PALEOECOLOGY AND EXTINCTION OF *SOLENOMYA DODERLEINI* IN THE PLIOCENIC SECTION OF THE STIRONE STREAM (ITALY)

PALEOECOLOGIE ET EXTINCTION DE *SOLENOMYA DODERLEINI* DANS LA SECTION PLIOCENIQUE DU TORRENT STIRONE (ITALIE)

PALEOECOLOGIA ED ESTINZIONE DELLA *SOLENOMYA DODERLEINI* NELLA SEZIONE PLIOCENICA DEL TORRENTE STIRONE

Valentino Straser

Istituto Tecnico Statale a Ordinamento Speciale Fornovo di Taro (Parma), Italy
E.mail: fifurnio@tiscali.it

Abstract

As remains of organisms, fossils are indicators of ancient environments, the expression of a community that existed in the geological times and of its relationships with the past environment A marine mollusc that became extinct about three million years ago opens new horizons for reading our present time and, in perspective, possible future events such as important environmental disturbances. Thanks to its colonization of ancient marine environments and mainly thanks to its extinction which made it available to us, it allows the casting of new light on the delicate matter of the climatic mutations at a global scale as well as the possible action the magnetic field upon living organisms. The knowledge of present ecological mechanisms enables us to acquire important information about the past, and vice versa.
Key words: *paleoecology, models and theory, ecology, Solenomya doderleini, biodiversity, bio-indication, electromagnetic fields, extinctions.*

Résumé

En étant des restes d'organismes, les fossiles sont des indicateurs d'habitats anciens, expression d'une communauté existée dans l'histoire géologique et de ses relations avec l'habitat du passé. C'est un mollusque marin éteint il y a environ trois millions d'années à ouvrir des horizons nouveaux pour la lecture du présent et, en prospective, d'événements futurs, même perturbations d'habitat. Grâce à son rôle de colonisateur d'habitats marins anciens et, surtout grâce à sa extinction par laquelle il est parvenu à nous, il nous permit de jeter nouvelle lumière sur le thème délicat des mutations climatiques à échelle globale, et aussi sur la possible action des champs magnétiques sur les organismes vivants. Pour comprendre le présent dans un ensemble global, la connaissance des mécanismes écologiques actuels permets d'acquérir des informations importantes sur le passé, et vice versa.
Mots-clés: *paléoécologie, modèles et théories, écologie, Solenomya dorerleini, biodiversité, bio-indicateur, champs électromagnétiques, extinctions.*

Riassunto
In quanto resti di organismi, i fossili sono indicatori di antichi ambienti, espressione di una comunità esistita nella storia geologica, e delle relazioni intrecciate con l'ambiente nel passato. E' un mollusco marino estinto circa 3 milioni di anni fa ad aprire nuovi orizzonti per la lettura del presente e, in prospettiva di eventi futuri, assimilabili a importanti turbative ambientali.
Grazie al suo ruolo di colonizzatore di antichi ambienti marini e, soprattutto grazie alla sua estinzione che lo ha fatto pervenire a noi, esso ci consente di gettare nuova luce sul delicato tema delle mutazioni climatiche a scala globale, oltre che sulla possibile azione esercitata dai campi magnetici sugli organismi viventi. Per comprendere il presente in un insieme globale, la conoscenza dei meccanismi ecologici attuali permette di acquisire importanti informazioni sul passato, e viceversa.
Parole chiave: *paleoecologia, modelli e teorie, ecologia, Solenomya dorerleini, biodiversità, bioindicatore, campi elettromagnetici, estinzioni.*

