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Theropod and sauropod footprints in the Early Cretaceous (Aptian) Apenninic Carbonate Platform (Esperia, Lazio, Central Italy): a further constraint on the palaeogeography of the Central-Mediterranean area

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SUMMARY - *Theropod and sauropod footprints in the Early Cretaceous (Aptian) Apenninic Carbonate Platform (Esperia, Lazio, Central Italy): a further constraint on the palaeogeography of the Central-Mediterranean area* - About eighty dinosaur tracks were recently discovered near the village of Esperia, in the Western Aurunci Mountains (Latium, Central Italy). The footprints are distributed on a bedding plane belonging to a shallow water limestone succession. Tridactyl footprints attributed to small-sized theropods and round to elliptical footprints tentatively ascribed to medium-sized sauropods have been recognized on the trampled layer. This ichnoassemblage reveals the contemporaneous occurrence of carnivores/piscivores (theropods) together with plant-eaters (sauropods) dinosaurs. The Esperia outcrop is the second ichnosite discovered in southern Latium and dates the dinosaur occurrences in the Apenninic carbonate Platform to the Aptian, adding a strong constraint on the Early Cretaceous palaeogeography of the Central-Mediterranean area.

RIASSUNTO - *Orme di teropodi e sauropodi nella Piattaforma carbonatica Appenninica del Cretaceo inferiore (Aptiano) (Esperia, Lazio, Italia centrale): un ulteriore vincolo alla ricostruzione paleogeografica dell'area centro-mediterranea* - Circa ottanta orme di dinosauro sono state recentemente scoperte nelle vicinanze di Esperia, sui Monti Aurunci occidentali (Lazio, Italia centrale). Le impronte sono distribuite su di una superficie di strato appartenente ad una successione di piattaforma carbonatica. Le orme sono state attribuite a teropodi di piccole dimensioni e a sauropodi di medie dimensioni. Questa icnoassociazione rivela la presenza contemporanea di dinosauri carnivori/piscivori (teropodi) ed erbivori (sauropodi). L'affioramento di Esperia è il secondo icnosito con orme dinosauriane scoperto nel Lazio meridionale e consente di anticipare all'Aptiano la presenza di dinosauri nella Piattaforma carbonatica appenninica, aggiungendo un ulteriore vincolo alla ricostruzione paleogeografica dell'area centro-mediterranea durante il Cretacico inferiore.

Key words: dinosaur footprints, theropods, sauropods, Aptian, Central Apennines, palaeogeographic reconstructions
Parole chiave: orme di dinosauro, teropodi, sauropodi, Aptiano, Appenino centrale, ricostruzioni paleogeografiche

1. INTRODUCTION

In September 2006 local hikers discovered abundant dinosaur footprints west of Esperia, about 30 km south of Frosinone (Latium, Central Italy). The track-bearing level belongs to a shallow water limestone succession and has been ascribed to the Aptian; it yielded about 80 dinosaur tracks of both quadrupedal and bipedal dinosaurs.

In recent years, following the discovery of the Altamura megatracksite (Apulia region, Andreassi *et al.* 1999; Nicosia *et al.* 2000a, 2000b), a number of new dinosaur tracksites were discovered in Central and Southern Italy, mainly in Southern Latium and Apulia (Gianolla *et al*. 2000a, 2000b; 2001; Conti *et al.* 2005; Petti 2006; Sacchi *et al.* 2006; Nicosia *et al.* 2007; Petti *et al.* 2008). The record of dinosaur tracks in Central and Southern Italy spans from Upper Jurassic to Upper Cretaceous and is related to two different tectono-stratigraphic units: the Apenninic Units and the Adriatic Foreland of the Adriatic/Africa verging system. These outcrops, displaying different degrees of preservation and ichnodiversity, have raised doubts about most of the current palaeogeographic restorations of the Central-Mediterranean region (Dercourt *et al*. 1993, 2000; Yilmaz *et al.* 1996), which are not able to justify all the existing palaeontological data (see also Bosellini 2002; Dalla Vecchia 2002, 2005; Petti 2006; Nicosia *et al.* 2007 for different interpretations).

