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# PRELIMINARY RESULTS ON THE "GROTTA DEL LAGO" HOLOCENE DEPOSITS (TRIPONZO, NERA RIVER VALLEY, UMBRIA, CENTRAL ITALY)

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RIASSUNTO - *Risultati preliminari sui depositi olocenici della Grotta del Lago presso Triponzo (Valnerina, Umbria, Italia centrale)* - Il Quaternario *Italian Journal of Quaternary Sciences* , 9(2), 1996, 745-752 - In questo lavoro vengono presentate le analisi geologiche, paleontologiche, archeologiche e le datazioni $^{14}C$ effettuate sulla successione di riempimento della Grotta del Lago, presso Triponzo (Valnerina, Umbria, Italia centrale). Questi primi risultati hanno permesso la ricostruzione dell'evoluzione olocenica del Lago di Triponzo. I dati suggeriscono un progressivo innalzamento del livello del lago creatosi in conseguenza dello sbarramento del corso dei fiumi Nera e Corno per l'accrescimento di una soglia travertinosa, innescato probabilmente dal miglioramento climatico verificatosi al passaggio Pleistocene/Olocene. L'uomo occupò la grotta circa 6.500 anni BP, durante l' Atlantico, mentre i sedimenti lacustri si depositavano 10-15 m al di sotto dell'entrata inferiore della grotta. Il sito antropico venne sepolto dai sedimenti del lago durante il Subboreale, circa 4.000 anni BP, ed il lago raggiunse il suo massimo livello (417 m a.s.l.) circa 3.100 anni BP. Il deterioramento climatico di questo periodo è testimoniato dall'associazione di ostracodi di ambiente lacustre contenenti diversi *taxa* oligotermofili. Successivamente, i fiumi iniziarono ad intagliare i loro letti nei sedimenti olocenici fino a raggiungere il presente livello, circa 50 metri più in basso, con una velocità media di erosione pari a circa 1,7 cm/anno.

ABSTRACT - *Preliminary results on the "Grotta del Lago" Holocene deposits (Triponzo, Nera River Valley, Umbria, central Italy)* - Il Quaternario *Italian Journal of Quaternary Sciences* , 9(2), 1996, 745-752 - The results of geological, paleontological, archeological investigations and of radiocarbon dating on the cave filling deposits of Grotta del Lago ( a cave near Triponzo, in the Nera River Valley, Umbria, central Italy) are presented. These allow for a first reconstruction of the Holocene evolution of the Triponzo Lake. Data show that the lake level progressively rised after the damming of the Nera and Corno rivers because of the development of a travertine threshold (probably triggered by the climatic amelioration at the Pleistocene/Holocene boundary). Man occupied the cave about 6,500 years BP, during the Atlantic chronozone, when the lacustrine sediments were being deposited some 10-15 m below the cave entrance. The lake deposits sealed the archeological site during the Subboreal chronozone, probably about 4,000 years BP and the lake reached its maximum level (417 m a.s.l.) ca. 3,100 years BP. The climatic deterioration of this period is recorded by the limnetic ostracod assemblages which are characterized by oligothermophilous species. After this time, the rivers started the erosive action, and about 50 m of Holocene sediments were eroded, down to the present *talweg* elevation, at a rate of 1.7 cm/year.

Key-words: Lacustrine sediments, archeology, radiocarbon dating, ostracods, molluscs, vertebrates, Holocene, palaeoenvironmental reconstruction, Central Italy
Parole-chiave: Sedimenti lacustri, archeologia, datazioni $^{14}C$, ostracodi, molluschi, vertebrati, Olocene, ricostruzione paleoambientale, Italia centrale

## 1. INTRODUCTION

During a geological field survey, carried out in 1991, fossil mammal bones were discovered near Triponzo (Nera River Valley, Umbria, Central Italy), in the fluvio-lacustrine deposits that are at the entrance of Grotta del Lago cave, which is carved into the Mesozoic limestones of the central Apennines (Fig. 1). Subsequently, two excavation fieldworks (in 1993 and 1995) in the cave, and a geological survey of the areas surrounding the cave were carried out. The survey was supported by paleontological and archeological investigations and radiocarbon dating.

Palinological investigations and the study of the influence of human impact on environmental changes will be the topic of the next phase of our work.

## 1. GEOMORPHOLOGICAL AND GEOLOGICAL SETTING (O. Girotti & D. Taliana)

The Triponzo village lies on a travertine body at the confluence of the Nera and Corno Rivers, which cut through the folded units of the central Apennines Chain, mainly of carbonate composition. Upstream of the confluence, the valleys are very narrow with steep slopes and gorges, and are filled by Recent sediments, the tops of which form a terrace at 420 m a.s.l. The surface of the terrace is set at 50 m above the *talweg* near a travertine threshold, but lowers to a few meters several kilometers upstream (Fig. 1).

