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Fossil beetles as possible evidence for transhumance during the middle and late Holocene in the high mountains of Talysch (Talesh) in NW Iran?

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A short sediment core (300 cm) was retrieved from a peaty deposit in the northeastern corner of Lake Neor in NW Iran yielding a 6500-year-old sequence relatively rich in pollen and beetle remains. Beetle assemblages contained a significant amount of coprophagous and coprophilous species all along the core. Pollen spectra suggest an open steppe landscape typical of the modern Irano-Turanian highlands with pollen indicators of agro-pastoral activities and also the proximity of the mesic temperate Hyrcanian forest to the east. Together, insect and pollen evidence, in agreement with the archaeological evidence for NW Iran, suggest that pastoralism was practised in the high elevation surroundings of Neor in Talysch Mountains at least since ca. 6500 years ago. This preliminary study highlights the strong potential of palaeoentomological investigations in furthering our understanding of the history of pastoralism in the Middle East.

Keywords: Coleoptera, Pollen, Holocene, Iran, Neor lake, Pastoralism

Introduction

Recent high-resolution palaeoecological investigations of lake and peat deposits have been very informative in detecting high-frequency climatic events, reconstructing human impact on ecosystems, and understanding socio-economic changes driven by climatic and historical events in the Middle East (Neumann *et al.* 2007; Ramezani *et al.* 2008; Djamali *et al.* 2009b). In Lake Maharlou in southern Zagros, significant human activity is implicated in causing a large-scale deforestation event, leading to an almost total destruction of *Pistacia-Amygdalus* steppe forest contemporaneous with the Achaemenid period (Djamali *et al.* 2008). However, despite the importance of pollen analysis in reconstructing past vegetation change in relation to climate change and human activities, and

the recent development of studies aiming to improve the interpretation of fossil pollen assemblages in Iran (Djamali *et al.* 2009a), it seems that the identification and classification of anthropogenic indicator pollen taxa is less clear or more poorly known in the Middle East and even Central Asia compared to Europe and the Mediterranean region (e.g. Djamali *et al.* 2008; Mische *et al.* 2009). However, at Lake Almalou, in the first palaeoentomological environment reconstruction in the Middle East, Djamali *et al.* (2009b) considered the discovery of dung beetle remains in layers corresponding to the Achaemenid period (2450–2220 cal. yr BP) to be possible evidence for intensive agro-pastoral activity in this region.

In the present study, we use fossil beetle analysis as a tool to complement pollen for finding traces of pastoralism in the Lake Neor region in NW Iran. The area has several interesting ecological and archaeological characteristics. First, it is located at the limit of two contrasting climatic systems: the temperate humid

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South Caspian climate in the east and semi-arid continental climate of Irano-Armenian plateau. Second, it lies at the extreme eastern limit of the Irano-Armenian montane steppes and is very close to the Hyrcanian forest (South Caspian forest) in the east. Third, the area still hosts nomadic tribes, and was densely populated in the past as shown in the archaeological records (Fahimi 2004; Kazua and Fahimi 2005; Khalatbari 2004; Mashkour 2005; Nokandeh 2005). These features suggest a high potential for the site to provide evidence of the past vegetation, climate and the history of agro-pastoralism.

The two main objectives of this study are therefore

- (i) to reconstruct the mid- to late-Holocene palaeoenvironment of Lake Neor region using both beetle and pollen analyses;
- (ii) to evaluate the potential of fossil beetles for understanding the history of pastoralism in a typical Middle Eastern mountainous region.

Physical Setting

Lake Neor (also Neur) is a freshwater lake of tectonic origin located in a high altitude intermontane closed basin (ca. 2480 m a.s.l.) in the Talesh Mountains (also Talysch) which form a high continuous range separating the Caspian Sea basin in the east from the high plateau of Azerbaijan in the west (Fig. 1). The lake is about 4000 m long and 1000 m wide. Mean water depth is ca. 2 m with a maximum of 5.5 m in the SE corner (Nejadsattari 1978). In several places where springs enter the lake, peat bogs have been encroaching towards the central part of the lake (see letter P in Fig. 1).