The site described here provides the first evidence of an Early Cretaceous dinosaur occurrence in the Apenninic carbonate Platform (ACP). Esperia dinosaur footprints belong to a single stratigraphic level of an inner carbonate platform succession. This paper describes the main sedimentological and ichnological features of the track-bearing level, providing a palaeoenvironmental interpretation of the studied stratigraphic section and the zoological attribution of the tracks.

2. GEOGRAPHICAL AND GEOLOGICAL SETTING

The Esperia ichnosite is located between the Latina Valley, to the north, and Gaeta (Tyrrhenian Sea) to the south (Fig. 1). The studied area belongs to the Western Aurunci Mountains that are part of the Volsci Range (Cosentino *et al.* 2002; Centamore *et al.* 2007). The Volsci structural unit is constituted by the Lepini, Ausoni and Aurunci Mountains with the exception of the Eastern Aurunci sector (Simbruini-Ernici structural unit) and represents the innermost sector of the ACP, bounded to the west, in the Pontina Plain or in the Tyrrhenian Sea, by pelagic deposits belonging to the Umbria-Marche-Sabina Basin, recognized in several wells (ENI 1972; Parotto & Praturlon 1975; Cippitelli 2005). The stratigraphic sequence of the Aurunci Mountains is mainly composed of Upper Triassic-Upper Cretaceous carbonate platform deposits testifying to different marine palaeoenvironments (sabkha, tidal flat, lagoon, open shelf) which are punctuated by palaeosoils related to depositional environments characterized by short emersions, mostly in the early Aptian-Cenomanian time interval (Accordi *et al.* 1967; Chiocchini & Mancinelli 1977; Carannante *et al*. 1978; Chiocchini *et al.* 1994; Rossi *et al.* 2002; Centamore *et al.* 2007).

This succession is typical of a carbonate platform environment where the carbonate deposition keeps pace with the accommodation space changes (eustasy, subsidence or uplift and sediment compaction) causing changes from subaerial to shallow subtidal environment (Carannante *et al.* 1978; Accordi *et al.* 1988; Chiocchini *et al.* 1994, Centamore *et al.* 2007).

3. THE ESPERIA SECTION: STRATIGRAPHY AND AGE

The analyzed section, including the track-bearing surface, crops out about 3 km to the west of Esperia, along the road from Esperia to Mt. Acquara di Costa Dritta, between Mt. San Martino to the west and Mt. Lago to the east at about 410 m a.s.l (41°22′39″N, 13°38′24″E).

The measured section is just over 2.0 metres thick (Fig. 2) and is cut off by a normal fault at the base of the sequence. The sedimentary succession is composed of well bedded hazel to light-brown limestone with texture varying from mudstone to grainstone, sometimes arranged in thicker layers, which alternate with subordinate oolitic levels and thin laminated mudstone layers. Locally miliolids and shell fragments are abundant as well as fenestral structures, evidences for subaerial exposure. The trampled layer consists of alternating grainstone and wackestone, with scattered miliolids and fenestral fabric. Just above the trampled layer the section is characterized by a conglomerate level (8 cm) with millimiter scale white mudstone clasts. The Esperia succession exhibits a cyclic facies, alternating from subtidal to supratidal; sandy facies prevail over muddy ones, suggesting a shelf environment, exposed to wave and tidal energy variations.

Analyses on thin sections of collected samples from the dinoturbated bed, reveals the occurrence of Dasycladaceans algae (*Salpingoporella* spp., ?*Thaumatoporella* spp.), rudist fragments and benthic foraminifers, such as abundant Miliolidae, Nubecularidae (*Spiroloculina* sp.), Polymorphinidae, Cuneolinidae (*Sabaudia briacensis* Arnaud-Vanneau 1980,