The geomorphology and stratigraphy of the area were already studied by Vinken (1968), and his conclusions agree with ours. He recognized a lacustrine to fluvio-lacustrine succession, about 50 m thick, which originated through the travertine damming at the confluence of the Nera and Corno Rivers. The top of the lake sediments is unconformably overlain by a fluvial deposit (high terrace), up to 5 m thick. The whole succession is then cut down to the Meso-Cenozoic substratum, and a lower terrace is preserved at about 2 m above the talweg. In 1965, a huge landslide slipped off the right bank of the Corno River, and an almost complete sec-

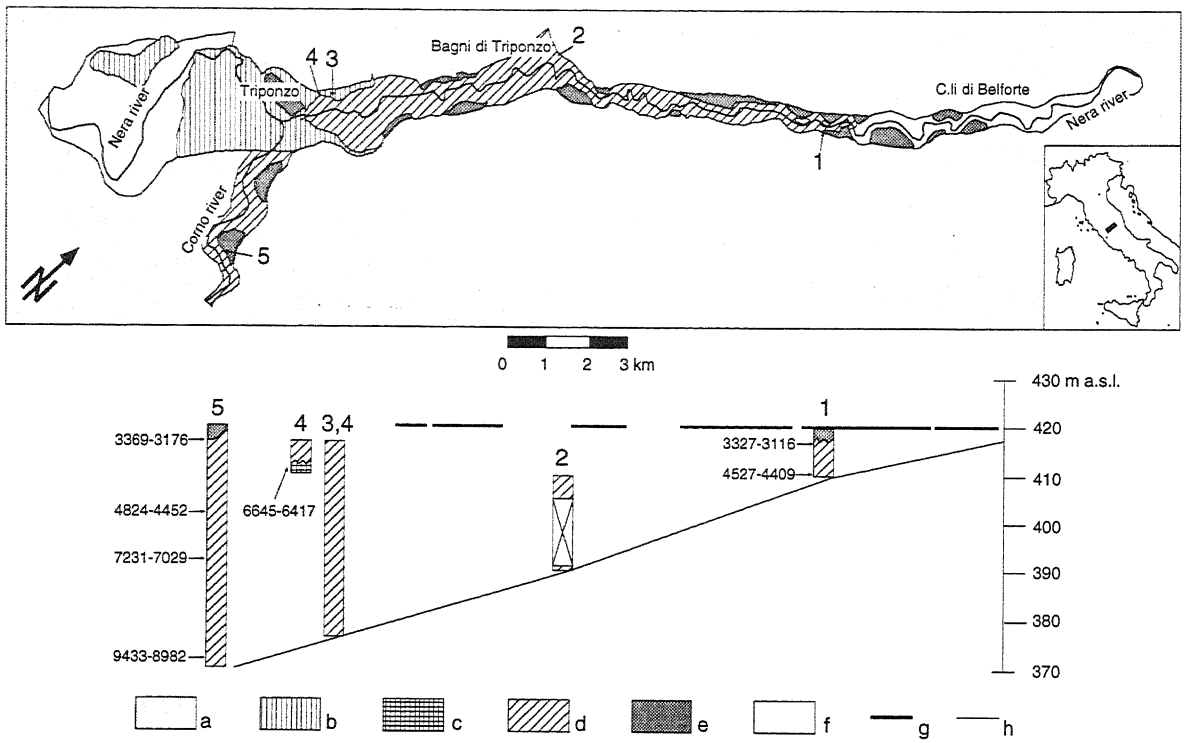


Fig. 1 - Geological and geomorfological sketch map of the Triponzo area. Numbers indicate the location of studied sections. In the lower part of the figure the longitudinal profile of the Nera River with schematic logs of the studied sections is shown (log 3,4 includes the sediments outcropping in section 3 and sediments outcropping immediately outside the cave). Legend: 1: the Nera River high terrace; 2: Bagni di Triponzo; 3: section 200 m ENE of Grotta del Lago cave ; 4: Grotta del Lago cave; 5: Corno River terrace studied by Vinken (1968); **a**: Mesozoic basement; **b**: travertines; **c**: deposit with anthropic evidence inside Grotta del Lago cave; **d**: lacustrine deposits; **e**: high terrace; **f**: low terrace; **g**: longitudinal profile of the high terrace; **h**: longitudinal profile of the Nera River.

*Schema geologico e geomorfologico dell'area di Triponzo con l'ubicazione delle sezioni studiate. In basso, profilo longitudinale del Fiume Nera con i* logs *schematici delle sezioni studiate (il* log *3, 4 è composito e rappresenta i sedimenti affioranti nella sezione 3 ed esternamente alla Grotta del Lago). Legenda: 1: terrazzo superiore del Fiume Nera; 2: Bagni di Triponzo; 3: sezione 200 m a ENE dalla Grotta del Lago; 4: Grotta del Lago; 5: terrazzo del Fiume Corno studiato da Vinken (1968);* **a**: *substrato mesozoico;* **b**: *travertini;* **c**: *deposito con resti antropici dentro la Grotta del Lago;* **d**: *depositi lacustri;* **e**: *terrazzo superiore;* **f**: *terrazzo inferiore;* **g**: *profilo longitudinale del terrazzo superiore;* **h**: *profilo longitudinale del Fiume Nera.*

tion of lacustrine sediments, capped by the high terrace, was exposed. Consequently, Vinken had a good opportunity to carry out the detailed stratigraphic study based on lithology, pollens, ostracods, molluscs and radiocarbon datings of woods. According to this Author the lacustrine sediments had been deposited between 10,000 and 3100 years BP (calibrated ages).

Unfortunately, today outcrops are rare and incomplete, especially along the Nera River. Three sections outcrop on the valley slopes, one section at Grotta del Lago, and a fifth section outcrops at about 200 m ENE of this cave (Fig. 1). The sections on the valley slopes (section 1, 2 and 5 in Fig. 1) consist of lacustrine and fluvio-lacustrine carbonatic silts, sands derived from travertine deposits and subordinate detrital talus breccias. The most upstream section (1 in Fig. 1) is characterized by the presence of large amounts of peat. Radiocarbon dating at 4 m and 11 m above the *talweg* yielded calibrated ages of 4527-4409 and 3327-3116 years BP, respectively.

