska jama; (*Bon 1996*), Grotta del Mitreo/Mitrej; (*Petrucci 1997*) and Grotta dei Ciclami/Orehova pejca; (*Riedel 1968*)) were analyzed (Fig. 15).

Kill-off curves from the Edera (phases 1, 2 and 3), Zingari (phase 2), Ciclami (phase 2) and Mitreo (phase 3) are similar to the dairying curve, as they document a relatively high cull of young lambs. However, the cull of juvenile and sub-adult animals is closer to the ideal meat model (Edera and Mitreo, sites with relatively large samples). The cull of adult animals is low.

Combined curves (Fig. 16) display trends towards higher culls of adult and lower culls of young animals. However, culls of juvenile animals are too high for the ideal meat model.

Curves from the latest assemblages (Mitreo and Ciclami, phase 4) are structurally different. Compared to the earlier curves this demonstrates lower culls of young animals and the increased culling of adults. The curves lie between the ideal milk and meat curves.

No curve resembles either the ideal meat or milk model. Examples of optimised meat economies can be found – among others – in early Neolithic Greek (*Halstead 1996a*) and Dalmatian sites. However, these are relatively large, occupied all year round, and provide evidence of domestic and agricultural activities. They are in sharp contrast to the small, seasonally used caves, from which all the assemblages analysed derive.

How can we interpret these puzzling curves? A seasonal bias needs to be accounted for. Since most sites were occupied during lambing, a high number of young lambs may reflect high mortality and/or culling. A high cull of juveniles may reflect fodder optimisation strategies (*Halstead 1998*) (e.g. autumn killing, (*Higgs and White 1963*)). Thus early curves demonstrate a relatively simple, unoptimised economy aimed at the domestic consumption of meat.

Curves from the latest assemblages may demonstrate trends towards the optimisation of meat production and/or the intensification of dairying. These curves may be the result of mixed farming strategies, where a small number of a variety of animals is kept for a mixture of products (meat and milk) principally for domestic use. This pattern not only seems more economically plausible, but is also evident in a trend toward heterogeneity that exists in the Late Neolithic, Eneolithic and Broze Age faunal assemblages. However, there is no evidence of an intensive dairy economy based on sheep and goat. However, in diversified herds, small stock is exploited principally for meat, while cattle are kept as a source of milk (*Dahl and Hjort 1976.223–56*). It is therefore possible that the trend of increased diversity of assemblages reflects a diversification in animal products, with cattle or goats as the main milk animals.

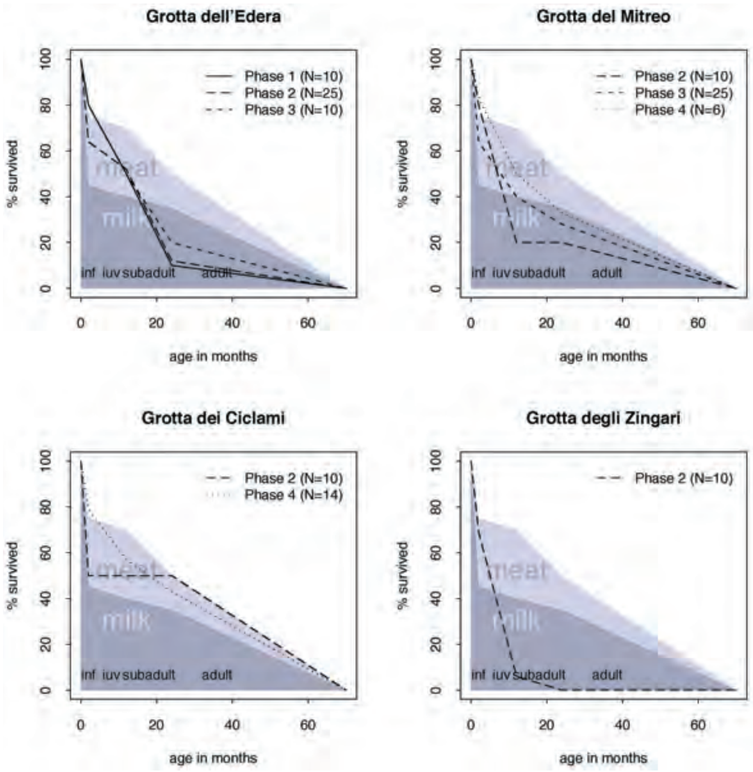

Fig. 15. Kill-off curves of assemblages from sites Grotta dell'Edera/ Stenašca, Grotta degli Zingari/Ciganska jama, Grotta del Mitreo/ Mitrej and Grotta dei Ciclami/ Orehova pejca.

Goats or sheep?

Goats and sheep are usually kept together as 'small stock' and regarded as one unit. Difficulties in distinguishing sheep from goat bones in faunal assemblages (*Boessneck 1969*) grouped under 'ovicaprines'. However, sheep and goat are complementary animals in terms of food preferences and grazing behaviour (*Dahl and Hjort 1976.249–56; Bartosiewicz 1999*). Most sources agree that under traditional pastoral conditions goats are more effective milk producers than sheep (*Dahl and Hjort 1976.210*). Therefore they allow for a fine grained diversification of herds. Combining sheep and goats has many practical advantages. Goats act as flock leaders and lead sheep to graze over wider areas (*Dahl and Hjort 1976.250*) and complementary dietary preferences allow a more effective use of land.

Goats are obviously present since the appearance of small stock in *Caput Adriae* (Grotta dell'Edera/Stenašca, layers 3a in 3; phase 1). However, their ratio is usually low, around 20% which is usually cited as the optimal proportion (*Bartosiewitz 1999*).

The percentage of goats is high in specialised assemblages, where caprines are the dominant component (60%.) However, large percentages of goats can be attributed to collection strategies, which favoured large, easily identifiable fragments (horn cores). In Edera/Stenašca, where sample size is relatively high (24 and 42 fragments determined to the level of species), the percentage of goat never exceeds 30 (Fig. 18).

Rowley-Conwy determined that Arene Candide goats were present from the Middle Neolithic onwards (*Rowley-Conwy 2000*), when they were used for milking. Rowley-Conwy attributes their late appaerance to their supposed unsuitability for sea transport.[9]

However, goats were present in the *Caput Adriae* region from the first introduction of the *caprinae*.

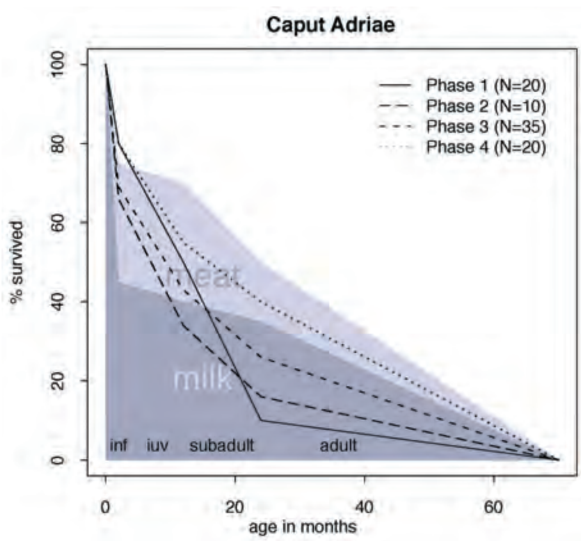

Fig. 16. Combined kill-off curves.

9 However, weak phylogeographic structure (i.e. high gene flow) in domestic goats (*Luikart et al. 2001*) indicates extensive transportation of goats. It also suggests that goats might have played an important role in historical human colonisations, migrations and commerce.

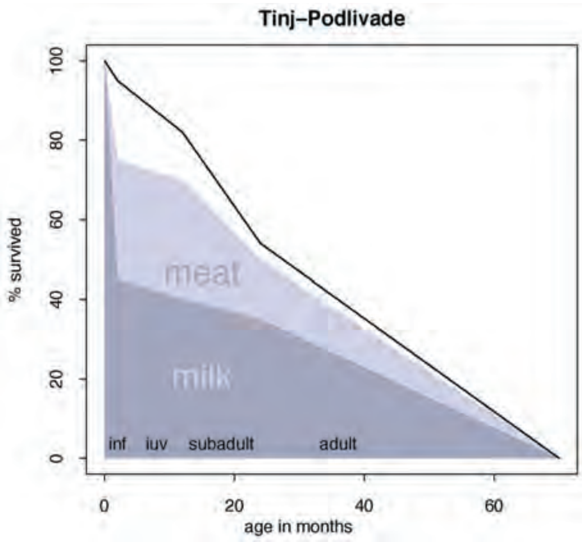

Fig. 17. Kill-off curve from Dalmatian open-air site Tinj-Podlivade, indicating exploatation of herds for meat.

They could have been used for small scale dairying, invisible in the crude resolution of kill-off curves. However, I believe that goats can not be connected to the process of diversification and appearance of dairying on a larger scale in the Late Neolithic.