Flora and Vegetation

Lake Neor region is located about 10 km to the west of the Hyrcanian forest which borders the southern plains of the Caspian Sea and the northern foothills of the Alborz Mountains. This forest is located in the extreme southeastern extension of the Euro-Siberian floristic region which receives moisture from Mediterranean, North Atlantic, Black Sea and particularly the Caspian Sea nearly all the year round. The higher altitude vegetation belts of this forest in Assalem (45 km to the SE of the lake) consist of a forest dominated by *Fagus orientalis* – *Vaccinium arctostaphylos* – *Ilex aquifolium* communities (1200–1800 m), a strongly disturbed and almost completely destroyed belt (1800–2100 m) potentially occupied by *Fagus orientalis* – *Carpinus orientalis* mixed forest, and *Carpinus orientalis* open scrubs at 2100–2600 m (Assadollahi 1980). More to the west, the high range of Talesh blocks the humid air masses of the Caspian Sea and deprives the western slopes of this mountain range of moisture

(Fig. 1). This leads to the development of typical Irano-Turanian montane steppes with occasional intruded plants of Euro-Siberian origin. In a recently published map representing the main vegetation types of Ardebil-Astara region (Sharifi 2009), the western slopes of mountain ranges in the immediate vicinity of Lake Neor are covered by an Irano-Turanian thorn-cushion montane steppe vegetation dominated by *Onobrychis cornuta* – *Astragalus* sp. – *Agropyron* communities. The eastern slopes are, however, dominated by *Festuca heterophyllum* – *Trifolium montana* communities. The vegetation around Lake Neor is under strong grazing activity as evidenced by the presence of many ruderal plants including *Rumex*, *Plantago* etc.

The most important plants growing in peaty soil on the lake banks can be listed as: Cyperaceae, *Ranunculus* sp., *Butomus umbellatus*, mosses (Amblystegiaceae cf *Drepanocladus* sp.), a liverwort species (*Riccia* cf *cavernosa*). While *Riccia* almost completely disappears before being incorporated in the peat, the moss species seems to be an important peat-forming taxon in the absence of *Sphagnum* spp. in the Iranian flora.

Material and Methods

Coring

Coring was carried out with a Russian-type corer. A 300-cm sedimentary sequence was extracted from a peaty area located in the North-East part of the lake (Fig. 1). This place was chosen for beetle analysis because it was located close to a small tributary, able to transport and deposit dead insects from a wider catchment basin. The upper 50 cm of the core was made up of a network of helophytic plant roots, fluid sediment and water; it was not recovered.

Lithology and Chronology

The lower parts of the core (270–300 cm) were lacustrine organic muds, overlain by a peat deposit from around 230 cm upwards. Three radiocarbon dates were performed on bulk sediment (Table 1). The age calibrations were done in Calib 5.0.2 software (Stuiver *et al.* 1998) and the age-depth model was constructed in the software package CLAM (Blaauw 2010) run in the software R (R Development Core Team 2010).

Sample Processing

Pollen

Pollen extraction was carried out following Moore *et al.* (1994) and using successive treatments with HCl, HF and acetolysis. For pollen identifications, we used the pollen reference collection of IMBE including reference slides of Iranian flora as well as the pollen atlases of Europe and N. Africa (Reille 1992, 1995, 1998; Beug 2004) and also pollen