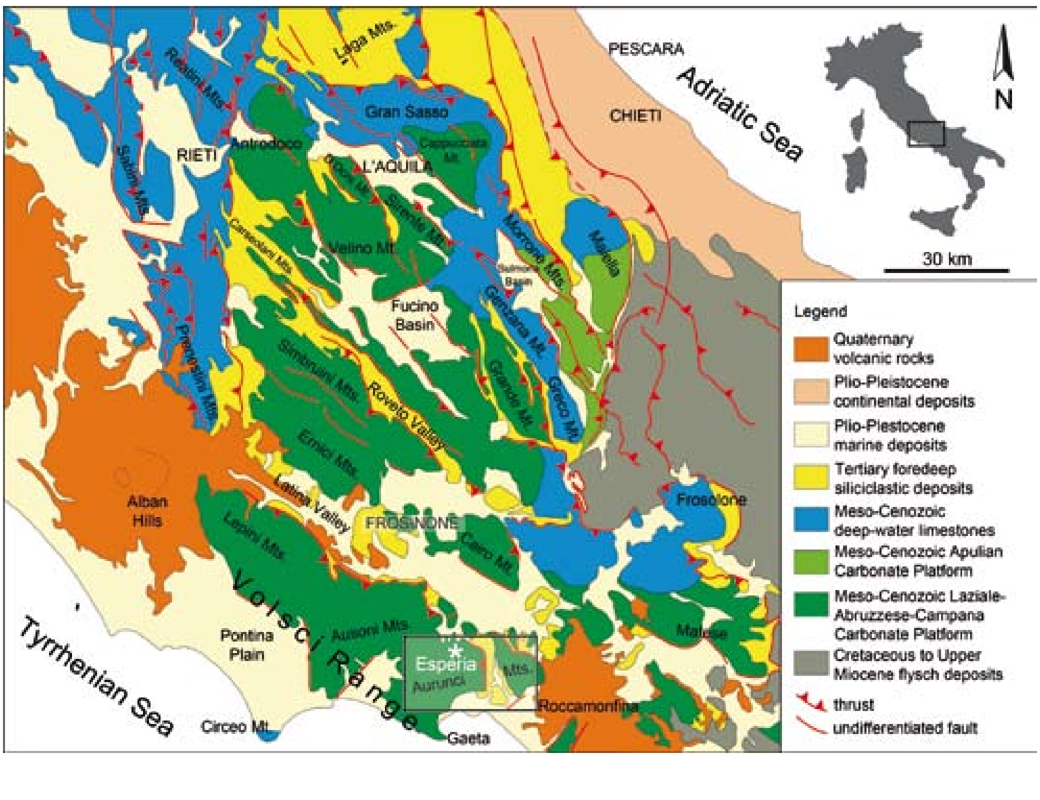


Fig. 1 - Geological and structural sketch map of the Central-Southern Apennines. The tracksite area is highlighted the box. From Calamita *et al*. 2006, redrawn and modified.

Fig. 1 - Carta geologico-strutturale dell'Appennino centro-meridionale. Nel riquadro l'ubicazione dell'icnosito. Da Calamita et al. *2006, ridisegnato e modificato.*

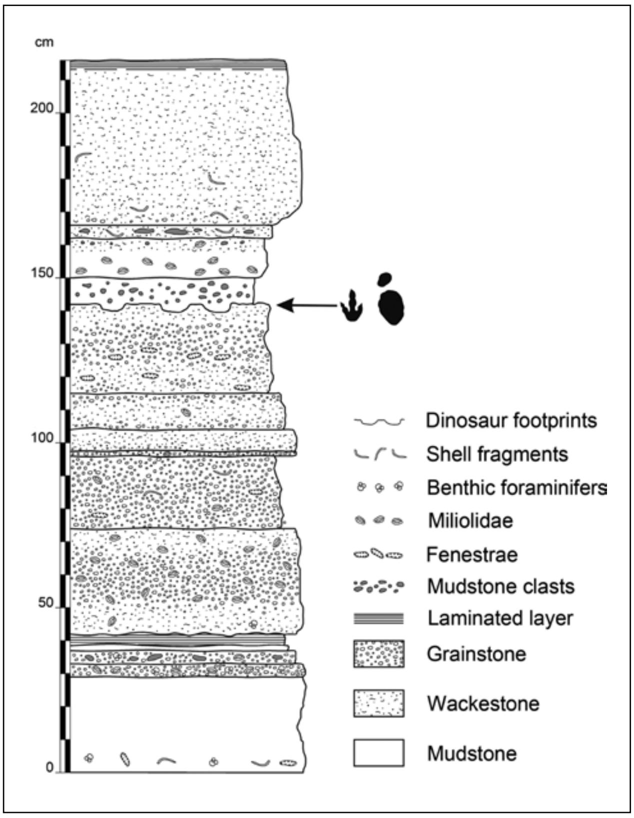


Fig. 2 - Stratigraphic log of the studied section.
Fig. 2 - Log stratigrafico della sezione analizzata.

