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Original article

The Lower-Middle Pleistocene succession of the Coastal Tuscany (Central Italy): new stratigraphic and palaeoecological data based on the ostracod fauna

La succession du Pléistocène Inférieur-Moyen dans la Toscane Côtière (Italie Centrale) : nouvelles données stratigraphiques et paléoenvironnementales fondées sur les ostracofaunes

Barbara Dall'Antonia *, Alessandro Bossio, Renzo Mazzanti

Dipartimento di Scienze della Terra, Universita di Pisa, Via S. Maria, 53, 56126 Pisa, Italy

Abstract

The Lower-early Middle Pleistocene succession of the Coastal Tuscany is known to comprise three marine cycles: (I) a Santernian–Emilian cycle; (II) a Sicilian ("small *Gephyrocapsa*" Zone) cycle; (III) a third cycle, referred through stratigraphic and palaeoethnological arguments to the late Sicilian-early Middle Pleistocene, including the fluvial-transitional San Marco fm and the shoreface to backshore sandy-arenitic deposits of the correlatable Bibbona and Casa Saracino formations, outcropping in the Bibbona (Lower Cecina Valley) and Rosignano areas respectively. Conversely to the older cycles the third one has been poorly studied and its chronology and depositional history have remained somewhat uncertain. With the aim to fill this gap of knowledge the sedimentary record exposed in the Rosignano and Bibbona areas was the object of new on field investigations and microfaunal content (chiefly ostracods) analyses. Furthermore, this has represented a good opportunity to enhance our knowledge of the Pleistocene Mediterranean ostracods. The main results achieved are in synthesis the followings. (1) Stratigraphic and palaeoenvironmental significance of ostracods from the first cycle is consistent with literature data. Unexpectedly the recovered assemblages comprise both warm-temperate species (e.g. *Cytherelloidea beckmanni* Barbeito-Gonzales, *Propontocypris solida* Ruggieri, *Verrucocythereis bulbuspinata* (Uliczny), which suggest a relatively warm climate phase, and an yet undescribed species of *Ruggieria*, a genus previously thought to be represented in the Italian Lower Pleistocene only by *Ruggieria nuda* Moyes. (2) In agreement with previous studies, sediments of the San Marco fm in the Rosignano area are referable to a floodplain-coastal lagoonal setting. Divergently from literature data, in the Bibbona area the unit exhibits vuggy carbonate glaebules and rizhoconcrections and yields very rare fresh-brackish water ostracods and marine microfaunas regarded as reworked. Despite interpretation of these sediments still poses many problems, we speculate that they represent marine deposits reworked in a poorly drained continental-transitional environment, which experienced pedogenic alteration. Furthermore, the common occurrence of the ostracode *Aurila punctricruciata* Ruggieri seems to support the supposition that reworked deposits included marine Sicilian sediments completely eroded and presumably correlatable to the Fabbriche fm. (3) Lithological–sedimentological features and absence of autochthonous macro-microfossils indicate that the Casa Saracino fm and most of the Bibbona unit accumulated in a backshore environment dominated by aeolian deposition. Only locally the latter unit includes shallow marine deposits with fairly rich ostracod faunas, which confidently indicate an age not younger than the Sicilian sensu Ruggieri and Sprovieri [Riv. Mineraria Siciliana 151/153 (1975) 1]. Thus, it seems possible that the Coastal Tuscany succession includes two marine cycles, which developed within the Sicilian.

Résumé

Le Pléistocène Inférieur-partie inférieure du Moyen de la Toscane Côtière comprend trois cycles sédimentaires marins : (I) un cycle Santernien-Emilien ; (II) un cycle Sicilien (Zone à petits *Gephyrocapsa*) ; (III) un troisième cycle attribué au Sicilien/partie inférieure du

* Corresponding author.
E-mail address: barbarad@dst.unipi.it (B. Dall'Antonia).