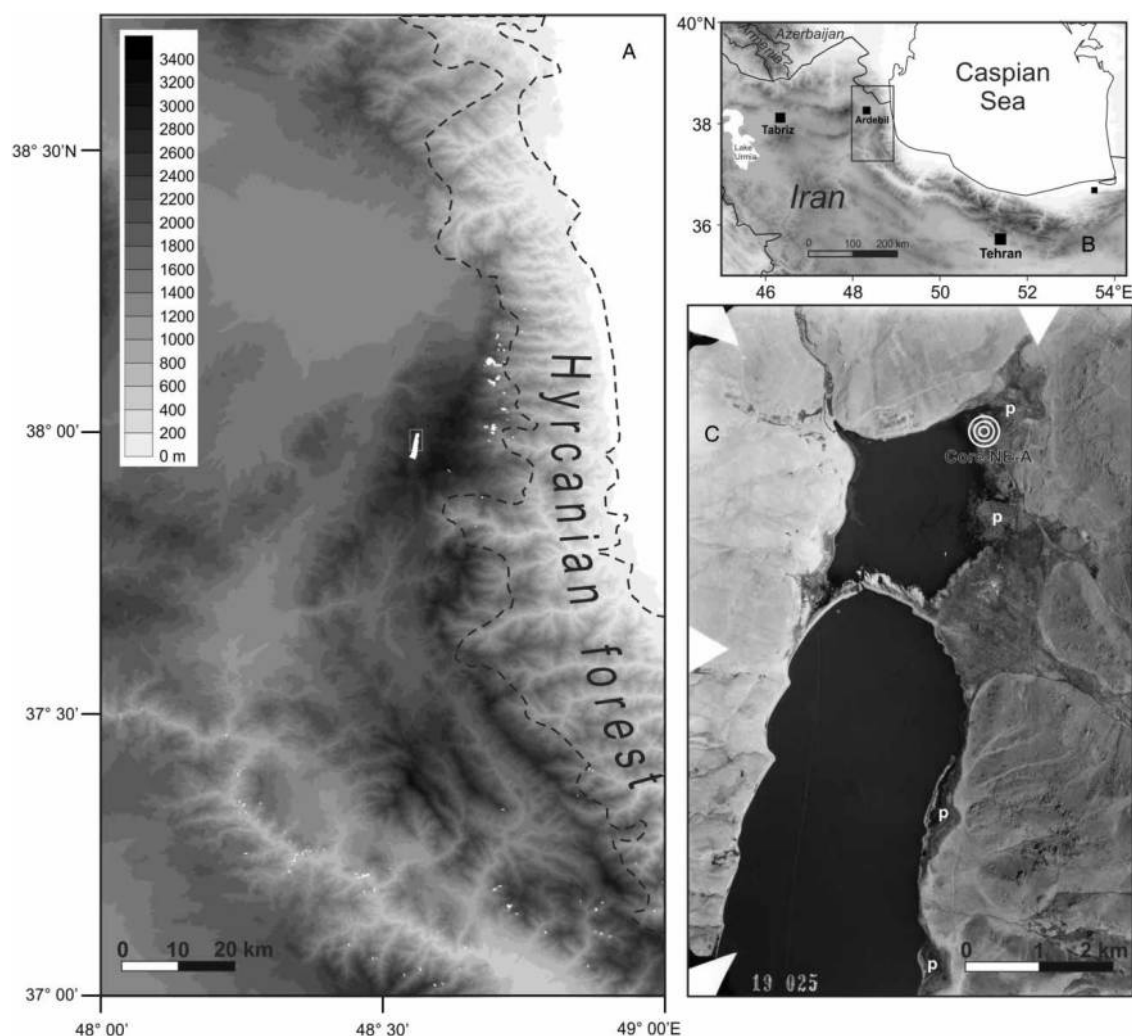


Figure 1 Location map of Lake Neor in NW Iran (A and B) and the coring site in NW of the lake (C). P marks the positions of peat bogs and concentric circles mark the coring site.

morphological data in van Zeist and Bottema (1977). A total of 20 samples were analysed. New samples will be analysed in the near future to improve the time resolution. Hygrophilous and aquatic plants (in particular Cyperaceae, which are over-represented) as well as non-pollen palynomorphs (NPPs), among them fungal spores, algal cysts and animal microremains, have been excluded from the pollen sum (PS).

Beetles

The sedimentary profile was cut into 25 samples for insect analysis. Each sample was 10-cm thick and ca. 140 cm³ in volume. The 25 insect samples numbered from 1 (bottom) to 25 (top of the sequence) span

continuously the entire sedimentary profile (250 cm), from the surface to the rocky bottom of the lake. The fossils were extracted using the method recommended by Coope (1986), and identifications were made by direct comparison with specimens from a modern reference collection. Ecological interpretation and biogeographical data are derived from Koch (1989a, 1989b, 1992), Böhme (2005), and Löbl and Smetana (2003–2010).