The section at Grotta del Lago (4 in Fig. 1, Fig. 2) is more complex because of the presence of many anthropic remains lie below the lacustrine deposits. The cave is cut into the *Maiolica* Formation, a micritic limestone of Tithonic-Neocomian age, which is here displaced by a NW-SE trending normal fault dipping 70°SW. The cave develops along the fault and consists of two intercommunicating rooms, the entrances of which are at 410 m and 417 m a.s.l., respectively. The lower room, when discovered, was almost completely filled by sediments. On the contrary, the roof of the upper room was outcropping at about 1.5 m above the room floor. The floor is about 10 $m^2$ wide and consists of gray lacustrine marls. The marls extend downwards inside the cave towards the lower room, and outside the cave where they cover the walls made of the Maiolica Fm.

Remains of *Bos taurus* Linnaeus, *Sus scrofa* Linnaeus, and of Neolithic pottery, were unearthed in 1991 from fluvio-lacustrine sediments at the foot of the entrance of the lower room of Grotta del Lago, and encouraged the further exploration of the cave. Excavations have been carried out for some weeks in 1993 and 1995 and we observed the following succession, from bottom to top (Fig. 2):

1) A layer, 10-15 cm thick, of dark grey silty clay containing rare speleothems and fragments of the cave roof. The base of this layer has not been reached so far. However, a burial with two human skeletons and fune-

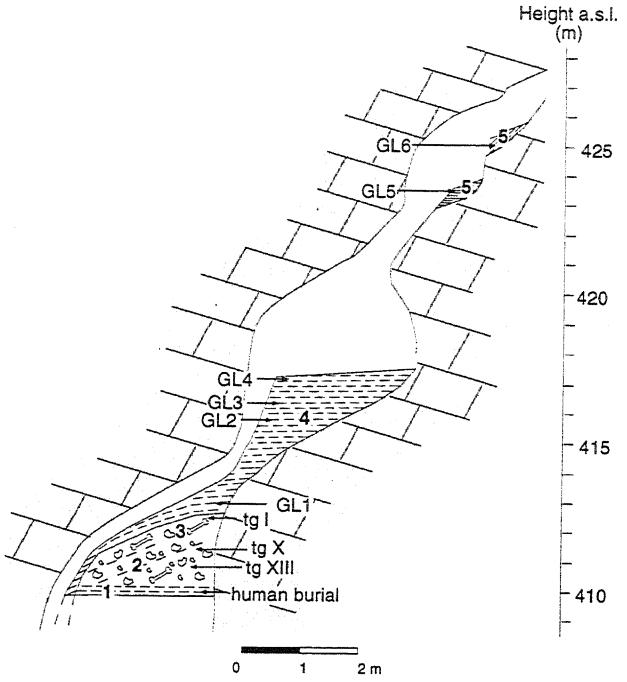


Fig. 2 - Schematic cross section of Grotta del Lago with location of some of the analyzed samples. For the description of the sediments (levels 1-5), see text.

*Sezione schematica trasversale della Grotta del Lago con l'ubicazione di alcuni dei campioni analizzati. Per la descrizione dei sedimenti (livelli 1-5) vedi testo.*

rary outfit was found.

2) About 1,20 m of a detrital sediment with a clayey, silty and travertinous sandy matrix. The lowermost 40 cm of this sediment contain abundant sharp-edged clasts collapsed from the roof, speleothem fragments, disarticulated, frequently broken and/or burned, vertebrate remains, crushed pieces of pottery, flintstones and coals, which yielded calibrated radiocarbon ages of 6645-6417 years BP. The next 60 cm show several reddish veins, whereas fragments of bone, pottery and host rock are rare. The topmost 15-20 cm display parallel laminae of carbonized matter in a travertinous-sandy matrix.

3) About 60 cm of reddish sandy silts and travertine sands, containing millimeter-sized calcareous and clayey particles with carbonate coating. Vertebrate and pottery remains are also present.

4) The aforementioned sequence is unconformably capped by a clayey body, more than 5 m thick, reaching upward the floor of the upper room of the cave. It consists of layered marly clays, grey to light- or hazel-brown in colour, with even, parallel laminations. They contain gasteropods, bivalves and ostracods indicative of a lacustrine facies. No archeological findings occur in this level. Outside the cave, the same clays form small patches on the external walls.

5) The upper room continues upwards in other passages, only 10 m of which have been explored so far. Here, two samples have been collected from a channelized and laminated sandy silt and from clays with oxidized laminae.

Sediments 2), 3) and 4) were deposited both inside and outside the cave, with dissimilar dip due to the topography of the substratum. It must be noted that, beneath the lower entrance, the clays alternate with travertinous sand levels and slope detritus, and contain bone fragments, pottery and coals. In addition, molluscs, ostracods and leaves are common.

Some 200 m ENE of Grotta del Lago, a 1 m-thick section, cropping out at about 405 m a.s.l. (section 3 in Fig. 1), is formed by (from bottom to top): a) matrix-supported breccia with angular calcareous pebbles embedded in a yellow-ocreaceous muddy sand (outcropping thickness: 10-15 cm); b) a 30-40 cm-thick gray clayey mud with dispersed pebbles; c) about 50 cm-thick light brown, muddy clay with sandy component increasing towards the top; d) yellow-reddish fine-grained sand (outcropping thickness: about 10 cm). This section has been sampled for paleontological analyses.