Seasonality and mobility

A basic tactic for enhancing the productivity of herds is mobility, seasonal, and inter-annual, to exploit the best available pasture or to prevent local overgrazing. An examination of seasonality of site use is an essential step if any light is to be cast on the organisation of an economic system. Patterns of the presence or absence of animals at sites through the seasonal cycle are represented in the distribution of young animals, whose ages can be accurately determined from tooth eruption patterns. The eruption of sheep teeth is relatively well understood and various methods can be applied to study age and seasonality. In this analysis I compiled analyses of the wear stages of mandibles from the original publication and standardised them against Payne's scheme (*1973*). The samples are generally very small, and only nine assemblages from two sites (Grotta dell Mitreo/Mitrej (*Petrucci 1997*) and Grotta dell'Edera/Stenašca (*Boschin and Riedel 2000*)) yielded enough data, which is presented in Figure 19). However, due to the very small samples and blurred age distributions, only some tentative conclusions can be drawn.

It appears that the majority of animals in Grotta dell Mitreo/Mitrej in phase 2 were culled between 2–6 months. Since no foetal remains are present, animals were probably not present on the site.[10] In phase 3 the pattern changes; the peak is still at 2–6 months, but younger animals and foetuses are present too, which suggests that sheep lambed on the site. No animals older than 6 months are present on the site.

The seasonality pattern in the Grotta dell'Edera/Stenašca seems to be different. All age ranges except 0–2 months are present in phase 1; however, this sample is unrepresentative due to the small size. Most animals were culled at 0–2 months in phase 2; animals from the age range of 2–6 months are absent. All age ranges are equally represented in phase 3; however, sample size is again very low.

Comparing the seasonality pattern of the sites, it is complementary. Most animals from Mitreo were culled at 2–6 months in phase 2, while this age range is absent from Edera.

Other assemblages offer some hints on seasonality patterns. The majority of animals from Grotta degli Zingari/Ciganska jama are older than six months, aged on the basis that most mandibles that had milk premolars were also characterised by molars in the process of eruption. The presence of neonatal animals demonstrates lambing on the site. A similar situation can be observed in Grotta Gigante/Pečina v Gmajni (*Riedel 1969*), where most mandibles have

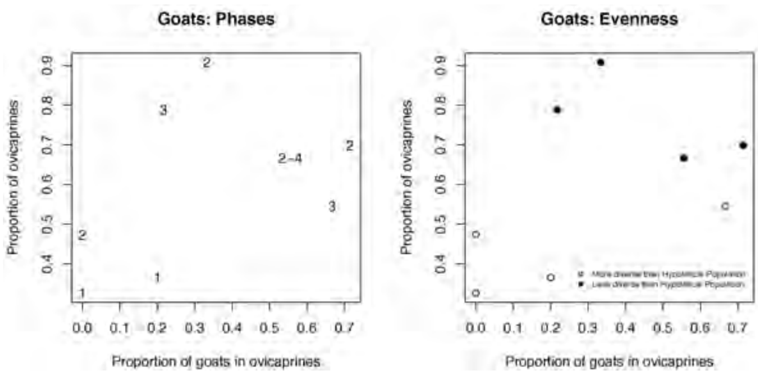

Fig. 18. Proportion of goats in the assemblages by relative evenness scores (left) and chronological phases (right).

10 Taphonomic factors may, of course, be responsible for the lack of foetal bones, but since foetal bones were recovered from other contexts, this may suggest that ewes were actually absent from the cave in the lambing season.

both milk premolars and molars in the process of eruptions, pointing at cull of animals older than six months.

In the Pupićina most of the animals whose age could be estimated were foetuses or younger than 2 months, suggesting occupation of the cave in the lambing season.

When in the seasonal cycle were the caves in use? The birth season of sheep and goats is crucial to the discussion. Wild sheep's oestrus is stimulated by decreasing day length, which triggers an increase in hormonal activity. Seasonality is more pronounced in more northerly regions. Wild sheep thus breed in late autumn/early winter and lamb in late spring/early summer. Oestrus can be manipulated by the practices of herders. Oestrus can be stimulated by the controlled introduction of rams into a flock. On the other hand, where ewes are not separated from rams, they become polyoestrous. This is the traditional Navajo shepherding strategy, which is aimed at maximising births (*Kelley 1994*).

It is thus not clear precisely when sheep and goat might be expected to give birth. At least two scenarios are possible.

Scenario 1. If Neolithic sheep gave birth in late spring/early summer, then 2–6 month animals were culled somewhere within the period between August and December, 6–9 month old animals in period the between December and March. Then animals from the phase 2 occupation of Grotta dell'Mitreo were culled in the period from August to March, with the peak between August and December; while in phase 3, animals were present on the site from June to December, with culling peak in autumn. Animals from phase 1 contexts from Edera were absent during the summer from the site, but in phase 2, most animals were culled in summer and absent during the autumn and early winter.

In *scenario 2* Neolithic sheep are polyoestrous, therefore give births over whole year. The seasonality pattern in this scenario is extremely difficult to interpret, but different and complementary patterns observed in different hint at the seasonal use of sites.

The complementary seasonal pattern observed in Mitreo and Edera may suggest that cave sites were not merely outstations of a larger pastoral system, with central sites elsewhere, but they comprised a full yearly cycle of seasonal mobility. However, due to the extremely small sample sizes, all conclusions here are tentative and further testing of the arguments is necessary.

Representation of body parts

The relative frequency of different body parts can provide valuable information about operational sequences on dead animals in the landscape. In this way can we identify processing and consumption sites, and the role of sites in the settlement pattern, and identify the spatial dimension of operational sequences on animals flowing through the landscape. The observed distribution of anatomical parts in archaeological contexts is a result of a potentially complex set of cultural and natural processes.

For the purpose of analysis skeletal elements were grouped into a series of carcass units. NISP counts

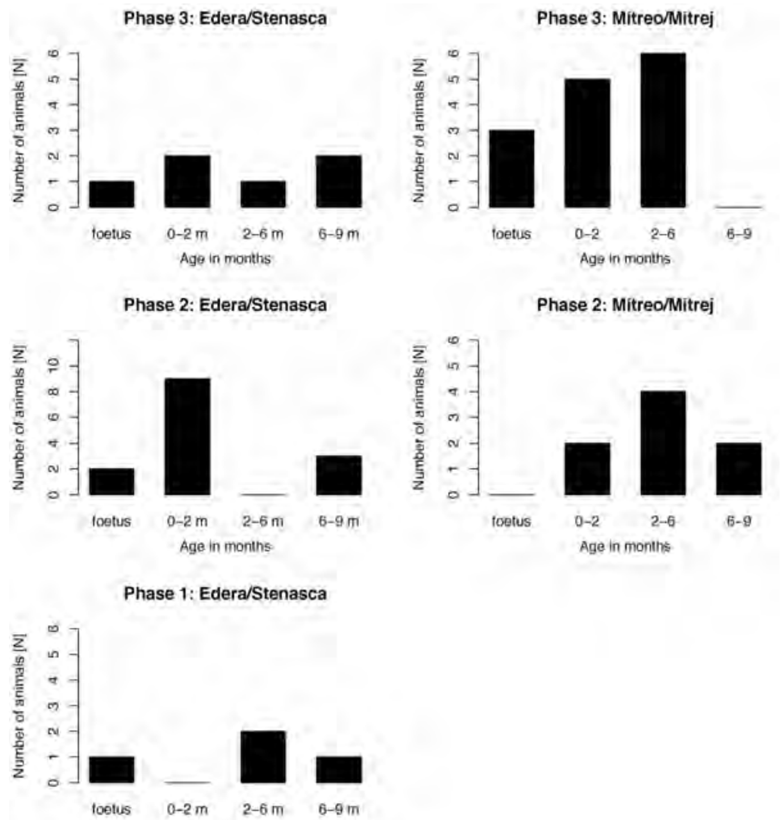

Fig. 19. Seasonality data for Grotta dell'Edera/Stenašca and Grotta dell Mitreo/Mitrej.

were corrected by dividing NISP for each carcass unit by the number of elements present in the carcass unit in a complete skeleton. Note that not all elements were included for each carcass unit.

The principal measure used in the analysis is %MAU, which was calculated by standardising corrected NISP for carcass units to 100 % by dividing values by the highest corrected NISP; The MGUI (*Binford 1978*) and volume density (*Lyman 1994.Table 7.6*) were are used as predictive models of carcass unit selection. Mean MGUI and density were calculated by averaging values for the different elements included in each carcass unit. Relationships between these variables and carcass unit frequencies were assessed using scatter plots and non-parametric statistical measures of correlation (Spearman's r).

Sample sizes are generally low, so some caution in interpreting results, as with the seasonality pattern is advised.

In Edera/Stenašca (Fig. 20) there is a strong positive correlation between food utility, as measured by the mean MGUI, and carcass unit frequency for phases 2 and 3, but a weak and statistically insignificant correlation for phase 1 assemblages. An obvious feature of body part distribution is the extremely large proportion of head bones. This can probably be attributed to the taphonomic processes (*Stiner 1991; Stiner 1994*). If one removes head bones from the analysis, then there is an even stronger correlation for phase 2 and 3, but a weaker and less significant correlation for phase 1 assemblages. Turning to red deer, we find an inverse pattern (Fig. 21). There is a negative correlation between food utility and carcass unit frequency over all four phases (grouped together due to the small sample sizes), which becomes stronger as head bones are removed from analysis.