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Pléistocène Moyen pour sa position stratigraphique et par la présence d'objets du Paléolithique Inférieur, qui inclue la formation fluvio/lagunaire de San Marco et les dépôts sableux-gréseux d'environnement côtier/rétro-côtier des formations de Bibbona et Casa Saracino qui affleurent dans les régions de Bibbona (vallée inférieure du Fleuve Cecina) et de Rosignano. Le troisième cycle a été peu étudié et son âge et son histoire sédimentaire sont incertains. Pour essayer de remédier à ces incertitudes nous avons étudié les successions sédimentaires des régions de Rosignano et de Bibbona sur le terrain et d'un point de vue micropaléontologique (surtout ostracodes). Cette étude nous a fourni une opportunité favorable pour étendre nos connaissances sur les ostracofaunes du Pléistocène méditerranéen. Les principaux résultats obtenus sont les suivants. (1) Les ostracofaunes du premier cycle donnent des indications stratigraphiques et paléoenvironnementales en accord avec les données déjà connues dans la littérature. Elles sont caractérisées par des espèces tempérées-chaudes (voir *Cytherelloidea beckmanni* Barbeito-Gonzales, *Propontocypris solida* Ruggieri, *Verrucocythereis bulbuspinata* (Uliczny)) qui suggèrent une phase climatique relativement chaude, et une espèce non encore décrite de *Ruggieria*, genre connu dans le Pléistocène Inférieur italien seulement par *Ruggieria nuda* Moyes. (2) Comme dans les études précédentes, les sédiments de la formation de San Marco dans la région de Rosignano sont rapportés à un environnement de plaine alluviale côtière-lagunaire. Dans la région de Bibbona, contrairement à ce qui a été publié précédemment, cette unité livre des concrétions carbonatées, des rhizoconcrétions, de très rares ostracodes d'eau douce ou saumâtre et des microfaunes marines remaniées. Cette unité pourrait représenter un dépôt qui remanie des sédiments marins dans un environnement continental côtier peu drainé et qui a subi une altération pédogénétique. La présence relativement commune d'*Aurila puncticruciata* Ruggieri pourrait indiquer la présence de sédiments de la formation sicilienne des Sables des Fabbriche, ici complètement érodée. (3) Les caractères lithologiques et sédimentologiques et l'absence des micro et macrofaunes autochtones indiquent que la formation de Casa Saracino et une partie de la formation de Bibbona ont été déposées dans un environnement de plage émergée et sont d'origine éolienne. C'est seulement dans quelques localités que la Formation de Bibbona livre des ostracofaunes très riches qui indiquent un âge pas plus jeune que le Sicilien sensu Ruggieri et Sprovieri [Riv. Mineraria Siciliana 151/153 (1975) 1]. En conclusion, il semble que dans la Toscane Côtière se soient développés deux cycles marins du Sicilien.

Keywords: Biostratigraphy; Palaeoecology; Ostracoda; Lower-Middle Pleistocene; Coastal Tuscany (Central Italy)

Mots clés : Biostratigraphie ; Paléoécologie ; Ostracodes ; Pléistocène Inférieur-Moyen ; Toscane Côtière (Italie Centrale)

1. Introduction

Features of the Quaternary geology of the Coastal Tuscany have excited interest since the mid-19th century. Researches carried out over the last three decades (e.g. Mazzanti, 1984; Bossio et al., 1993; Mazzanti, 1995) have pointed out that the main areas of interest for stratigraphic studies on the Lower-Middle Pleistocene successions of the Coastal Tuscany are located in the Lower Arno, Fine and Cecina valleys (Fig. 1).

According to the present-day knowledge (Barsotti et al., 1974; Bossio et al., 1981; Giannelli et al., 1981,1982; Mazzanti, 1984; Bartoletti et al., 1986; Lazzarotto et al., 1990; Bossio et al., 1993; Mazzanti, 1995) the Lower-early Middle Pleistocene succession of the Coastal Tuscany is characterized by three marine cycles (Fig. 2).

- A first Santernian–Emilian cycle comprising four main informal formations: i.e. the Villa Magrini Conglomerates fm, the Morrona fm (Dini and Mazzanti, 2004; formerly Sands and Clays with *Arctica islandica* fm) and the overlaying and/or heteropic Montescudaio Sandy Limestones and Nugola Vecchia Sands formations.
- A second Sicilian cycle represented by the Fabbriche Sands fm known only from a small outcrop and boreholes in the Fine Valley–Rosignano area (Bartoletti et al., 1986) and from cores drilled in the Livorno surroundings (Dall'Antonia et al., 2004).

According to molluscs, foraminifers, calcareous nannofossils and ostracods analyses (Bossio et al., 1993, cum bib.) the first cycle extends from the base of the Pleistocene to the MNN 19d ("large *Gephyrocapsa*") nannofossils Zone of Raffi and Rio (1979) and the second one is comprised within the MNN 19e ("small *Gephyrocapsa*") Zone.

- The third cycle developed after an intense phase of fluvial erosion and comprises inferiorly fluvial conglomerates and alluvial to transitional marly clays of the San Marco fm (known mainly from the Rosignano area) and upwards the Bibbona fm and the Panchina di Grotti fm (herein referred to as Casa Saracino fm, the name Grotti being already in use for a different formation). The Bibbona and Casa Saracino formations, which crop out in the Lower Cecina Valley and Fine Valley respectively, have been described as calcarenites and sands with local pebbles concentrations and interpreted as shoreface to backshore deposits. Both these geographically distant units have not been studied in the same detail as the remaining Pleistocene succession. The few carried out investigations (Galiberti et al., 1982; Mazzanti and Sanesi, 1987) have revealed the absence of biostratigraphically significant macrofaunas. Based on the analogs depositional environment and identical stratigraphic position, a likely correlation between these units is, however, largely accepted in the literature. Currently, the San Marco and Bibbona–Casa Saracino formations are regarded as late Sicilian and/or early Middle Pleistocene in age on the basis of their position. This is also corroborated by the occurrence of Lower Palaeolithic human industries in the Bibbona fm (Galiberti et al., 1982).

Overall, conversely to the two older cycles the third one has been so far poorly studied and its chronology and depositional history have remained somewhat uncertain.

For this purpose the late Lower-early Middle Pleistocene sedimentary record exposed in the Rosignano area (Fine Val-