Results

Pollen

The mean PS is 365 (NPPs excluded) and the total of taxa identified (NPPs included) is 147. The pollen

Table 1 Radiocarbon ages of core Neor NE-A*

Sample No.	Depth (cm)	Lab code	¹⁴ C age (yr BP)	Calibrated age (cal yr BP)	Material dated
Neor NE-A1	64–65	Poz-29447	110.79 ± 0.36 pMC	90 ± 29	Peat
Neor NE-A2	150–151	Poz-29448	2780 ± 30 BP	2872 ± 80	Peat
Neor NE-A3	282–283	Poz-29449	5410 ± 35 BP	6235 ± 57	Gytja

*Calibrated dates are reported as the mean of the 2σ ranges with highest probability. Age-depth model corresponding to these ages are depicted in Fig. 2.

concentration is low as is often the case in pollen spectra coming from peat deposits of arid environments (Djamali 2008). The lower 20 cm of the core was depleted of pollen as well as the sample situated at 113 cm that was mainly made up of charcoal particles, indicating important fire event(s). The flora identified in the pollen record is typical of NW Iran with a mixture of both Hyrcanian phytogeographical zone (nowadays occupying the southern edges of Caspian Sea) and the Irano-Turanian region of the Azerbaijan plateau. Many taxa indicators of livestock breeding or associated with cultural activities were recognised in the whole of the pollen record testifying to early anthropogenic activities in the Talesh mountains. The description of the vegetation history recorded at Lake Neor relies on the simplified pollen diagram presented in Fig. 2 and is particularly focused on the impact of human activities on the environment.

The mean relative frequencies of the tree pollen remain very low (<20% of the PS) throughout the sequence. The Hyrcanian forest is represented by low values of *Fagus* (2%), *Carpinus* (2%), *Acer* and median values of deciduous *Quercus* (10%). Usually, the pollen of *Fagus* is not a long distance transported pollen but the presence of *in situ Fagus* forest cannot occur over 2000 m above sea level and it is extremely probable that this pollen has come from areas of lower altitudes, bordering the southern coast of the

Caspian Sea. The landscape around the lake was mainly occupied by grass steppes with Poaceae (24.8%), *Artemisia* (23%), Chenopodiaceae (3.6%) and several Compositae (*Anthemis*, *Aster*, various species of *Centaurea*, *Cirsium*, Cichorioideae, *Cousinia*, *Echinops*, *Evax*). Fabaceae observed at Neor are diverse and comprise (ascending order): *Ononis*-type, *Hedysarum*-type, *Lotus*-type, *Ulex*, *Lupinus*-type; some of them could have been cultivated (*Lupinus*) to feed regional human populations or used as fodder plants (*Hedysarum* and *Lupinus*) for the livestock. The presence of crop plants is noted from the bottom of the core and comprises undifferentiated Cerealia and *Secale* associated with arable weeds (*Turgenia latifolia*, *Centaurea cyanus*, *C. solstitialis* and *Polygonum aviculare*), and fruit trees (*Prunus*, *Juglans*, *Olea*). The regular pollen occurrence of nitrophilous plants and ruderals (*Plantago lanceolata*, Cichorioideae, *Polygonum aviculare*, *Urtica*) seems to indicate that farmers reared livestock in the vicinity of the site. Frequent visits to the edge of the lake by mammal herds can also explain the high values of fungal spores, some of which are dependent on mammal dung.

The depositional environment changes from the bottom to the top, passing from a lacustrine stage to a terrestrial environment when a peat bog forms (Fig. 3). These two phases are recorded in the pollen spectra by the presence of many aquatic or