Introduction

The point of convergence between ecology and paleoecology is the comparison among present and fossil species, as well as the correlations with organisms morphologically similar to those of the past in a temporal continuum ruled by the Natural Selection Theory. How would it be possible to trace the natural dynamics that took place in the past if we ignore present-day mechanisms? In this sense, the ecological principle is unifying. Ecology mainly concerns the study of all relationships among organisms and their surrounding environment, and the study of their mutual relationships. In both present and past processes, the distribution of communities is controlled by physical factors such as depth, substrate, salinity, current, and other parameters. Therefore, for the ecologist and the paleoecologist it is important to consider the holistic and dynamic aspects of the units to detect the varying levels or types of ecological interactions.
The ecologist deals with short-term processes concerning years; the paleoecologist deals with spaces and times concerning millions of years. While the ecologist lacks time perspective, the paleoecologist lacks a number of fossils that missed becoming such. A further point of convergence between these two sciences is the working methodology that can be summarized in two branches of research. One studies the relations of the organisms with the environment, the other studies the biological features: life history (evolution), interaction with the other organisms, and integration in the community. The paleoenvironmental reconstruction depends on a well determined stratigraphic structure, a good taxonomy, and a clear ecological background. In fact, the aim of paleoecology is to reconstruct in as much detail as possible the ecosystem pattern of the organisms that, for instance, are today discovered in the sediments from the last period of two million years, named until recently 'Quaternary' (Dodd and Stanton, 1981). The ecological reconstructions are made considering as a starting point the present-day natural environments and the

biological, physical, and chemical parameters characterising them, such as average temperature and range, nature and quantity of available food, grade and intensity of sunlight, water salinity, and so on. A large part of such parameters is not revealed by the sediments and has to be gathered indirectly.

As already said, fossils are indicators of ancient environments because they are remains of organisms. For the paleoecological interpretation, they are organisms in an evolution happening through speciation phenomena, along time, whose fossil remains can be considered the example of a process - appearance and disappearance - in relation with bio-events. Hence, the paleoecological research field includes the study and the relationships among fossil species identified in their lifetime, their natural environment, their death, laying, burial.

The surface sediments in the Emilian foothill area are mainly Pliocenic clays through which gullies variously cut. These compact and relatively plastic rocks (Zanzucchi, 1980) contain marine fossils of organisms that lived from 3.5 to 2.5 million years ago, i.e. in the Pliocene. The fossil remains preserved in the Pliocenic section of the Stirone Stream from 120 to 200 metres approx. (Fig. 1) mainly consist of a malacofauna (gastropods and bivalves), corals and micro-organisms bathymetrically assignable to the passage from epibathyal to circumlittoral environments (Marasti and Raffi, 1976).

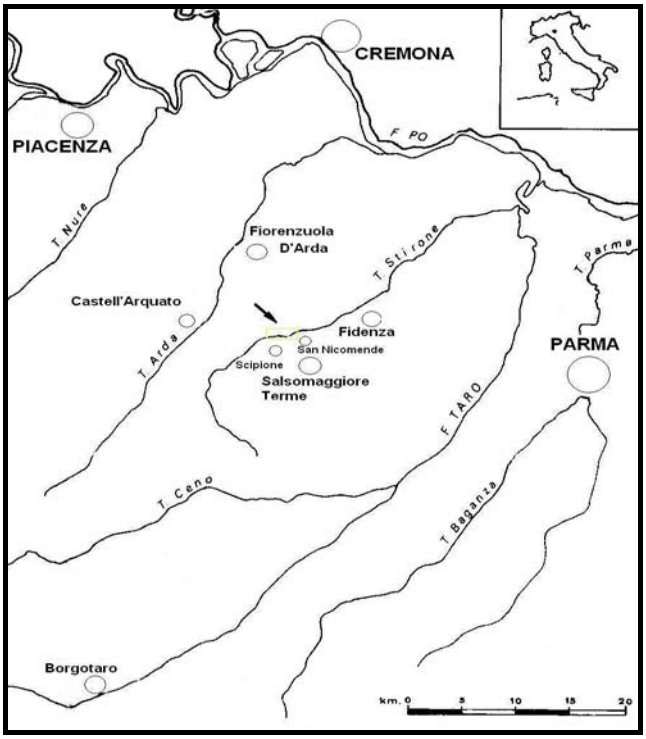

Figure 1

Index map

The area between the villages of Scipione Ponte and San Nicomede, may be integrally seen in the Emilia-Romagna Regional Technical Chart Element No. 180161 'Scipione', scale 1:5000.

Materials and methods

For this study, the method used was the so-called 'Square' method, since it proved to be especially suitable for the particular situation of the Stirone Stream. Our survey area square was in compact mud banks showing small evidence of stratification planes. Each trial delimited a 4 m^2 area excavated to 20 cm depth approx. All surface elements were gathered. Unfortunately, even if having the undoubtful advantage of avoiding the transport of voluminous samples, this method does not allow to detect the malacofauna invisible to the naked eye, nor to carry out a rigorous quantitative evaluation.