## 2. PALEONTOLOGICAL ANALYSES

### 2.1 Molluscs (D. Esu)

The malacological analysis of the limnic sediments sampled inside and outside Grotta del Lago cave has put to evidence oligotypical assemblages of freshwater molluscs characterized by some species linked to subterranean water and spring systems.

In the lower clayey sediments overlying the anthropic site inside the cave (GL1, Fig. 2) a few species of freshwater gastropods were recovered (Fig. 3). The species found belong to the prosobranchs Hydrobioidea: *Belgrandia mariatheresiae* Giusti & Pezzoli, *Belgrandia minuscula* (Paulucci), *Islamia* cf. *I. pusilla* (Piersanti) and *Bythinella schmidti* (Küster). These *taxa* are linked to cold springs and can also penetrate into subterranean waters (Pezzoli, 1978; 1988; Giusti & Pezzoli, 1980). The assemblage is indicative of flowing waters. The oligo-typical character of the mollusc assemblage is proper of the cave environment.

The clayey sediments outside the cave yielded oligotypic mollusc assemblages of freshwater gastropods and bivalves. The species found belong to the aforementioned prosobranchs Hydrobioidea, *i.e. Belgrandia mariatheresiae* Giusti & Pezzoli, *Belgrandia minuscula* (Paulucci), *Islamia* cf. *I. pusilla* and *B. schmidti,* and to the following pulmonates: *Acroloxus lacustris* (Linné) and *Ancylus fluviatilis* (Müller). Bivalves are represented only by one species of Fam. Pisidiidae: *Pisidium amnicum* (Müller). The species *A. lacustris, A. fluviatilis* and *P. amnicum* colonize various limnetic environments, like rivers, lakes and ponds. Among these species, only *P. amnicum* can penetrate occasionally into the cave water systems. The assemblage point to a limnic depositional environment in which some lacustrine species could live and shells of spring and subterranean water species could accumulate.

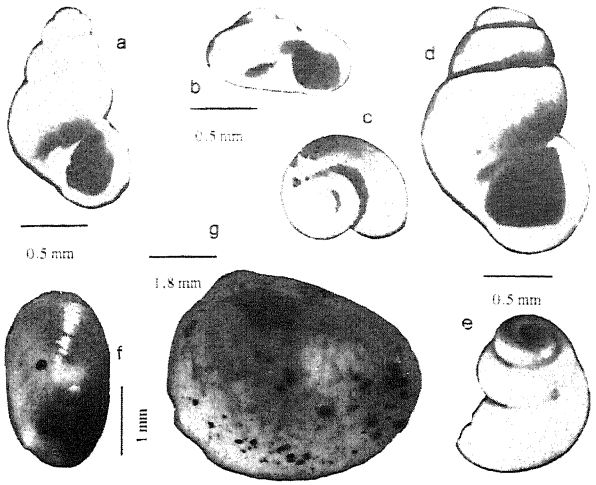


Fig. 3 - Molluscs from Grotta del Lago (section 4): a) *Bythiospeum* sp. (M.P.U.R.-7-1333); b - c) *Islamia* cf. *I. pusilla* (Piersanti) (M.P.U.R.-7-1334-1335); d - e) *Bythinella schmidti* (Küster) (M.P.U.R.-7-1336-1337); f) *Acroloxus lacustris* (Linné) (M.P.U.R.-7-1338); g) *Pisidium amnicum* (Müller) (M.P.U.R.-7-1339) (Esu-Girotti coll.).

*Molluschi della Grotta del Lago (sezione 4): a)* Bythiospeum *sp. (M.P.U.R.-7-1333); b - c)* Islamia *cf.* I. pusilla *(Piersanti) (M.P.U.R.-7-1334-1335); d - e)* Bythinella schmidti *(Küster) (M.P.U.R.-7-1336-1337); f)* Acroloxus lacustris *(Linné) (M.P.U.R.-7-1338); g)* Pisidium amnicum *(Müller) (M.P.U.R.-7-1339) (coll. Esu-Girotti).*

The uncertainty of the systematic attribution of the species of *Islamia* is due to the scarce knowledge about living molluscs in subterranean waters and springs of Central and Southern Italy. Further research on both living and fossil forms of Hydrobioidea are necessary.

*B. mariatheresiae* is proper of springs in Marche and was found as fossil in the Holocene travertine deposits of this same region (Calderoni *et al.*, this volume); *B. minuscula* is typical of some springs and rivers of Central Italy. *I. pusilla,* endemic Italian species, is living in the Apennines areas of Italy. *B. schmidti* (*sensu* Giusti & Pezzoli, 1977; Pezzoli, 1988) is known all along the Italian peninsula and neighboring regions. The other species are widespread in Europe. Our study yields the first occurrence of fossil *B. schmidti* and *B. minuscula,* whereas *I. pusilla* was found in the Holocene calcareous silts of the "Marmore" travertine barrier (Rieti basin) (5,000 - 3,000 years BP) (Carrara *et al.*, 1995). The other species are common from Pliocene onwards.

The molluscs assemblage recorded by Vinken (1968) in the Corno River section (Fig. 1, section 5) falls in the same time span of the lacustrine deposit of the archeological site and indicates a shore environment.