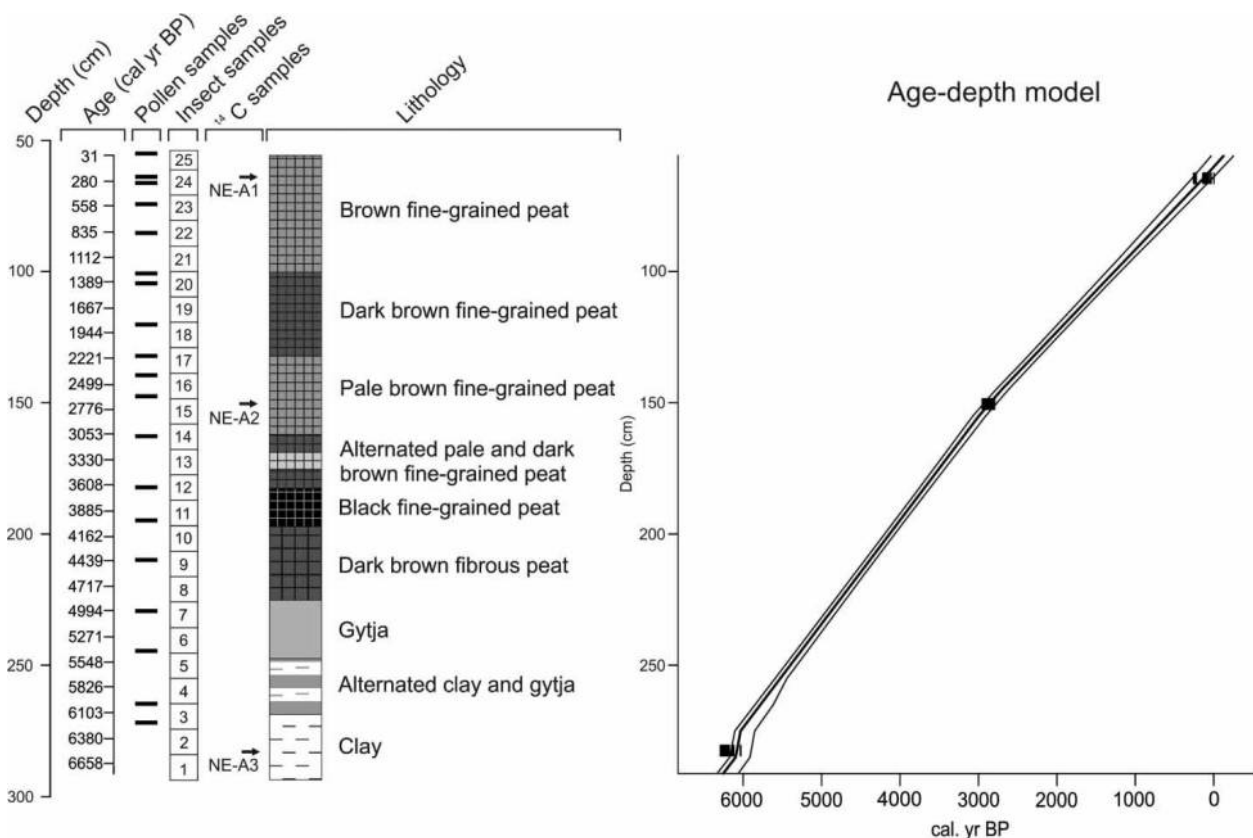


Figure 2 Age-depth model and stratigraphy of core Neor NE-A.