In Grotta dell'Mitreo/Mitrej a weak positive correlation between food utility and carcass unit frequency can be observed, similar to the phase 1 assemblages from Edera/Stenašca. However, this may be due in both cases to very small sample sizes. The proportion of head bones to other carcass units is much lower than at Edera, suggesting different taphonomic agents operating on the site from those at Edera (Fig. 22). The sample sizes are admittedly small, and the results are preliminary, but the overall impression is that sheep and goats were consumed on the site, suggested by the presence of meatier parts, but red deer carcasses were only butchered in the Edera/Stenašca and consumed elsewhere. If this is true, then we have evidence for two seasonally exclusive uses of the site: as a herding camp, and as a hunting camp. Meagre seasonal indicators for red deer[11] suggest that red deer were hunted in winter during phase 1, while in phase 2 the hunting season shifted to summer-autumn.

The large ratio of sheep and goat bones to red deer suggests significantly greater consumption, and may indicate that this was a residential camp where flocks were accompanied by entire household(s) and not just shepherds.

Another question is whether these results reflect the selective use of carcass units or are merely the result of taphonomic processes (*Grayson 1981; 1984*). Carcass unit frequency is not significantly correlated with volume density; however, it is much weaker and even negative when head bones are excluded (Fig. 23). Thus a large proportion of head bones in Edera are possibly a result of the density mediated destruction of bones. However, a significant positive correlation between carcass unit frequencies and food utility, and a negative correlation between carcass units and volume density with head bones excluded suggests that assemblages can still yield some information on the selective use of carcass units.

Sites

The work of J. E. Brochier (*1983; 1990; 1991; 1996*) in the French Midi demonstrates that sedimentological and soil micromorphological analyses of the sediments of caves can indicate whether caves were used as animal shelters as they are made up of and contain abundant calcareous spherullites and pytholiths. Giovanni Boschian (*2000; Boschian and Montagnari Kokelj 2000; Boschian and Miracle 2003*) has established that the soil morphology evidence for these deposits was formed by the accumulation of ash derived from the burning of the shelter layers containing herbivore droppings.[12] Two different facies were determined for stable deposits.

11 Only animals older than six months are present in contexts 3a and 3, while in context 2a and 2 foetuses, newborns and animals younger than 6 months are present (*Boschin and Riedel 2000.Table 8*). However, sample size is again very low.

12 Boschian (*2000*) has identified stable deposits in caves from the Triestine Karst, Azura, Lonza, Caterina, and Pupićina. On the basis of descriptions such deposits also be infered for other caves, such as Podmol pri Kastelcu, Mala Triglavca, Acijev spodmol, Vaganaćka pečina, Vela spila, Hateljska peć.

Facies 3 deposits ('layer-cake') are made up of finely alternating black and white lenses. They appear in the form of 'heaps' and are mainly found near the cave walls, and may be result of cleaning the ash from the centre of the cave and of heaping in marginal areas (*Boschian 2000.364; Boschian and Miracle 2003*). The thin, finely layered charcoal lenses suggest that this process was repeated cyclically, probably over a long period (Fig. 24).

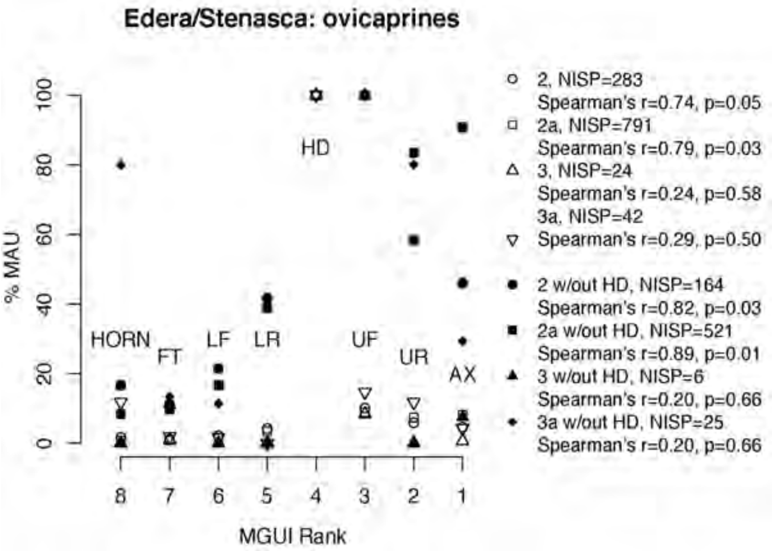

Fig. 20. Representation of carcass units of sheep in assemblages from Grotta dell'Edera/Stenašca.

The basic components of facies 4 are the same as those found in facies 3 and are the result of similar sedimentary processes. These deposits are highly homogenous, as coprolithic aggregates are very sparse throughout the deposits. The disaggregation of coprolites was probably due to reworking and trampling, as suggested by the compactness of the facies 4 sediment. Large patches of phosphates are common. This facies is usually found in the centre of the caves.

The varying distribution of facies suggests that the cave space was somehow structured, with a central area used for animal accomodation, which was regularly cleared, and marginal areas at the cave walls used as a dump for burned dung. Sheep can produce large quantities of dung. Modern breeds can produce around 500 kg of dung per year (up to 900 kg/year animal) and around 1.5 kg per day; goats are even more productive. Cattle can produce up to 10 000 kg of dung per year (*Slicher van Bath 1963*). And even if animals do not stay in the cave for the whole year and only part of the day (night, midday) a small herd can produce a large qauntity of dung[13]. Thick layers of dung cause cave floors to be slippery, wet and generally uncomfortable for animals. This can cause weight loss and susceptibility to diseases and parasites. Animal droppings are a medium for parasites such as strongyloid, which can be often found in humid and unattended stables (*Kompan et al. 1996; Pogačnik et al. 1998*). However, sheep dung is around 80% water and has to be dried in order to make it flammable.

Based on his work in the Midi Pyrenees Brochier has proposed a model for a complex agro-pastoral system in which transhumant shepherds seasonally moved from their lowland open-air settlement (*habitats bergeries*) to the upland caves (*grottes bergeries*). This produced a settlement pattern with two exclusive type of sites, seasonally occupied caves, where animals were kept during the summer and permanent open air villages. This pattern is similar to the *Alpwirtschaft* and ethnographically documen-

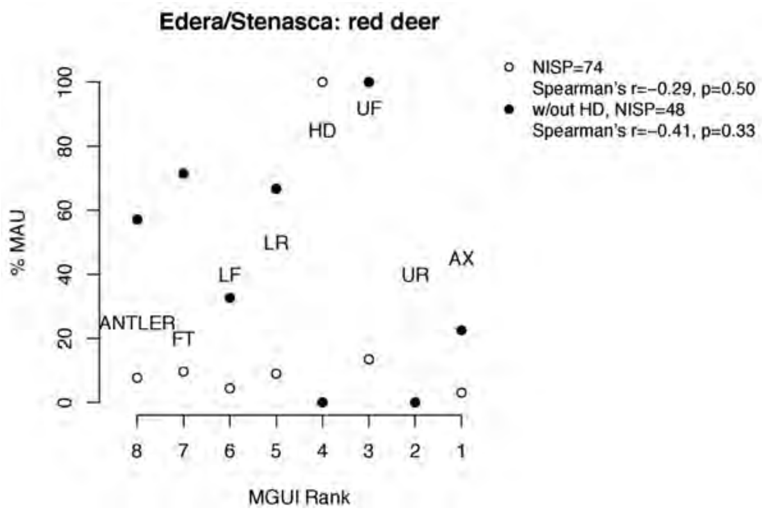

Fig. 21. Representation of carcass units of red deer in assemblages from Grotta dell'Edera/Stenašca.

13 Thus a herd of 100 animals which spends 8 hours per day in a cave can accumulate 4000 kg of fresh and around 2800 kg of dry dung in one year.

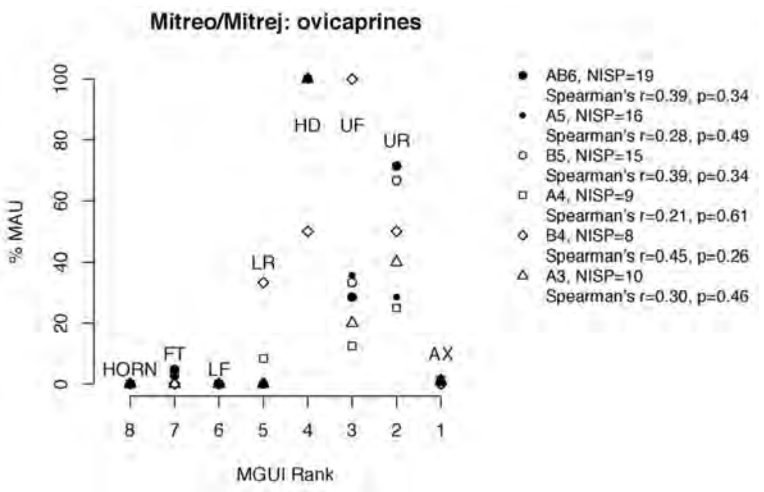

Fig. 22. Representation of carcass units of sheep in assemblages from Grotta dell'Mitreo/Mitrej.

ted systems of normal transhumance practiced in the Dinarides, or with seasonal upland pastoral settlements (*stine, katuni*) and lowland villages (*Marković 1980*). This model was somehow uncritically accepted also for the eastern Adriatic and the Triestine Karst. However, there are also other ethnographically documented uses of caves in the pastoral systems of eastern Adriatic coast and Dinarides. Caves were often used as winter stables, especially on Dalmatian islands (*Mlekuž.field notes*, Fig. 25) and at Bukovica (*Vinščak 1989*). Use of similar structures is attested also for Greece, where similar structure in Argolid was documented by Claudia Chang (*Chang and Murray 1981*).