Results

This study aimed to discover species colonizing habitats that were characterized by environmental disturbances and, in particular, species that lived in muddy and sandy shallow waters of the deep circalittoral. This is the case of *Lucinoma borealis* (Fig.2) and *Solenomya doderleini* (Fig.3), the latter species being known from the Mediterranean Sea, in the Miocene and Pliocene.

Figure 2

Lucinoma borealis

Figure 3

Solenomya doderleini

The paleoenvironmental evolution and the taxonomic difference of the Stirone Stream Pliocenic section as far as mollusc associations are concerned was previously discussed (Straser, 1984), whereas the Stirone Stream Plio-Pleistocenic section was investigated by Papani & Pelosio (1962) for the first time. Other malacofauna studies examined the Pleistocenic section (Papani. and Pelosio, 1962; Pelosio and Raffi, 1974). The first great Pliocene extinctions consequent to an important phase of climatic worsening (Shackleton and Opdyke, 1977; Raffi & Marasti, 1982) correspond to the Tabianian sensu Mayer-Plaisancian passage. In the effort to reckon such a passage here, the associations and their environmental significance were analyzed. The search for other possible ecobiostratigraphic general events concerned the initial glacial Pliocene, about 2.5 million years ago (Thunnell and Williams, 1983; Schackleton and Cita, 1979). Further studies considered possible links between the electromagnetic field variations (Straser, 2007) and the extinction of marine organisms such as molluscs and Cetacea. The section at the ceiling of the examined tract is characterized by at least five debris flow episodes with transported infralittoral mollusc and calcareous algae fossil assemblages (TFA), interpretable as a bathymetric variation due both to climatic changes and to orogenic phenomena in the Apennine Chain upthrust (Monegatti & Raffi, 1997).

Discussion and conclusions

In the studied area, the sediment-eater bivalves were relatively more abundant than the suspension feeders in deep water. They ranged second in the food chain and were found in muddy substrates, i.e. in the presence of deposited food and in energetically poor environments. The fossil documentation of the Stirone Stream Pliocenic section enabled the conjecture of two paleoenvironmental situations (Straser, 1984). The first, documenting an epibathyal environment, is characterized by the almost-total absence of Eulamellibranchia, the presence of *Turrides* or anyway of a number of predator gastropod species, and a prevalence of Phyllobranchia bivalves over Ctenodonts. It is clear that, in a standard situation, the complex structure of Eulamellibranchia remains unused in a silt sedimentation-based environment. In conclusion, we can assume that the high metabolism of Eulamellibranchia prevents their survival in bathyal environments that, it is well known, provide limited resources for filter feeders.
The most peculiar species in the association is *Korobkovia oblonga* (Fig. 4) which was the exclusive distinctive species. In the top intervals of the series, *Solemya doderleini* appears especially frequently in association with *Lucinoma borealis*.
The two species can be assumed to have a real role as colonizers in the malacofauna (Fig. 5).

Figure 4

Korobkovia oblonga

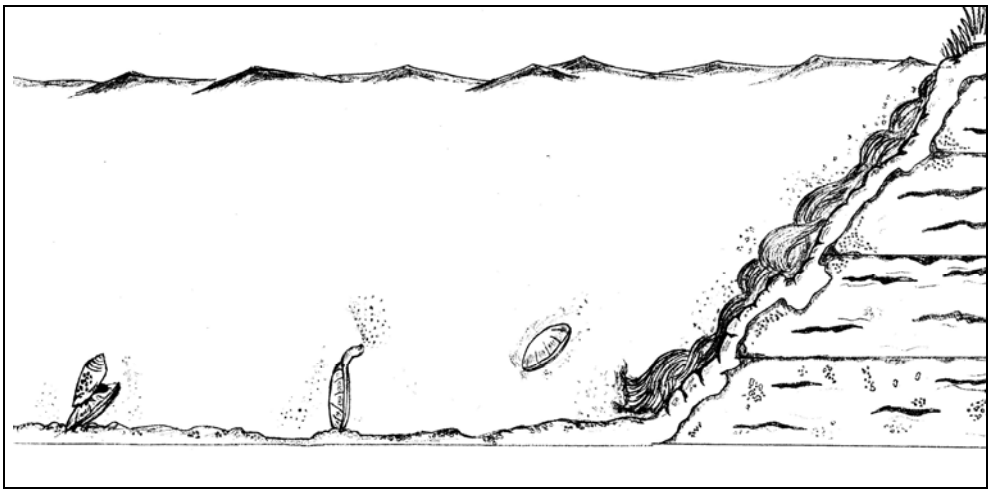

Figure 5 - *Solenomya doderleini, colonizer of ancient marine environments (drawing by Filippo Gradella)*