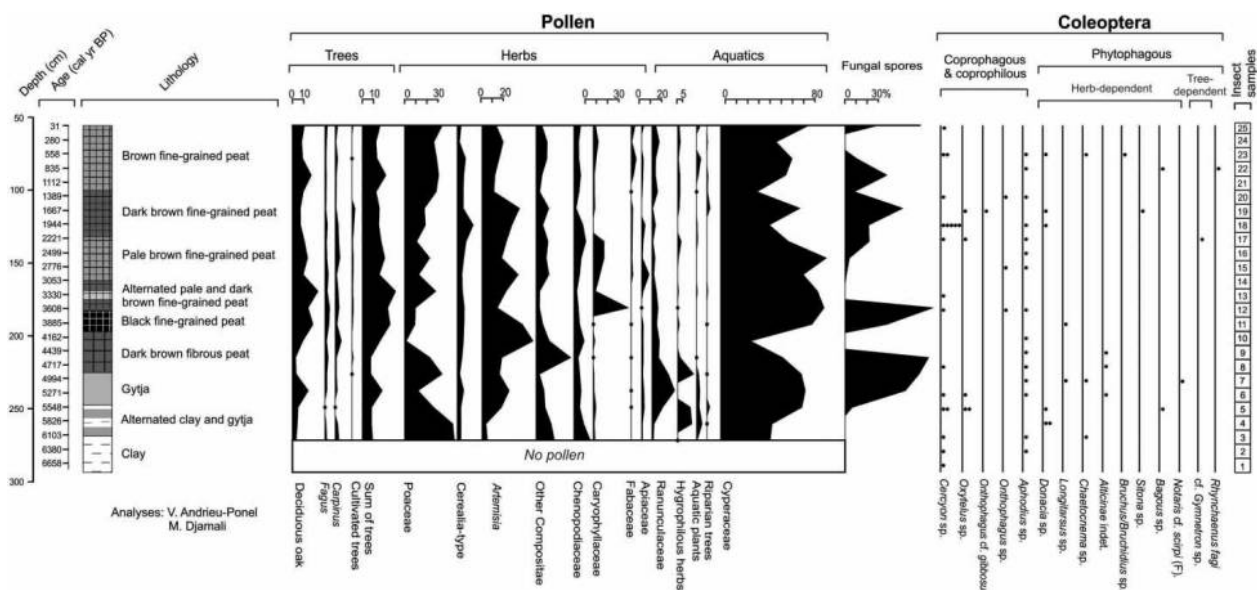


Figure 3 Pollen percentage diagram and insect frequency diagram from Lake Neor.

hygrophilous plants during the lacustrine stage (between ca. 6100 cal BP/4150 BC and 4700 cal BP/2750 BC) and their decline upwards (but not disappearance) indicates that water holes could persist when the Cyperaceae peat bog expanded.

Coleoptera

A total of 63 taxa of Coleoptera (beetles) were identified in the sedimentary sequence (Table 2). Other orders are Heteroptera, with three taxa, and Hymenoptera, represented by unidentified ant fragments (Formicidae). Beetle fragments are present throughout the sequence but there is a clear impoverishment of the assemblages in the middle part of the sequence, and no insects were recovered from sample 14. This could be attributed to a change in taphonomic conditions. Most of the taxa identified in the sedimentary sequence are present today in Iran (Löbl and Smetana 2003–2010). The ecological requirements of beetles contained in fossil assemblages are diverse, including hygrophilous, aquatic, coprophagous/coprophilous, herb-dependent and tree-dependent Coleoptera. Only the three last categories will be included in the synthetic diagram (Fig. 3) and discussed here.

Two important genera of coprophagous Coleoptera are present throughout the sequence, *Onthophagus* and *Aphodius*. At Neor, *Aphodius* is present in almost every beetle assemblage, whereas *Onthophagus* is less frequent. Both taxa feed on dung deposited by big mammals. The adults of *Onthophagus* lay eggs in burrows excavated in the substratum below the dung, whereas *Aphodius* species live during larval and adult stages inside the mass of excrement itself. Both genera are represented by hundreds of species in the Palaeartic region. *Cercyon* is a Hydrophilidae genus

mainly associated with dung and decaying plant debris. Another beetle category associated with dung are the coprophilous insect genera *Oxytelus* and *Platysthetus* that prey upon small Arthropods such as Diptera larvae and mites that in turn feed on excrement.

Herb-dependent Coleoptera belong to three main families: Chrysomelidae, Bruchidae and Curculionidae. *Donacia* is a leaf beetle genus including about 22 West Palaeartic species, all of them associated with aquatic or helophytic plants. The flea beetles *Longitarsus* and *Chaetocnema* belong to two large genera that include hundreds of monophagous or oligophagous insects, associated with a wide variety of herbaceous plants. *Bruchus/Bruchidius* are almost exclusively dependent on Fabaceae, and develop inside the seeds during the larval stages. The weevil genus *Sitona* is also associated with Fabaceae and feeds on leaves and stems both adult and larva. Two other weevil taxa are associated with aquatic or helophytic plants: *Bagous* is a truly aquatic genus that feeds on *Potamogeton*, *Utricularia*, *Ceratophyllum*, *Stratiotes*, *Callitriche*, according to the species, and *Notaris cf. scirpi* that lives on *Carex*.

Tree-dependent Coleoptera are represented by a unique specimen that occurs in sample 22 only. This insect is *Rhynchaenus fagi*; as suggested by its name, this minute weevil is mainly associated with *Fagus* (Hoffmann 1958), although it is also recorded on some other broadleaved trees. This is a widespread species occurring in most of the Palaeartic region.