Perhaps an even better analogy for caves are *staje*, shelters where animals are kept during the midday heat and during bad weather (*Vilfan 1957*). Sometimes *staje* were used for overnight shelter, especially if pastures were too far from villages. *Staje* are usually natural shelters, caves, rock shelters, doline, used mainly for animals, although shepherds may use them too. *Staje* are reused, as can be observed in the dry walls used to structure the space. Most of the excavated caves in the Triestine karst were used as *staje* in historical times, which can be attested by the reports of informants and the dry wall structures visible in excavation reports.[14] However, it is important to note that *staje* were used in a system of non-transhumant pastoralism, documented for the Adriatic Islands and Triestine Karst, where animals were pastured on common land around the village (*Vilfan 1957; Vukelić 1973*).

This may be compared to the technique called 'hogan grazing' practiced by the Navajo, who bedded their flocks close to their homes – hogans or rock shelters. Flocks were allowed to graze nearby during the day, but in the evenings they were returned to the corrals (*Bailey 1980.77; Blomberg 1983; Kelley and Whitley 1989. 88–99*).

The intensive presence of grazing animals around the caves can be attested also by the presence of 'open vegetation' pollen and the low percentage of grasses in palinological record (Podmol pri Kastelcu (*Turk et al. 1992*)), which indicates that grasses were grazed before flowering (*Groenman-van Waateringe 1993*).

The most direct evidence for the presence of flocks of domestic animals in the archaeological record are

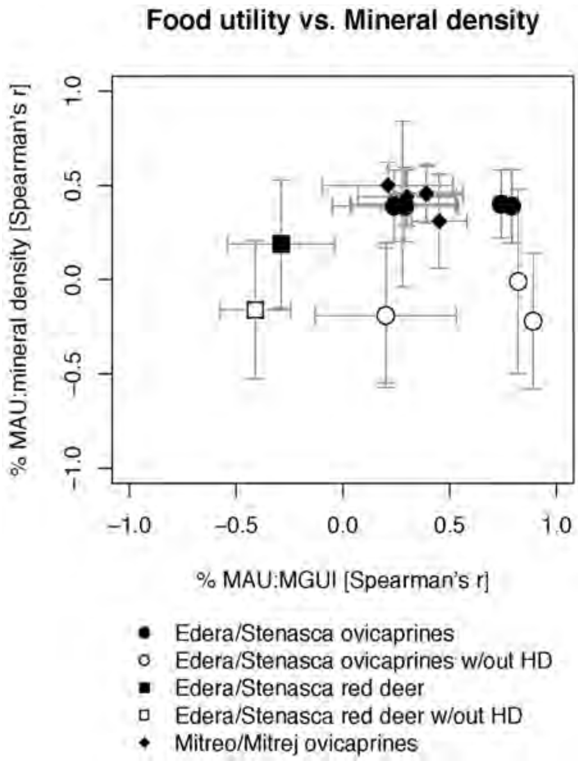

Fig. 23. Correletion between representation of carcass unit representation and food utility vs. correlation between carcass unit representation and mineral density.

14 Use of caves for *staje* can be attested at Grotta Azzura/Pečina na Leskovcu (*Cremonesi et al. 1984*), Mala Triglavca (*Leben 1988*), Podmol Pri Kastelcu (*Turk et al. 1992*), Grotta degli Zingari/Ciganska Jama (*Marzolini 1971*), Pejca v Lašcu (*Moser 1899*) and Grotta dell'Orso/Pečina pod Muzarji (*Guacci 1959*).

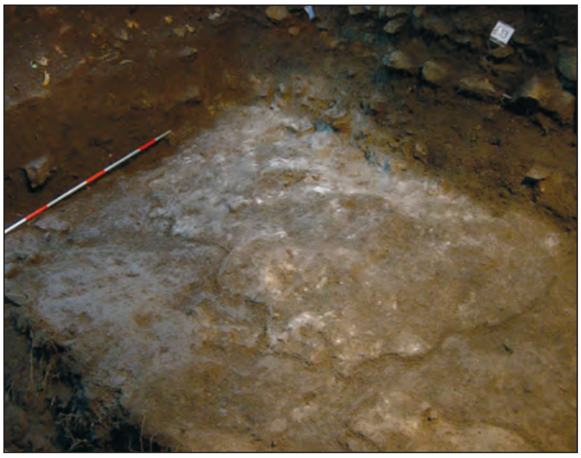

Fig. 24. Facies 3 deposit at the Mala Triglavca.

Fig. 25. Cave-stable near Matajna on the Island Pag.

shelter deposits. Although sites were probably used only seasonally, main anthropogenic component attests to the periodically intensive presence of animals. And this is in contrast to the relatively low rates of bone deposition, indicating a very low culling of animals.

Integrating the results into the wider picture

The first sheep and goat bones appear in the late Mesolithic contexts of phase 1 (Fig. 26). The ratio of sheep and goat in the assemblages are usually well below 50%, and most assemblages are diversified, with red deer and boar being the main components. These assemblages can be understood as the seasonal hunting camps of indigenous hunter-gatherer communities. Sheep and goat bones document the formation of domestic herds, still, however, incorporated into traditional modes of land use.

The main change can be observed at the advent of phase 2 (Fig. 27). The first Neolithic contexts of the 'Vlaška group' yielded some very specialised assemblages with ratios of sheep and goat well above 50%, sometimes even close to 100%. However, there are still some diversified assemblages similar to those from phase 1 and marked by high proportions of red deer or boar. Seasonality analyses suggest changes in the seasonal use of sites from previous phases. The observed complementary seasonal patterns suggest that Triestine Karst caves enclosed the full cycle of anual mobility. The concentration of animals is suggested by the appearance of stable deposits, which also documents a shift in cave use from gatherings of people to animal shelters. However, caves were also sites of consumption, as the pattern of selective uses of sheep and goat carcass units suggests. The main animal product was meat. Kill-off patterns suggest unoptimised culling for immediate consumption. Wild animals were butchered on-site, but consumed elsewhere. This may indicate the complementary use of the cave during the annual cycle, whereby caves were used for part of the year as animal shelters or as herding camps, and as hunting camps at other times. Therefore, phase 2 documents the emergence of carnivorous pastoralism in the area.

In the late Neolithic (phase 3, Fig. 27) and Eneolithic and Early Bronze Age (phase 4, Figure 28) a trend

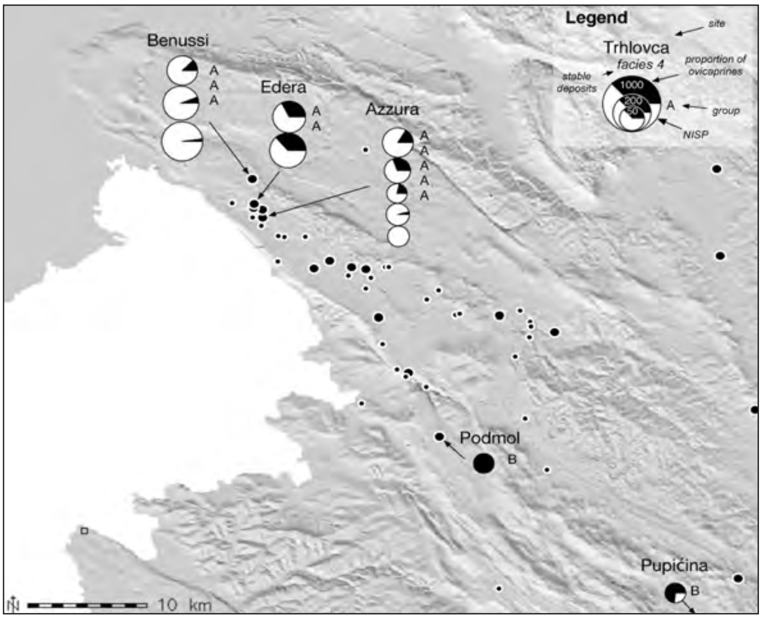

Fig. 26. Caput Adriae assemblages at the Mesolithic/Neolithic transition (phase 1).