Coinciding with the disappearance of *Korobkovia oblonga* and *Solemya doderleini*, and for the first time in the section, was noted the appearance of *Pseudamussium clavatum* and *Amusium cristatum,* species revealing an important diminishing of the depth of the sedimentation environment and, in particular, the shift to a circalittoral environment.

The 'bioclastic sediments' in the stratigraphic succession can be dated back to 3-2.5 million years ago, periods marking a cooling and progression of the icecap in our hemisphere, two subsequent phases clearly readable in the Mediterranean record (Paganelli, 1998), particularly that of the mollusc fauna (Raffi et *al.*, 1989; Monegatti and Raffi, 1997). The colonizing role of *Solenomya doderleini* can be 'compared' with that of some current types that settle first after environmental disturbances. With regard to *L. borealis,* it is interesting to note that present-day species such as *Lucinoma kazani* live in the Mediterranean eastern basin, between

Rhodes and Cyprus. Some specimens were found in the Kazan volcano at a depth of 1709 m., and others near volcanoes, at varying depths. Their kind of habitat is characterized by mud with high levels of methane and low values of oxygen in deep waters (Salas and Woodside, 2002).
Conversely, *Lucinoma borealis* can be found in oxygen-deprived environments (Dando *et al*., 1994) similar to those with low oxygen values of the Stirone Stream habitat. The extinction of many molluscs (such as *Solenomya doderleini)* in the Stirone Stream Pliocenic section occurred in coincidence with the Earth's magnetic field shift (AA.VV., 1996). Since the sixties, a number of scientists began to speak of an imminent shift of the magnetic fields (Heirtzler, 1986), and the example of species that lived in the geological past, as did *Solenomya doderleini*, could provide useful information for addressing the current research on fresh and marine waters, it being a well-known fact that several animals use the Earth's magnetic field to orient themselves, as does the marine mollusc *Tritonia diomedea* which has a 'magnetic compass' and a simple nervous system (Beck *et al.*, 2000; Gaston, 1998; Murray *et al*.,1992; Pavlova *et al*., 1999).
More indications about magnetic field effects on living organisms could be collected, in perspective, in areas undergoing tectonic stresses. There, the seism-electro-magnetic phenomena are particularly intense (Freund *et al.*, 2006; Straser, 2007). The associated release of ELF and VLF might interact with attackable organs, and not merely in molluscs. Such a study could open new visions on the mechanisms of the past great extinctions and, together, provide a new role for the environmental analysis of present-day indicators.

References

AA.VV. (1996) Guida alle escursioni, Soc. Paleont. It., XIII Convegno, Parma, 10-13 settembre 1996, Centro Grafico Università di Parma, p. 14 (1996)
BECK, J. C., COOPER, M. S. AND WILLOWS, A. O. D. (2000) Immunocytochemical localization of pedal peptide in the central nervous system of the gastropod mollusc Tritonia diomedea.J. Comp. Neurol. 425:1-9.
DANDO P.R., RIDGWAY S.A., SPIRO B. (1994) Sulphide 'mining' by lucinid bivalve molluscs: demonstrated by stable sulphur isotope measurements and experimental models. Mar. Ecol. Prog. Ser. Vol. 107: 169-175.
DODD, J.R. , STANTON, R. J. (1981) Jr, Paleoecology, Concepts and application. Wiley, New York.
FREUND, F., TAKEUCHI, A. AND LAU B. (2006) Electric Currents Streaming Out of Stressed Igneous Rocks - A step towards understanding pre-earthquake low frequency EM emissions. Physics and Chemistry of the Earth, 31: 389-396.
GASTON, M. R. (1998) Neuropeptide TPep action on salivary duct ciliary beating rate in the nudibranch mollusc Tritonia diomedea. Invert. Neurosci. 3:327-333.
HEIRTZLER, J.R., (1986) L'espansione dei fondali oceanici. Le Scienze - Quaderni, 32: 44-51.
MARASTI R., RAFFI S. (1976) Osservazioni biostratigrafiche e paleoecologiche sulla malacofauna del Piacenziano di Maiatico (Parma, Emilia occidentale). Boll. Soc. Paleont. It., 15 (2): 189-214.