Discussion

The importance of herb-dependent taxa, along with the almost complete absence of tree-dependent taxa suggests that the environment was open throughout

the sequence, probably similar to the modern landscape on the Neor Plateau. The isolated occurrence of one specimen of a *Fagus*-associated weevil (*Rhynchaenus fagi*) may result from distant transport by wind; however, *Fagus* was certainly present in the Talysh mountains at this time, probably at lower altitude, on the slopes facing the Caspian Sea (Assadollahi 1980).

Coprophagous and coprophilous Coleoptera are present in every beetle assemblage from the bottom to the top of the sedimentary sequence. They suggest that dung was present throughout the sequence, and indicate the regular presence of medium and large size herbivores, wild and/or domestic. It is impossible to distinguish coprophagous/coprophilous Coleoptera associated with livestock, from Coleoptera associated with wild herbivores, but pollen data support a strong and early human impact expressed by the continuous presence of the pollen of *Cerealia*, arable weeds and ruderals.

From an archaeological point of view, the radiocarbon dates associated with these organic remains (quoted above) are culturally between the late Neolithic and Chalcolithic periods. The region of Talysh has a very rich archaeological record especially for the Bronze Age and Iron Age periods which was first recognised in the 19th century by Jacques de Morgan, a French scientist and prehistorian who worked in western Iran and later by other archaeologists (Khalatbari 2004; Tadahiko *et al.* 2003, 2004a, 2004b, 2005). These data, together with recent archaeological investigations, indicate that the region was occupied from the Lower Palaeolithic (Biglari *et al.* 2004). The discovery of a Late Neolithic site interpreted as a seasonal campsite (Nokandeh 2005; Ghasidian 2005), allows us to hypothesise possible transhumance during this period. The earliest domestication evidence of goats in the adjacent areas, namely the Zagros mountain range, is known to be around the 10 000 BP (Zeder and Hesse 2000). Closer to the Talysh region, in the Qazvin plain, sheep and goat were already domesticated during the seventh millennium BP (Mashkour *et al.* 1999; Mashkour 2002). In all these regions, the exploitation of upland zones in summer, and lowlands or plains during the winter must have been a necessity for early populations in search for pasture (Bocherens *et al.* 2001; Mashkour *et al.* 2005).

The study of the animal bones from an Iron Age site in Talysh suggests the possibility of mobile pastoralism (Mashkour 2005). The ethnographic study by Marcel Bazin during the 70s provides a precious and very detailed description of land use in Talysh (Bazin 1980, 9–45) and especially the use of different altitudes on the mountain in different periods of the year for herding sheep/goat and cattle. He divides the

mountain into three ecological zones: the inferior level of the mountain (below 800 m), the medium mountain (from 800 to 1400 m), finally the “Alpages” (higher than 1400 m and extending up to 3000 m). These high grass lands are exclusively used for sheep and goat herding. They are densely occupied seasonally by specialised herders. In another region of the Talysh, the Kaluraz valley, the same pattern of pastoral mobility is verified through a systematic survey of the present day distribution of the lowland and highland (Fahimi 2004; Kazua 2005; Kazua and Fahimi 2005). Bazin (1980) does not use the term “transhumance”, but instead uses (in French) “*migration pastorale*”. These are terms with precise ethnographic definitions. Here, we use “pastoral mobility” which is a general term referring to the fact that people had to move their herds for grass.

Lake Neor is located in the “Alpage” zone of summer pasture lands. Using these archaeological and ethnographic records it is plausible to envisage the high concentration of dung around the lake as an indicator of pastoral mobility, at least from the Late Neolithic to Late Chalcolithic/Early Bronze Age (end of the fifth millennium to the first quarter of third millennium) as indicated by the radiocarbon dates. This type of seasonal mobility has been also suggested for the adjacent areas, like the Zagros (Mashkour 2004; Mashkour and Abdi 2002; Mashkour *et al.* 2005).

In conclusion, both pollen and arthropod data are in agreement, indicating that during the last 6700 years at Neor, the landscape remained continuously open and subject to long-term impact by human groups. They show the early practice (at least from 6700 cal. BP) of cereal cultivation and later fruit tree cultivation (Cereals, Fabaceae, *Prunus*, *Juglans* and *Olea*).

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