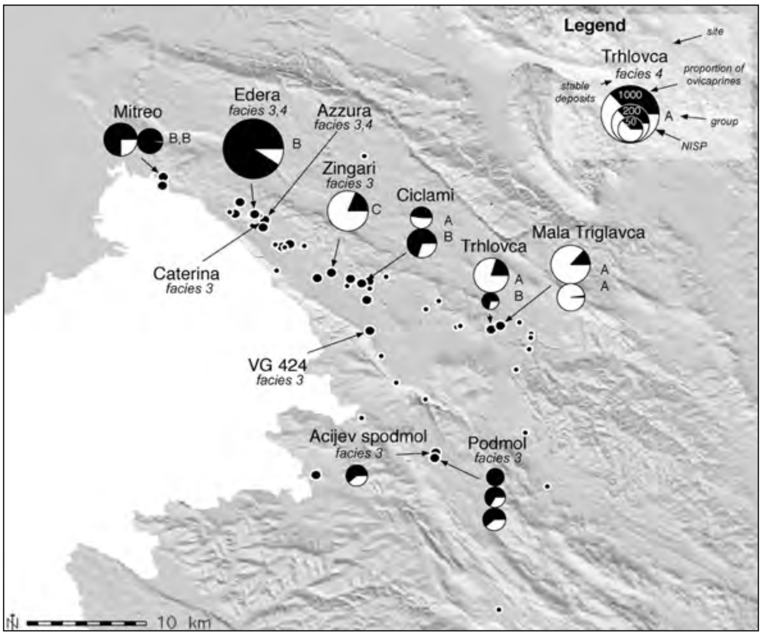

Fig. 27. 'Vlaška group' assemblages (phase 2).

reproduce within the household which obtained them. Small proportions of sheep and goat in assemblages suggest that animals were not herded, but used only for display and feasts. With the establishment of farming villages in the Istrian lowlands and northern Dalmatia a channel for the massive acquisition of sheep and goats was opened. When households could obtain them (through exchange or raiding), they become more numerous, and this led to the establishment of domestic herds. But through their reproduction they reproduce the principle of divided access to resources. They become the medium for the reproduction of new social relations of production.

towards the homogenisation and diversification of assemblages can be observed. Assemblages are now much the same as each other and more diversified. This may be the consequence of the increased use of some animals (cattle) for milk and assigning a more specialised role to each species in the herd, as kill-off patterns for sheep indicate. Thus a mixed stock economy emerges, with more flexible security strategies than those of carnivorous pastoralism.

CONCLUSION

The first evidence of sheep and goats on the eastern Adriatic coast appear in late Mesolithic contexts. Although they are domesticates, they do not document the beginning of pastoralism, but rather an internal political dynamic. They were obtained through exchange networks and used as prestige foodstuffs in a competitive feast operating in and between hunter-gatherer communities in the eastern Adriatic (*Miracle 2001*). But they opened a path for different transformations. Those animals – although shared – are beyond the obligations of sharing that apply in the case of hunted animals.

When sheep and goats were rare, they were eaten before they could

New relations between people and between people with respect to animals can be observed are marked by the establishment of domestic herds, which serve as sources of food. In the archaeological record this change can be read from stable deposits, which evidence the concentration of domestic animals on sites, and high proportions of sheep and goat in assemblages, which points to their importance for subsistence. Both indicators of new relationships between people and animals appear together, at the end of 'transitional phase' (phase 1), around 7500 cal BP. Thus can phase 1 be understood as a period

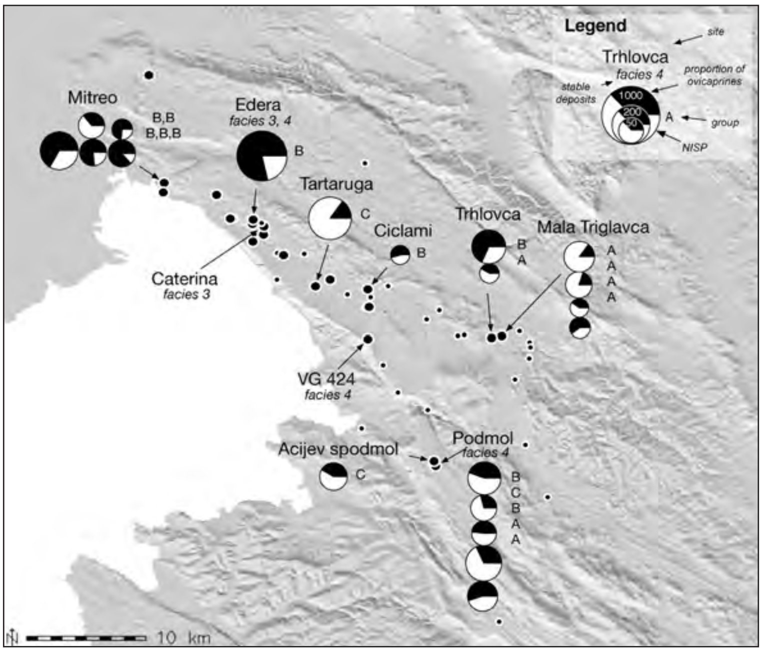

Fig. 28. Late Neolithic/Eneolithic assemblages (phase 3).

of structural transformation of hunter-gatherers into full-blown pastoralists. It seems that this process was relatively fast,[15] which is probably connected to the high reproductive capacity of small stock. A similarly rapid transformation can be observed in the case of the Navajo in the 18th century.

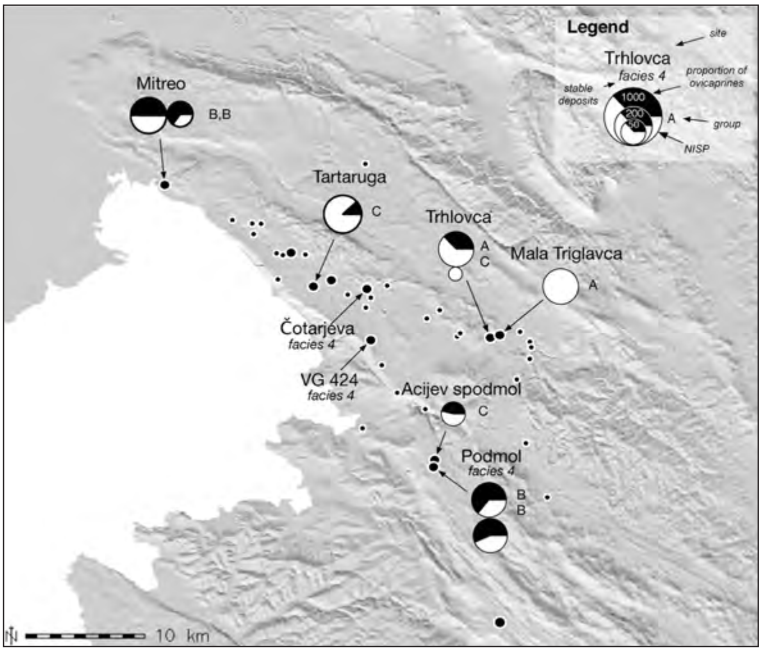

Fig. 29. Eneolithic/Bronze Age assemblages (phase 4).

Although sporadic finds of domestic sheep can be found in late Mesolithic contexts, specialised strategies of small stock management appear in the early Neolithic. This change is also reflected in a radically different use of sites from the early Neolithic onwards. Mesolithic sites were primary gatherings of people; with the appearance of small stock they became animal shelters. Generally, the small sample sizes of animal bones demonstrate low rates of bone deposition, which is consistent with the cull and consumption of only one household. Sites were seasonally occupied. The pattern of seasonal use of sites can be interpreted by two exclusive scenarios. However, both support the idea that sites from the study area are part of a complete seasonal cycle. In the Early and Middle Neolithic, domestic animals were exploited mainly for meat. Animal management strategies were not optimized and were geared towards the satisfaction of immediate needs. Milk probably became an important animal product in the late Neolithic/Eneolithic. This change in the pattern of animal product exploitation is also reflected in a trend of diversification of animal management strategies. The remains of wild animals display a pattern where only low-utility parts can be found at sites, whereas high utility animal parts were consumed elsewhere. The bones of domestic animals display the reverse pattern. This may demonstrate the complementary use of sites through the seasonal cycle.

I believe that *Caput Adriae* and the Dinarides were settled by small, autarchic and mobile groups. Although pure pastoralism is rare in the ethnographic record (*Salzman 2004*), I believe that the Neolithic pastoralists of the eastern Adriatic were as pure carnivorous pastoralists as can be. The social relations of carnivorous pastoralism kept political life to a minimum; households did not enter complex social structures such as exchange networks. This may explain the pattern observed by Budja (*2001*). He noted a general lack of painted pottery, anthropomorphic figurines, stamp seals, tokens and stylised amulets on the eastern Adriatic coast and explained this curious absence by social barriers which prevented engaging and maintaining the circulation of goods and people over long distances (*Budja 2001.41*). The reason for the exclusion of eastern Adriatic from the regional networks exchange is therefore to be sought in the fragmentation and isolation of carnivorous pastoralist households, who lead a 'very careful life' of isolated accumulation of their herds. East Adriatic carnivorous pastoralist can be best portrayed as Cyclops.

The transformation of hunter-gatherer groups into pastoralists was a deep structural transformation, which involved much more than the incorporation of novel resources into existing societies. It was a revolutionary transformation which created a different set of social relations between animals and people and between people with respect to animals, new organisations of production, different ways of life and different perceptions of landscape. And although the archaeological record of pastoralism from the eastern Adriatic coast displays many differences from hunting and gathering, it is not the result of population change, but a structural change in social relations which changed the hunting and gathering mode of production into carnivorous pastoralism.

15 Most phase 1 radiocarbon dates tend to cluster around 7500 cal BP.

REFERENCES

AMMERMAN A. J., GIFFORD L. D. P. and VOORPS A. 1978. Towards an evaluation of sampling strategies: simulated excavations of Kenyan pastoralist site. In I. Hodder (ed.), *Simulation Studies in Archeology*. Cambridge Univeristy Press, Cambridge.