MARASTI R., RAFFI S. (1980) La diversità tassonomica dei bivalvi del Pliocene mediterraneo: elenco preliminare; proposta di lavoro al Gr. C.N.R. Paleobenthos. Prospettive di ricerca. Riunione del 24-28 maggio, 1980, Palermo, pp. 1-30.

MONEGATTI P., RAFFI S. (1997) Castell'Arquato e i suoi dintorni: la culla degli studi sul Pliocene, Soc. Paleont. It. 36 (1-2): 43-56.

MURRAY J. A., HEWES R. S., WILLOWS A. O. D. (1992) Water-flow sensitive pedal neurons in Tritonia: role in rheotaxis. J. Comp. Physiol. 171:373 -385.

PAGANELLI P. (1998) Primi risultati di una ricerca palinologica sulla foresta fossile di Dunarobba (Umbria-Italia Centrale), Atti del Convegno Internazionale (Avigliano Umbro 22-24 aprile 1998), Ediart, pp. 83-103.

PAPANI G., PELOSIO, G. (1962) La serie plio-pleistocenica del T. Stirone (Parmense occidentale). Boll. Soc. Geol. It., 81: 293-335.

PAVLOVA G. A., WILLOWS A. O. D. , GASTON M. R. (1999) Serotonin inhibits ciliary transport in esophagus of the nudibranch mollusk Tritonia diomedea. Acta. Biol. Hung. 50:175 -184.

PELOSIO G., RAFFI S. (1974) Osservazioni su Arctica islandica ed altri Lamellibranchi del Calabriano dell'Emilia occidentale. L'Ateneo Parmense-Acta Naturalia 10: 347-367.

RAFFI S., MARASTI R. (1982) The Mediterranean Bioprovince from the Pliocene to the Recent: Observation and Hypoteses based on the evolution of the taxonomic diversity of molluscs. International Meeting on Paleontology, Essential of Historical Geology, Venezia, pp. 151-177.

SALAS E., . WOODSIDEE. (2002) Lucinoma kazani n. sp. (Mollusca: Bivalvia): evidence of a living benthic community associated with a cold seep in the Eastern Mediterranean Sea, Deep-sea research. Part 1. Oceanographic research papers, Elsevier, vol. 49 (6): 991-1005.

SHACKLETON N..J., CITA B.M. (1979) Oxygen ad carbon isotope stratigraphy of benthic foraminifers at site 397: Detailed history of climatic change during the late Neogene; in: von Rad, U. Ryan, W.B.F., et al., Initial Reports of the Deep Sea Drilling Project, 47: 433-445, Washington (U.S. Government Printing Office).

SHACKLETON N.J., OPDYKE N.D. (1977) Oxigen isotope and paleomagnetic evidence for early Northern Hemisphere glaciation. Nature 270: 216-219.

STRASER, V. (1984) La malacofauna a molluschi della sezione pliocenica del T. Stirone. Università di Parma. Tesi inedita.

STRASER, V. (2007) Precursory luminous phenomena used for earthquake prediction - The Taro Valley, North-western Apennines, Italy. New Concepts in Global Tectonics Newsletter 44:17-31.

THUNELL R.C., WILLIAMS D.F. (1983) The stepwise development of Pliocene-Pleisto cene paleoceanographic conditions in the Mediterranean: oxygen isotopic studies of DSDP Sites 125 and 132. Utrecht Micropalent. Bull. 30:111-127.

ZANZUCCHI G. (1980) Lineamenti geologici dell'Appennino parmense. Note illustrative alla Carta e sezioni geologiche della Provincia di Parma e Zone limitrofe (1:100.000). In: Volume dedicato a S.Venzo, Step Parma, 201-233.