## 2.2 Ostracods (E. Gliozzi & I. Mazzini)

Ostracofaunas were analysed on several samples from the deposits which are inside Grotta del Lago cave (section 4), from those outcropping immediately outside the cave and from the section 3 deposits (Fig.1). Thirteen species have been recognized (Fig. 4). Figures 5 and 6 show their distribution and frequencies. It is possible to identify at least the following four associations:

1) *Candona neglecta-Ilyocypris bradyi* assemblage, which is typical of the lower part of the cave filling deposits. These two species are accompanied by two hypogean species of the genus *Mixtacandona* (*M. stammeri* and *Mixtacandona* sp.1, a new species, Gliozzi & Mazzini in progress) and by rare valves of *Paralimnocythere messanai, Pseudocandona* sp., *Candona fabaeformis* and *Cypria lacustris.* This oligotypic assemblage suggests an instable environment, probably linked to several alluvial episodes which flooded the cave, inhabited only by the

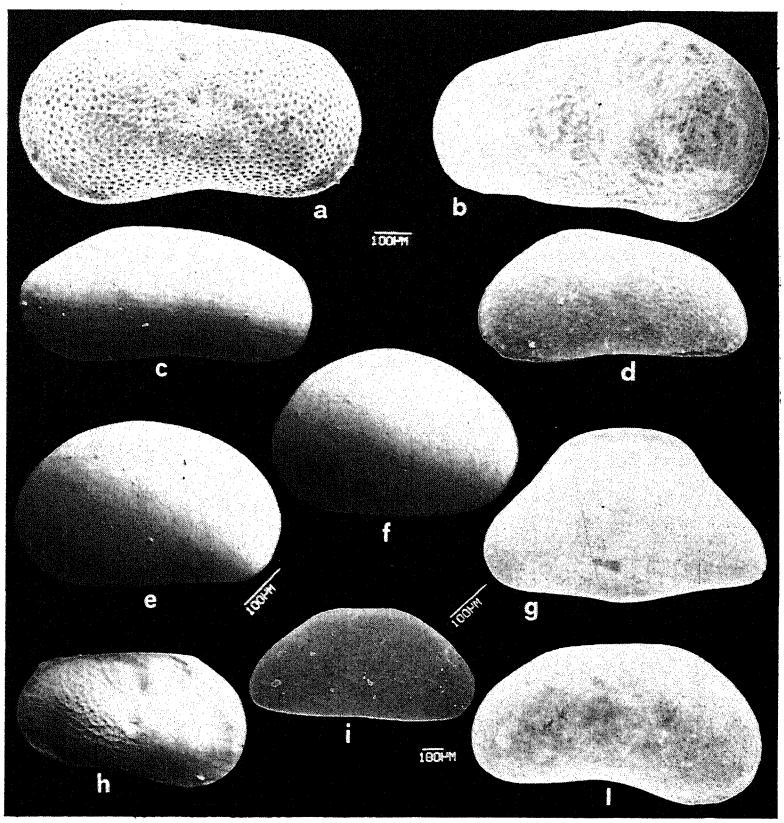


Fig. 4 - Ostracods from Grotta del Lago area (sections 3, 4): a) *Ilyocypris brady* Sars; b) *Cytherissa lacustris* Sars; c) *Candona fabaeformis* (Fischer); d) *Potamocypris zschokkei* (Kaufmann); e) *Cypria lacustris* Sars; f) *Cyclocypris laevis* (Müller); g) *Mixtacandona* sp.1; h) *Paralimnocythere messanai* Martens; i) *Mixtacandona stammeri* (Klie); l) *Candona neglecta* Sars.

*Ostracodi rinvenuti nell'area di Grotta del Lago (sezioni 3, 4): a)* Ilyocypris brady *Sars; b)* Cytherissa lacustris *Sars; c)* Candona fabaeformis *(Fischer); d)* Potamocypris zschokkei *(Kaufmann); e)* Cypria lacustris *Sars; f)* Cyclocypris laevis *(Müller); g)* Mixtacandona *sp.1; h)* Paralimnocythere messanai *Martens; i)* Mixtacandona stammeri *(Klie); l)* Candona neglecta *Sars.*