BAILEY L. R. 1980. *If You Take My Sheep... The Evolution and Confilcts of Navajo Pastoralism, 1630--1868*. Westernlore, Pasadena (Ca).

BARAĆ L., PERIČIĆ M., KLARIĆ, MARTINOVIĆ I., ROOTSI S., JANIĆIJEVIĆ B., KIVISILD T., PARIK J., RUDAN I., VILLEMS R. and RUDAN P. 2003. Y chromosomal heritage of Croatian population and its island isolates. *European Journal of Human Genetics 11 (7): 535–42*.

BARFIELD L. 1971. The first Neolithic cultures of north east Italy III. In H. Schwabedissen (ed.), *Die Anfange des Neolithikums von Orient bis Nordeuropa. Teil VII: Westliches Mittelmeer gebiet und Britische Inseln.* Böhlau Verlag, Köln–Wien: 182–216.

BARTH F. 1961. *Nomads of South Persia*. Little, Brown and Co, Boston.

BARTOSIEWITZ L. 1999. Sheep vs. goat meat consumption. In L. Bartosiewitz and J. H. Greenfield (eds.), *Transhumant pastoralism in southern Europe*. Archaeolingua. Budapest: 47–60.

BATOVIĆ Š. 1973. Prapovjesni ostaci na zadarskom otočju. *Diadora 6: 5–166*.

1979. Jadranska cona. *Praistorija jugoslovenskih zemalja* II. 473–635.

1966. *Stariji neolit u Dalmaciji. Dissertationes II*. Arheološki muzej Zadar, Zadar.

BAXTER M. J. 1994. *Exploratory multivariate analysis in archaeology*. Edinburgh University Press, Edinburgh.

BENAC A. 1958. Zelena pećina. *Glasnik Zemaljskog muzeja Bosne in Hercegovine, Arheologija XIII: 61–92*.

1975. Mladi praistorijski periodi u Crvenoj stijeni. In Đ. Basler (ed.), *Crvena stijena: Zbornik radova*. Zajednica kulturnih ustanova, Nikšić: 121–46.

BENDER B. 1978. Gatherer-hunter to farmer: a social perspctive. *World Archaeology 10(2): 204–22*.

1981. Gatherer-hunter intensification. In A. Sheridan and G. Bailey (eds.), *Economic Archaeology. BAR International Series 69: 149–57*.

BIAGI P. 2003. New data on the Early Neolithic of the Upper Adriatic. In L. Nikolova (ed.), *Early Symbolic Systems for Communication in Southeast Europe. BAR International Series 1139: 337–48*.

BIAGI P. and STARNINI E. 1999. Some aspects of the neolithization of the Adriatic region. *Atti della Societá per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia* XI: 7–17.

BINFORD L. R. 1978. *Nunamiut Ethnoarchaeology*. Academic Press, New York.

BINFORD L. R. and BERTRAM J. B. 1977. Bone frequencies – and attritional processes. In L. R. Binford (ed.), *For Theory Building in Archaeology*. Academic Press, New York: 77–153.

BLOMBERG B. 1983. *Mobility and sedentism: the Navajo of Black Mesa, Arizona*. Center fot Archaeological Investigations, Southern Illinois University at Carbondale, Carbondale.

BOESSNECK J. 1969. Osteological differences between sheep (Ovis aries Linné) and goat (Capra hircus Linné). In D. R. Brothwell and E. S. Higgs (eds.), *Science in archaeology.* Thames and Hudson, London: 331–58.

BON M. 1996. La fauna neolitica della Grotta degli Zingari nel Carso Triestino. *Atti della Societá per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 9: 127–35*.

BOSCHIAN G. and MIRACLE P. 2003. Shepherds and caves in the Karst of Istria (Croatia). In G. Boschian, R. Langhor, S. Limbrey and R. I. Macphail (eds.), *Second International Conference on Soils and Archaeology – extended abstracts.* Dipartimento di Scienze Archeologiche, Universita di Pisa, Pisa: 17–21.

BOSCHIAN G. and MONTAGNARI KOKELJ E. 2000. Prehistoric Shepherds and Caves in the Trieste Karst (Northeastern Italy). *Geoarchaeology: An International Journal 150(4): 331–71*.

BOSCHIAN G. 2000. New data on the pastoral use of caves in Italy. *Atti della Societá per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 13(Quaderno 8): 63–72*.

BOSCHIN F. and RIEDEL A. 2000. The late Mesolithic and Neolithic fauna of the Edera cave (Aurisina, Trieste Karst): a preliminary report. *Societá Preistoria Protoistoria Friuli-Venezia Giulia, Trieste, Quaderno 8 (82): 73–90*.

BRAJKOVIĆ D. 2000. Šandalja. *Histria archaeologica 29: 5–26*.

BROCHIER J. E. 1983. Bergeries et feux de bois néolithiques dans le Midi de la France. *Quartär 33/34: 181–94*.

1990. Des techniques géo-archélogiques au service de l'étude des paysages et de leur exploitation. In J. L. Fiches and S. E. van der Leeuw (eds.), *Archéologie et espaces. Actes X rencontres internationales d'archéologie ed d'historie d'Antibes.* Université Nice, Antibes: 453–72.

1991. Géoarchéologie du monde agropastoral. In J. Guilaine (ed.), *Pour une archéologie agraire.* A. Colin, Paris: 303–22.

1996. Feuilles u fumiers? Observations sur rôle des poussièers sphérolitiques dans l'interprétation des dépôts archéologiques holocèenes. *Anthropozoologica 24: 19–30*.

BUDJA M. 2001. The transition to farming in Southeast Europe: perspectives from pottery. In M. Budja (ed.), *Documenta Praehistorica 28: 27–47*.

CHANG C. and MURRAY P. 1981. An Ethnoarchaeological Study of Contemporary Herder's Site. *Journal of Field Archaeology 8: 373–81*.

CHAPMAN J. and MÜLLER J. 1990. Early farmers of the Mediterranean basin: the Dalmatian evidence. *Antiquity 64: 127–34*.

CHAPMAN J., SHIEL R. and BATOVIĆ Š. 1996. *The changing face of Dalmatia*. Leicester University Pres. Leicester.

CHAPMAN J. 1990. Demographic trends in Neothermal South-East Europe. In C. Bonsall (ed.), *The Mesolithic in Europe: papers presented at the third international symposium Edinburgh 1985.* John Donald, Edinburgh: 500–15.

1994. The origins of farming in South East Europe. *Préhistoire Européene 6: 133–56*.

CREMONESI G., MELUZZI C., PITTI C. and WILKENS B. 1984. Grotta Azzura: Scavi 1982 (Nota preliminare). *Il Mesolitico sul carso Triestino. Societá per la Preistoria e Protoistoria della Regione Friuli-Venezia Giulia 5: 21–64*.

CVIJIĆ J. 1966. *Balkansko poluostrvo i južnoslovenske zemlje*. Zavod za izradu udžbenika SFRJ, Beograd.

ČEČUK B. and RADIĆ D. 2001. Vela spilja: preliminarni rezultati dosadašnjih iztraživanja. *Arheološka iztraživanja na području otoka Korčule i Lastova.* Hrvatsko arheološko društvo, Zagreb: 75–118.

2002. Vela spila: naslage gornjeg pleistocena i donjog holocena. *Vjesnik za arheologiju i historiju dalmatinsku 95: 9–51*.

ČEČUK B. 1982. Prilog proučevanju keramike impresso-cardium na otocima Lošinju i Cresu. *Arheološka istraživanja na otocima Cresu i Lošinju. Izdanja Hrvatskog arheološkog društva 7.* Hrvatsko arheološtvo, Zagreb: 19–32.

DAHL G. and HJORT A. 1976. *Having herds: pastoral herd growth and household economy*. University of Stockholm, Stockholm.

DEDIJER J. 1916. La transhumance dans les pays dinariques. *Annales de Géographie 25(137): 347–65*.

DIETLER M. 2001. Theorizing the Feast: Rituals of Consumption, Commensal Politics and Power in African Context. In M. Dietler and B. Hayden (eds.), *Feasts: archaeological and ethnographic perspectives on food, politics, and power.* Smithsonian Institution Press, Washington and London: 65–114.

EVANS-PRITCHARD E. E. 1940. *The Nuer: A Description of the Modes of Livelihood and Political Institutions of a Nilotic People*. Oxford University Press, Oxford.

1951. *Kinship and marriage among Nuer*. Oxford University Press, Oxford.

FABEC T. 2003. Neolitizacija Krasa (Neolithization of the Karst). *Arheološki vestnik 54: 73–122*.

FORENBAHER S. and MIRACLE P. 2005. The spread of farming in the Eastern Adriatic. *Antiquity 79: 514–28*.

FORENBAHER S. and VRANJICAN T. P. 1985. Vaganaćka pećina. *Opuscula Archaeologica 10: 1–21*.

FRIEDMAN J. 1974. Marxism, Structuralism and Vulgar Materialism. *Man 9, 444–469*.

FRISBIE C. J. and MACALLESTER D. P. (eds.) 1978. *Navajo Blessingway Singer: the autobiography of Frank Mitchell 1881–1967*. University of Arizona Press, Tuscon.

