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EVIDENCE FOR A "PLUVIAL" PERIOD BETWEEN 8-7 KA ON APUAN ALPS (CENTRAL ITALY): IMPLICATIONS FOR THE SAPROPEL PARADIGM IN THE EASTERN MEDITERRANEAN

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ABSTRACT*: Zanchetta et al.,* Evidence for a "pluvial" period Between 8-7 KA on Apuan Alps (Central Italy): Implications for the sapropel paradigm In the Eastern Mediterranean. (IT ISSN 0394-3356, 2011)
A stratigraphic and chronological study of the upper level of Renella Cave (Apuan Alps, Central Italy) reveals that two episodes of flowstone accumulation bracket a thick clastic layer deposited between ca. 8.2 and 7.1 ka. This layer, which represents a period of enhanced cave flooding, is substantially in phase with an interval of depleted oxygen isotopes values previously recorded in a stalagmite from nearby Corchia Cave, previously interpreted to have resulted from an increase in local precipitation. Combined evidence from Renella and Corchia Cave suggests that this wettest phase was shorter than the condition leading to the formation of Sapropel S1. A synchronicity between signal dominated by the advection of vapour masses from the Atlantic, as Corchia and Renella archives should record in their proxies, cannot straightforwardly correlated with events (at least in duration) dominated by the monsoon signal as could be sapropels in the Mediterranean.

RIASSUNTO: Zanchetta *et al*., Evidenze di un intervallo "pluviale" tra 8-7 KA nelle Alpi Apuane (Italia Centrale): Implicazioni per il paradigma dei sapropel nel Mediterraneo orientale. (IT ISSN 0394-3356, 2011)
Lo studio stratigrafico e cronologico della galleria superiore della Grotta della Renella (Alpi Apuane, Italia Centrale) ha permesso di individuare due episodi di concrezionamento separate da uno spesso deposito clastico depositosi in un periodo compreso tra circa 8,2 e 7,1 ka. Questo livello è interpretabile coem un perido in cui i processi di allagamento e alluvionamento della grotta erano particolarmente frequenti. Cronologicamente questo intervallo è in sostanziale accordo con i dati isotopici provenienti dalla vicina cavità carsica del dell'Antro del Corchia, indicando che in questo periodo si registra un sostanziale incremento delle precipitazioni meteoriche. Considerazioni di carattere cronologico suggeriscono che questa fase ad elevate precipitazioni è sostanzialmente più breve delle condizioni che hanno portato alla formazione del sapropel S1 nel Mediterraneo orientale. Si è quindi portati a pensare che non esiste una perfetta sincronicità tra la fase di elevate precipitazioni registrate sulle Apuane, certamente governate da una maggiore advezione di masse di vapore dal Nord Atlantico e registri dominati dall'effetto delle precipitazioni monsoniche, come il sapropel dovrebbe essere il caso.

Key Words: Central mediterranean, climatic changes, Holocene

Parole Chiave:Mediterraneo centrale, cambiamenti climatici, Olocene

Many palaeoclimate records from the Central to Eastern Mediterranean region suggest a wetter climate during the Early to Middle Holocene compared with the second half of the Holocene (e.g. BAR-MATTHEWS *et al.,* 2000; SADORI & NARCISI, 2001; ROBERTS *et al.,* 2008). Further south in the Sahara region, the wettest conditions for the Holocene (the so-called "African Humid Period" e.g. GASSE, 2000) were also experienced during the first half of this epoch. At this time, monsoon circulation was enhanced, which led to a substantial increase in Nile River discharge. This increase in discharge is considered to be one of the main causes of stagnation in the eastern Mediterranean Sea, leading to the formation of an organic-rich sapropel layer, S1 (e.g. ROSSIGNOL-STRICK *et al.,* 1982). Stagnation of the eastern Mediterranean may also have been enhanced by increased river discharge derived from local rainfall (e.g. KALLEL *et al.,* 1997).The degree of synchronicity between the interval of enhanced precipitation throughout the eastern and central Mediterranean on the one hand, and sapropel formation on the other hand, has yet to be determined.

Recent data obtained from caves from Apuan Alps allow to improve our knowledge on the wettest phase in Central Mediterranean.

A stratigraphic and chronological study of the infilling of the upper level of Renella Cave reveals that between ca. 9.2 and 7.1 ka there was an increased frequency of flooding in the upper, now inactive, passage, which was particularly severe between ca. 8.2 and 7.1 ka, which left thick layers of sands (ZHORNIAK *et al*., 2011). This period of enhanced flood activity was substantially in phase

with the interval of lower $\delta^{18}O$ values recorded in a stalagmite from nearby Corchia Cave, inferred to have resulted from an increase in local precipitation (ZANCHETTA *et al.,* 2007). These data reinforce the previous interpretation of oxygen isotopic records from Corchia Cave and confirm that during this period of time the region experienced wetter conditions but may have also experienced an increase of exceptional storm events capable of producing floods that allowed invasion of the higher passages.

The timing of the clastic phase occurred when the Eastern Mediterranean experienced deposition of sapropel layer S1, which is thought to reflect the stagnation of sea water produced by enhanced flood activity along the Nile due to increased monsoon intensity in northern equatorial Africa. Recent estimates suggest that S1 may have lasted from ca 10.8 to ca 6.1 ka cal BP (DE LANGE *et al.,* 2008). Combined evidence from Renella and Corchia Cave suggests that the period corresponding to the wettest phase was shorter than the condition leading to the formation of Sapropel S1, and therefore, a synchronicity between signal dominated by the advection of vapour masses from the Atlantic, as Corchia and Renella archives should record in their proxies, probably cannot straightforwardly correlated with events (at least in duration) dominated by the monsoon signal as could be sapropels in the Mediterranean.

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