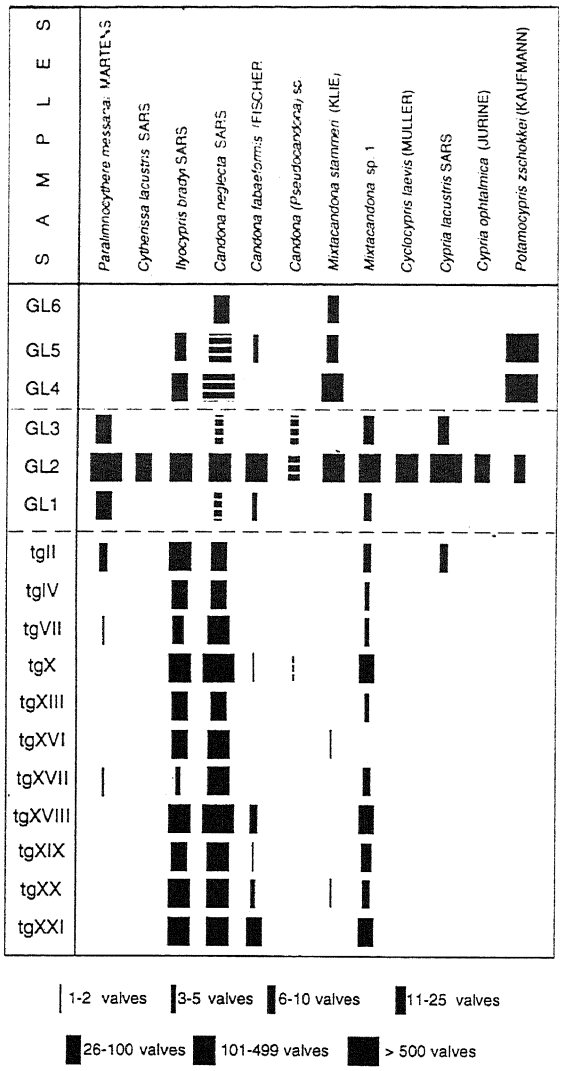


Fig. 5 - Grotta del Lago cave filling deposits: Ostracods frequency diagram.

*Diagramma di frequenza degli ostracodi del deposito all'interno della Grotta del Lago.*

troglophil *taxa*.

2) *Paralimnocythere messanai-Mixtacandona* spp. assemblage, which characterizes the intermediate portion of the cave filling deposit and the marly clays immediately outside the cave that crop out about 80-100 cm below the lower cave entrance. This represents the richest assemblage recovered. Besides the troglophil *Mixtacandona* species and *Paralimnocyhere messanai,* a lacustrine dweller adapted to interstitial environments (Martens, 1992), the abundance of *Cypria lacustris, Candona fabaeformis, Cyclocypris laevis* and the presence of *Cytherissa lacustris* indicate that a lacustrine domain invaded the cave. At present, *Cypria lacustris,* a typical lacustrine dweller, is common in Central and Northern Europe, whereas in Italy it has been recorded only from Lakes Pausa and Ragogna in Friuli (Colizza *et al.*, 1987) as a possible relict of Ice Ages microthermal associations. The *Paralimnocythere messanai-Mixtacandona* spp. assemblage reaches its maximum diversity in one sample (GL3), and probably records the

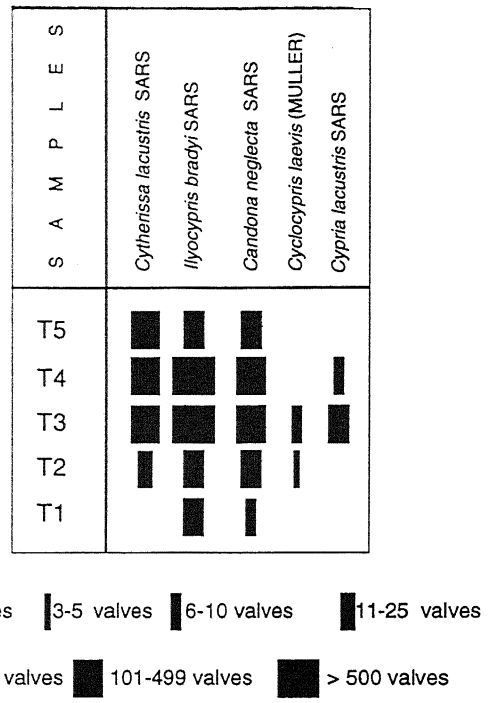


Fig. 6 - Frequency diagram of Ostracods from section 3.

*Diagramma di frequenza degli ostracodi della sezione 3.*

highest lake level.

3) *Mixtacandona stammeri-Potamocypris zschokkei* assemblage. This oligotypical assemblage has been recognized in the upper part of the sedimentary filling deposit of the cave. It marks the retreat of the lake and the recovery of the hypogean environment, probably characterized by the presence of springs or by a fast dripping.

4) *Cytherissa lacustris* assemblage. All the samples analysed (5) from section 3 are characterized by the presence of *Cytherissa lacustris,* a typical oligothermophilous (≤ 18°C; Loffler, 1990) lacustrine dweller. At present, the species shows a northern distribution (northern and central Europe, northern part of N. America), whereas it was reported in northern Italy by Garofalo & Pugliese (in Danielopol *et al.*, 1990) only in the Rio Vodizza basin (Friuli). On the contrary, during Pleistocene glacial periods it expanded its habitat to the south (down to Morocco). In Italy, it has been found as fossil in the Middle Pleistocene lacustrine sediments of the Liri River Valley (Devoto, 1965) and in the Late Pleistocene sediments of a core drilled at Lago Lungo (Rieti) (Calderoni *et al.*, 1994). In the studied assemblage, *Cytherissa lacustris* occurs with abundant *Ilyocypris bradyi* (oligothermophilous species) and *Candona neglecta,* whereas *Cypria lacustris* and *Cyclocypris laevis* are less frequent. The *Cytherissa lacustris* assemblage is indicative of a lacustrine domain characterised by cool or cold waters.

## 2.3 Vertebrates (L. Capasso Barbato & R. Sardella)

Most of the studied vertebrate specimens come from the deposit filling the cave, from samples taken between "tg X" and "tg XXI" (Fig. 2). Several specimens

were recovered during the fieldworks of 1993 and 1995, from the detrital talus outside the cave and can be correlated with certainty with those levels. Bones are commonly very fragmented and, sometimes, show traces of burning. The following *taxa* have been recognized:

Pisces indet.;

Aves: Anatidae indet., *Cygnus* sp.;

Mammalia: *Sorex araneus* Linnaeus, *Crocidura* sp., *Rhinolophus ferrumequinum* (Schreber), *Myotis bechsteini* (Leisler in Kuhl), *Apodemus (Sylvaemus)* sp., *Clethrionomys glareolus* (Schreber), *Microtus (Terricola)* sp., *Arvicola terrestris* (Linnaeus), *Meles meles* (Linnaeus), *Canis familiaris* Linnaeus, *Sus scrofa* Linnaeus, *Bos taurus* Linnaeus, *Cervus elaphus* Erxleben, *Capreolus capreolus* (Linnaeus).