GLASS M. 1991. *Animal Production Systems in Neolithic Central Europe*. BAR International Series 572.

GODELIER M. 1972. *Rationality and irrationality in economics*. New Left Books, London.

1977. *Perspectives in Marxist Anthropology*. Cambridge University Press, Cambridge.

1978. Infrastructures, Societies and History. *Current Anthropology 19(4): 763–71*.

1980. The emergence of Marxism in anthopology of France. In E. Gellner (ed.), *Soviet and western anthropology.* Duckworth, London: 3–18.

GRAYSON D. K. 1981. The effect of sample size on some derived measures in vertebrae faunal analysis. *Journal of Archaeological Science 83: 77–88*.

1984. *Quantitative Zooarchaeology*. Academic Press, New York.

GROENMAN-VAN WAATERINGE W. 1993. The effect of grazing on pollen production of grasses. *Vegetation History and Archaeobotany 2: 157–62*.

GUACCI A. 1959. I muri della Grotta del Orso. *Tecnica Italiana 24: 3–12*.

GUILAINE J. 1993. Questions ouvertes sur la néolithisation de la haute vallée de l'Aude. In J. Guilaine, M. Barbaza, J. Gasco, D. Geddes, J. Coularou, J. E. Brochier, F. Briois, J. André, G. Jalut and J. L. Vernet (eds.), *Dourgne: derniers chasseurs-collecteurs et premiers éleveurs de la Haute-Vallée de l'Aude. Centre d'Anthropologie des Sociétés Rurales/Archéologie en Terre d'Aude.* Carassonne, Toulouse: 365–97.

HALSTEAD P. 1996b. The development of agriculture and pastoralism in Greece: when, how, who and what. In D. R. Harris (ed.), *The spread of agriculture and pastoralism.* UCL Press, London: 296–309.

1998. Mortality models and milking: problems of uniformitarianism, optimality and equifinality. *Anthropozoologica 27: 3–20*.

1996a. Pastoralsim or hosuehold herding? Problems of scale and specialization in early Greek animal husbandry. *World Archaeology 28(18): 20–42*.

HAYDEN B. 1990. Nimrods, piscators, pluckers and planters: the emergence of food production. *Journal of Anthropological Archaeology 9: 31–69*.

2001. Fabulous Feasts: A Prolegomenon to the Importance of Feasting. In M. Dietler and B. Hayden (eds.), *Feasts: archaeological and ethnographic perspectives on food, politics, and power.* Smithsonian Institution Press, Washington and London: 23–64.

2003. Were luxury foods the first domesticates? Ethnoarchaeological perspectives from Southeast Asia. *World Archaeology 34(3): 458–69*.

HIGGS E. S. and WHITE P. J. 1963. Autumn killing. *Antiquity 37(148): 282–89*.

INGOLD T. 1980. *Hunters, pastoralists and ranchers*. Cambridge University Press, Cambridge.

1986. *The appropriation of nature. Essays on human ecology and social relations*. Manchester University Press, Manchester.

KELLEY K. B. 1994. Pastoralism, material culture and the market in the Southwestern United States. In C. Chang and H. A. Koster (eds.), *Pastoralists at the periphery.* University of Arizona Press, Tuscon: 62–78.

KELLEY K. B. and WHITLEY P. M. 1989. *Navajoland: family settlement and land use*. Navajo Community College Press, Tsaile (Arizona).

KINTIGH K. W. 1984. Measuring Archaeological Diversity by Comparison with Simulated Assemblages. *American Antiquity 49(1): 44–54*.

1989. Sample Size, Significance and Measures of Diversity. In R. D. Leonard and G. T. Jones (eds.), *Quantifying Diversity in Archaeology*. Cambridge Univeristy Press, Cambridge: 25–36.

KOMPAN D., KASTELIC D., KAVC S., KERMAUNER A., ROGELJ I. and VIDRIH T. 1996. *Reja drobnice*. Kmečki glas, Ljubljana.

KOZŁOWSKI J. K., KOZŁOWSKI S. and RADOVANOVIĆ I. 1994. *Meso- and Neolithic Sequence from the Odmut Cave (Montenegro)*. Wydawnictwa Uniwersytetu Warszawskiego, Warszawa.

KUŽIR S., BABIĆ K. & KOZARIĆ Z. 2005. Životinjske kosti iz Vele spile na otoku Korčuli. *Vela spila: višeslojno pretpovjesno nalazište – Vela Luka, otok Korčula*. Centar za kulturu Vela Luka, Vela Luka.

LEBAN V. 1950. Nanos: gospodarska povezava s sosedstvom. *Geografski vestnik 22: 100–37*.

LEBEN F. 1988. Novoodkrite prazgodovinske plasti v jamah na Krasu. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 16: 65–76*.

LEROI-GOURHAN A. 1988. *Gib in beseda, I–II*. Škuc, FF, Ljubljana.

LUIKART G., GIELLY L., EXCOFFIER L., VIGNE J.-D., BOUVET J. and TABERLET P. 2001. Multiple maternal origins and weak phylogeographic structure in domestic goats. *Proceedings of the National Academy of Sciences of the United States of America 98(10): 5927–32*.

LYMAN R. L. 1994. *Vertebrate taphonomy*. Cambridge University Press, Cambridge.

MALEZ M. 1975. Kvartarna fauna Crvene stijene. In Đ. Basler (ed.), Crvena stijena: *Zbornik radova*. Zajednica Kulturnih Ustanova, Nikšić: *147–69*.

1979. Osnovne crte paleolitika i mezolitika u Hrvatskoj. *Radovi Jugoslovenske akademije znanosti i umetnosti. Razred za prirodne znanosti 383(18): 117–53*.

1987. Pregled paleolitička i mezolitička kultura na području Istre. *Arheološka istraživanja u Istri i Hrvatskom primorju. Izdanja Hrvatskog arheološkog društva 11/1.* Hrvatsko arheološko društvo, Pula: 3–48.

MALEZ M., SLIEPĆEVIĆ A. and SRDOĆ D. 1979. Odredivanje starosti metodom radiaktivnog ugljika kvartarnim naslagama na nekim lokalitetata u dinarskom kršu. *Radovi Jugoslovenske akademije znanosti i umetnosti. Razred za prirodne znanosti* 383 (18): 227–71.

MARKOVIĆ Č. 1985. *Neolit Crne Gore*. Filozofski fakultet, Centar za arheološka istraživanja, Beograd.

MARKOVIĆ M. 1971. Stočarska kretanja na Dinarskim planinama. *Zbornik za narodni život i običaje Južnih Slavena 45*.

1980. Narodni život i običaji sezonskih stočara na Velebitu. *Zbornik za narodni život i običaje Južnih Slavena 48: 5–139*.

MARX K. and ENGELS F. 1968. *Manifesto of the Communist party*. Penguin, London.

MARZOLINI G. 1971. Gli scavi nella Grotta degli Zingari. *Annali Associazione XXX Ottobre – Club Alpino Italiano 5: 57–69*.

MCCARTNEY P. H. and GLASS M. F. 1990. Simulation Models and the Interpretation of Archaeological Diversity. *American Antiquity 55(3): 521–36*.

MELUZZI C., PITTI C., RADMILI A. M. and WILKENS B. 1984. Il Mesolitico nella Grotta Lonza. Il Mesolitico sul carso Triestino. *Sociétá per la Preistoria e Protoistoria della Regione Friuli-Venezia Giulia 56: 109–30*.

MIHAJLOVIĆ D. 1996. Upper palaeolithic and Mesolithic chipped stone industries from rock-shelter of Medena Stijena. In D. Srejović (ed.), *Prehistoric Settlements in Caves and Rock-shelters of Serbia and Montenegro I. Centre for Archaeological Research 16.* The University of Belgrade, Belgrade: 9–60.

MIHAJLOVIĆ D. and DIMITRIJEVIĆ V. 1999. Lea fin du Paléolihique Supérieur et le Mésolithique dans le Monténégro. évolution des techniques et du mode de subsistance. In A. Thévenin (ed.), *L'Europe des dernierss chasseurs.* CTHS, Paris: *391–98*.

MIRACLE P., GALANIDOU N. and FORENBAHER S. 2000. Pioneers in the hills: early Mesolithic foragers at Šebrn Abri (Istria, Croatia). *European Journal of Archaeology 3(3): 293–29*.

MIRACLE P. 1996. Diversification in Epipaleolithic subsitence strategies along the Eastern Adriatic Coast: a simmulation approach applied to zooarchaeological assemblages. *Atti della Societá per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 9: 33–62*.

1997. Early holocene foragers in the Karst of northern Istria. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 24: 43–62*.

2001. Feast or famine? Epipaleolithic subsistence in the northern Adriatic Basin. In M. Budja (ed.), *Documenta Praehistorica 28: 177–97.*

MIROSAVLJEVIĆ V. 1971. Jamina Sredi dans l'ile de Cres. In (ed.), *UISPP, Epoque préhistorique et protohistorique en Yougoslavie (Belgrad 1971).* Beograd: *102–05.*

MLEKUŽ D. 2003. Early herders of the Eastern Adriatic. In M. Budja (ed.), *Documenta Praehistorica 30: 139–51.*

MONTAGNARI KOKELJ E. 1993. Prehod iz mezolitika v neolitik na Tržaškem krasu. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 21: 69–84.*

1998. Some comments on the Vlaška Group or "Gruppo dei Vasi a Coppa" in the Trieste Karst in the light of recent data. *Preistoria Alpina 34: 245–51.*

MOSER K. 1899. *Der Karst und seine Hölen*. F. H. Schimpff, Triest.