Among the large mammals, most of the specimens belong to the Ungulates. The most common *taxon* is *S. scrofa,* of which a great number of teeth, some cranial portions, ribs and limb bones have been found. These probably pertained to at least three adults and several juveniles. *B. taurus* is less frequent, and is represented mainly by ribs, phalanges and some tarsal bones. Both adults and juvenile specimens can be recognized. *C. elaphus* is identified by several bones (antlers, teeth, thoacic and lumber vertebrae, ribs and limb bones) which can be ascribed to one adult male and to some juvenile specimens. Among cervid remains, an antler fragment and some teeth of *C. capreolus* have been collected.

Carnivors are poorly represented. One specimen of *C. familiaris* (a distal portion of humerus and a proximal epiphysis of cubitus in anatomical connection), and probably one specimen of *M. meles* (testified by limb bones and pelvis) have been recognized.

Micromammal analysis has highlighted the rare occurrence of some insectivores, bats and rodents: *S. araneus, Crocidura* sp., *R. ferrumequinum, M. bechsteini, Apodemus (Sylvaemus)* sp. (at least four individuals), *C. glareolus, Microtus (Terricola)* sp. and *A. terrestris.* Some fragments of bird bones have also been collected. They can be probably ascribed to small Anatidae indet. and to *Cygnus* sp. (fragmentary humerus and pelvis).

The human influence in the composition of the aforementioned mammal assemblage can be traced in the presence of domestic forms. The occurrence of roe deer and badger shows the importance of hunting as feeding habit of the cave dwellers. On the contrary, the presence of an almost complete skeleton of *C. elaphus* could be related to burial cerimonies.

The wild fauna association gives some information about the palaeoecological and climatic conditions of the area. The association *S. scrofa, C. elaphus* and *C. capreolus* is characteristic of woodlands in the humid phases of the Holocene. Anatidae and, among micromammals, *S. araneus* and *A. terrestris* are also indicative of humid conditions.

## 3. RADIOMETRIC AND ABSOLUTE DATINGS (M. Alessio, L. Allegri & S. Improta)

The samples we dated came from the following materials: samples 11E from wood embedded in a clayey matrix (section 1); samples 11F from peat mixed with clay (section 1); sample "tg XIII" from charcoal scattered in a terrigenous matrix (level 2 inside Grotta del Lago).

Table 1 - Radiometric conventional and absolute ages of samples from the Nera River area

*Età radiometriche e datazioni assolute dei campioni prelevati nell'area del Fiume Nera.*

| Sample | Lab.code | Conventional age | Calibrated age BP | $\delta^{13}C$(‰) |
|---|---|---|---|---|
| 111 | R-2326 | 3025±50 | 3327-3116 | -27.3 |
| 111 | R-2351 | 4000±60 | 4527-4409 | -30.9 |
| Tg.XIII | R-2570 | 5732±75 | 6645-6417 | -23.9 |

All the samples were subjected to physico-chemical treatments (Improta, 1994), as follows:

a) Pre-treatment. For all the samples a preliminary analysis, in order to remove foreign matter, was carried out. 11F and the "tg XIII" samples were reacted with 0,1 N NaOH to get rid of humic acid traces which seemed to be present.

b) Combustion and $CO_2$ production. $CO_2$ is used for $^{14}C$ activity measurements; therefore, samples were ignited in a quartz tube, at 800°C and in a stream of oxygen. The gas obtained was chemically purified to remove electronegative impurities such as CO, $SO_2$ and halogens.

Radon, if present, was removed by decay storing during a time interval longer than 7 half-lives.

c) Measurements of ß-activity. $CO_2$ proportional counters, of about 1000 and 1500 $cm^3$, were used. Working voltage was 8564V at a pressure 3.04 x $10^5$ Pa.

Massive and electronic shields were used, as it is usual, against cosmic rays and environmental radioactivity influence.

d) Conventional age determination. Conventional ages were obtained by comparison with the ANU (Australian National University) Sucrose standard, which was checked through an international calibration promoted by IAEA in 1991.

Fom the background determination, $CO_2$ from the same stock of Carrara marble employed for the aforementioned calibration was used.

The $\delta^{13}C$ anlyses were performed at "Laboratorio Isotopi Stabili, Dipartimento di Scienze della Terra, Università La Sapienza", by Prof. B. Turi and Dr. M. Preite.

e) Absolute ages determination. Conventional ages were converted in absolute ages by means of the "revised Calib. 3.0" (Stiver & Reimer, 1993) calibration program. The results are given in Table 1.

1σ is the statistical uncertainty in conventional ages; calibrated ages refer to a confidence interval of 68%.

## 4. ARCHEOLOGY (C. De Angelis)

Human bones in partial anatomical connection have been discovered in level "tg XIII" at Grotta del Lago (Fig. 2), along with some pottery (Fig. 7). These consist of an un-turned coarse paste, with a yellow-brown surface. The shapes are simple (frustum of cone), and of various heights; the spool-like handles ("a rocchetto") are long and thin if placed on the rim, or large and heavy if placed

beneath the rim. Rare decorations (dents or dots) embellish the rims.

On the basis of these characters, the pottery can be ascribed to an advanced phase of the "Diana Culture". The use of a natural cave as funerary site is well documented in the framework of this culture.

## 5. DISCUSSION AND CONCLUSIONS

The results of this preliminary study indicate that the stratigraphic history of the infilling of Grotta del Lago is linked to the Holocene evolution of the Nera River valley in the Triponzo area. A thick travertine threshold dammed the Nera River and its left tributary, the Corno River, and originated upstream two narrow lacustrine basins. The waters of the Nera lake raised above Grotta del Lago and its sediments sealed the archeological site containing a human burial of about 6500 years BP thus preserving it up to the present days.

Ostracod analyses allow to infer the palaeoenvironmental evolution of the cave-filling succession from a unstable environment (levels 1 and 2), probably linked to several alluvial episodes which flooded the cave, to a stable lacustrine environment (level 4) characterized by cool or cold waters, up to the recovery of a typical hypogean domain (level 5). Ostracod and mollusc assemblages outside the cave show the presence of a lacustrine domain below the level of the lower cave entrance, with environmental characteristics deeply affected by the nearby hypogean habitat, whereas ostracods from section 3 indicate a cool or cold lake, deeper than 2 m. The elevations of these two latter deposits (respectively 409 and 405 m a.s.l.) suggest that they correspond to a time interval in which the lake level had not yet reached the cave entrance. Presumably the lacustrine environment recorded in level 4, yielding both *Cytherissa lacustris* and *Cypria lacustris,* corresponds to the same lake identified by the ostracod assemblage of section 3 at its high-stand level.

From our records and from the literature (Vinken, 1968) we can hypothesise that a lacustrine environment developed from about 10,000 y BP along two branches of the Nera and Corno Rivers. Data show that the lake level progressively rised after the damming of these rivers through the growth of a travertine threshold (probably triggered by the climatic amelioration at the Pleistocene/Holocene boundary, as suggested by the temperate ostracofauna from the lacustrine sediments of this age) (Vinken, 1968). The youngest calibrated ages obtained for the lacustrine sediments are 3,300 y BP in the Vinken's Corno River section (section 5 in Fig. 1) and 3327 - 3116 and 4527-4409 y BP in our section (section 1 in Fig. 1) in the Nera valley. The elevations of the corresponding levels fit that of the lacustrine layer overlying the archeological site (dated 6645-6417 years BP) inside the cave. Vinken obtained 7231-7029 years BP (calibrated age) for samples set at about 390 m a.s.l. If this age is correct, we can infer that the top of the lacustrine sediments was located at about 10-15 m below the lower room of the cave, when the human body was buried 6500 years BP. The height of the water column above the lake bottom is unknown, but the cave must have been accessible.

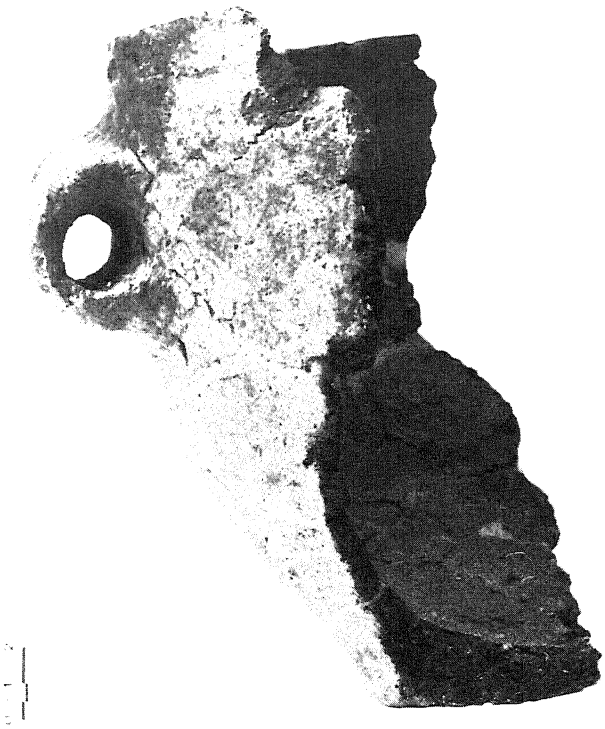

Fig. 7 - Grotta del Lago: Neolithic pottery from the cave filling deposits with human evidence.

*Ceramica neolitica proveniente dai depositi della Grotta del Lago contenenti reperti dell'attività umana.*

The detrital deposits between the burial and the lacustrine layers are characterized by fragments of bones, charcoal and pottery, bound in a clayey-silty-sandy matrix. This matrix was probably deposited by flood waters, which episodically entered the lower parts of the cave in connection with increased flows in the Nera River. At this time, the site must have been abandoned, and served only as waste deposit.

Man occupied the cave during the Atlantic chronozone, when the lake shore lay some 10-15 m below the cave entrance. The lacustrine sediments sealed the archeological site during the Subboreal chronozone, presumably 4,000 y BP, in agreement with the age of the deposits at the same elevation, and assuming that the lake bottom was nearly horizontal.

The fluvial sediments of the high terrace capping the lacustrine deposits mark the position of the river bed at about 3,000 years BP. After this time, the rivers started to erode the about 50 m thick Holocene sediments down to the present *talweg* elevation, at a rate of 1.7 cm/year.

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