MÜLLER J. 1994. *Das ostadriatische Frühneolitikums. Die Impresso-Kultur und die Neolithisierung des Adriaraumes*. Volker Spiess, Berlin.

PAINE R. 1971. Animals as capital: comparision among northern nomadic herders and hunters. *Anthropological Quartely 44: 157–72.*

PAYNE S. 1973. Kill-off patterns in sheep and goats: the mandibles from Asvan Kale. *Anatolian studies 23: 281–303.*

PETRUCCI G. 1997. Resti di fauna dai livelli neolitici e post-neolitici della Grotta del Mitreo nel Carso di Trieste (Scavi 1967). *Atti della Societá per la Praistoria e Protoistoria della Regione Friuli-Venezia Giulia 10: 99–118.*

POGAČNIK M., CESTNIK V., CURK A., JUNTES P., KOSEC M. and ZADNIK T. 1998. *Zdravje in bolezni drobnice*. Kmečki glas, Ljubljana.

POHAR V. 1986. Kostni ostanki mezolitskega najdišča Pod Črmukljo pri Šembijah (Ilirska Bistrica). *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 14: 11–20.*

RIEDEL A. 1968. I Mamifer domestici della Caverna dei Ciclami nel Carso Triestino. *Atti e Memorie della Commissione Grotte "E. Boegan" 82: 79–110.*

1969. Resti di animali domestici preistorici della Grotta Gigante sul carso Triestino. *Atti e Memorie della Commissione Grotte "E. Boegan" 9: 107–12.*

1975. La fauna epipaleolitica della Grotta Benussi. *Atti e Memorie della Commissione Grotte "E. Boegan" 15: 123–44.*

ROWLEY-CONWY P. 1995. Making first farmers younger: the West European Evidence. *Current Anthropology 36: 346–53.*

2000. Milking caprines, hunting pigs. In P. Rowley-Conwy (ed.), *Animal Bones, Human Societies.* Oxbow, London: *124–32.*

2003. Early domestic animals in Europe: imported or locally domesticated? In A. J. Ammerman and P. Biagi (eds.), *The widening harvest: the Neolithic transition in Europe: looking back, looking forward.* Archaeological institute of America, Boston (MA): 99–117.

RUSSELL N. 1998. *The Mesolithic-Neolithic transition in the faunal assemblage from Konispol Cave, Albania*. In H. Buitenhuis, L. Bartosiewicz and A. Choyke (eds.), *Archaeozoology of the Near East III*. Groningen Institute of Archaeology, Groningen: 145–99.

SAHLINS M. 1972. *Stone age economics*. Aldine, Chichago.

SALZMAN P. C. 2004. *Pastoralists: equality, hierarchy and the state*. Westview, Boulder (Colorado).

SCHULDENREIN J. 1998. Konispol Cave, southern Albania, and correlations with other Aegean caves occupied in the Late Quaternary. *Geoarchaeology: An International Journal 13: 501–26.*

SHENNAN S. 1988. *Quantifying archaeology*. Edinburgh University Press,

SHERRAT A. 2002. Diet and cuisine: farming and its transformations as reflected in pottery. In M. Budja (ed.), *Documenta Praehistorica 29: 61–71.*

1981. Plough and pastoralism: aspects of the Secondary Products Revolution. In I. Hodder, G.

Isaac and N. Hammond (eds.), *Pattern of the past.* Cambridge University Press, Cambridge: *261–306.*

1983. The Secondary Exploitation of Animals in the Old World. *World Archaeology 15(1): 90–104.*

1997b. *Economy and Society in Prehistoric Europe*. Edinburgh University Press, Edinburgh.

1997a. The Secondary Exploitation of Animals in the Old World (revised). *Economy and Society in Prehistoric Europe*. Edinburgh University Press, Edinburgh: 199–228.

SLICHER VAN BATH B. H. 1963. *The agrarian history of Western Europe AD 500 – 1850*. Arnold, London.

SMERDEL I. 1989. *Ovčarstvo na Pivki: transhumanca od srede 19. do srede 20. stoletja ali trije "ovčarji": etnološka razprava*. Lipa, Koper.

1999. The three "Sheepmasters". Transhumance in Pivka (Slovenia) from the middle of the 19th to the middle of 20th century. In L. Bartosiewicz and J. H. Greenfield (eds.), *Transhumant pastoralism in Southern Europe. Recent Perspectives from Archaeology, History and Ethnology.* Archaeolingua, Budapest: *197–212*.

SORDINAS A. 1969. Investigation of the prehistory of Corfu during 1964–1966. *Balkan studies 10(2): 392–424*.

SREJOVIĆ D. 1974. The Odmut Cave – a new facet of Mesolithic culture of the Balkan Peninsula. *Archeologia Iugoslavica 15: 3–6*.

STEFFÈ DE PIERO G. 1978. Note sui resti faunistici racolti nella Grotta del Mitreo (Carso Triestino). *Quaderni di Storia Antica ed Epigrafia dell'Universita degli Studi di Trieste 29: 31–38*.

STINER M. C. 1991. Food procurement and transport by human and non-human predators. *Journal of Archaeological Science 18: 455–82*.

1994. *Honor among thieves: a zooarchaeological study of neanderthal ecology*. Princeton University Press, Princeton(NJ).

TERRAY E. 1969. *Le marxisme devant les sociétés "primitives"*. Maspero, Paris.

THOMAS J. 1993. Discourse, Totalization and 'The Neolithic'. In C. Tilley (ed.), *Interpretative Archaeology.* Berg, Oxford: *357–94*.

TRINGHAM R. 1971. *Hunters, fishers and farmers of Eastern Europe 6000–3000 BC*. Hutchinson, London.

TURK I., MODRIJAN Z., PRUS T., CULIBERG M., ŠERCELJ A., PERKO A., DIRJEC J. and PAVLIN P. 1992. Podmol pri Kastelcu – novo večfazno najdišče na Krasu, Slovenija. *Arheološki vestnik 44: 45–96*.

TURK M. and TURK I. 2004. Part 2: Mala Triglavca. Archaeological finds. In I. Turk (ed.), *Vikotrjev spodmol and Mala Triglavca: Contributions to understanding the Mesolithic period in Slovenia.* Opera Instituti archaeologici Sloveniae 9. ZRC–SAZU, Ljubljana: *176–96*.

UMEK E. 1956. Prispevki k zgodovini ovčjereje na Krasu in slovenski Istri. *Slovenski etnograf X: 71–77*.

VILFAN S. 1957. Podobe iz nekdanje živinoreje med Trstom in Slavnikom. *Kronika V(2): 69–88*.

VINŠČAK T. 1989. Kuda idu "horvatski nomadi". *Studia ethnographica 1: 79–98*.

VOORIPS A., GIFFORD D. P. and AMMERMAN A. P. 1978. Towards an evaluation of sampling strategies: simulated excavations using stratified smapling designs. In J. Cherry, C. Gamble and S. Shennan (eds.), *Sampling in Contemporary British Archaeology. BAR British Series 205: 227–61*.

VUKELIĆ D. 1973. Ovčarstvo na našim otocima. *Otočki ljetopis Cres – Lošinj 1: 183–96*.

WACE A. J. B. and THOMPSON M. S. 1914. *The nomads of Balkans*. Methuen, London.

WILKENS B. 1991. Il ruolo della pastorizia nelle economie preistoriche dell'Italia centro-meridionale. In R. Maggi, R. Nisbet and G. Barker (eds.), *Archeologia della pastorizia nell'Europa meridionale II. Rivista di Studi Liguri 57. 81–94*.

WOBST H. M. 1974. Boundary conditions for Paleolithic social systems: a simulation approach. *American Antiquity 39(2): 174–78*.

1976. Loational relationshis in Palaeolithic society. *Journal of human evolution 5: 49–58*.

ZILHÃO J. 1993. The spread of agro-pastoral economies across Mediterranean Europe: a view from far west. *Journal of Mediterranean Archaeology 6: 5–63*.

1997. Maritime pioneer colonisation in the early Neolithic of the west Mediterranean. testing the model aginst the evidence. *Poročilo o raziskovanju paleolitika, neolitika in eneolitika 24: 19–42*.

ZVELEBIL M. 1986. Mesolithic prelude and Neolithic Revolution. In M. Zvelebil (ed.), *Hunters in transition. Mesolithic societies in temperate Eurasia and their transition to farming.* Cambridge University Press, Cambridge: 5–16.

1995. Neolithization in Eastern Europe: A View from Frontier. *Poročilo o raziskovanju paleolita, neolita in eneolita v Sloveniji 22: 107–52*.

2001. The agricultural transition and the origins of Neolithic society in Europe. In M. Budja (ed.), *Documenta Praehistorica 28: 1–26*.

ZVELEBIL M. and LILLIE M. 2000. Transition to agriculture in eastern Europe. In T. D. Price (ed.), *Europe's first farmers.* Cambridge University Press, Cambridge: 57–92.