Sabaudia minuta (Hofker 1965), Spiroplectamminidae (*Bolivinopsis* cf. *ammovitrea* (Tappan 1940), Hyperamminoididae (?*Giraliarella prismatica* Arnaud-Vanneau 1980), Bagginidae (*Valvulineria* Cushman 1926) and Nezzazatidae (*Nezzazata* sp.). The whole microassemblage (Pl. I) can be assigned to the Aptian age.

4. DESCRIPTION OF TRACKS

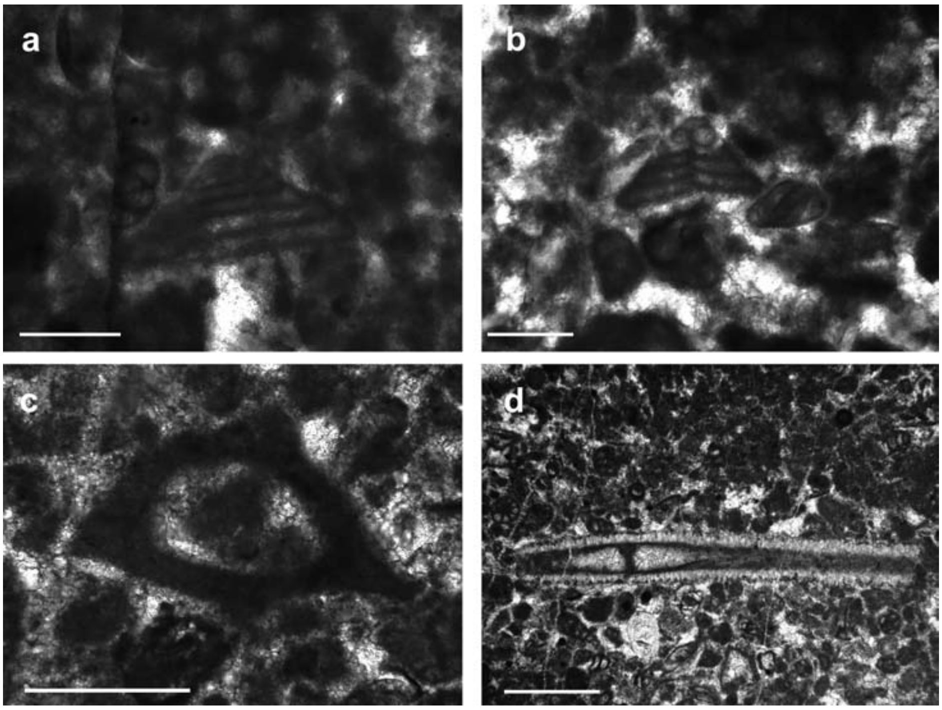
The trampled surface covers an area of about 40 m^2 and dips of about 45° W. Footprints are randomly oriented, and no trackways have been identified (Figs 3, 4). Tracks are poorly preserved, both diagenetically and due to the tectonic cleavage, hindering ichnotaxonomic attribution. Nevertheless track morphological features (i.e. shape, number of digit impressions, heteropody in recognized *manus-pes* couples) allow the track maker to be identified.

All the footprints can be distinguished into two distinct groups, the first represented by tridactyl bipedal tracks, the second by sub-elliptical and round imprints ascribed to a dinosaur with a quadrupedal gait. The Esperia ichnites have been labelled with the acronym ES (Esperia) followed by an identification number.

4.1. *Tridactyl footprints*

The first morphotype is represented by three small tridactyl footprints, preserved as concave hyporeliefs.

A detailed morphological description of tridactyl specimens associated with the main morphometric parameters (FL = foot length, FW = foot width, total divarication, interdigital angles, te = protrusion of digit III beyond the line connecting the tips of digits II and IV) is given below. In one case (ES2) numbering of digits was difficult; for this footprint the left digit is reported as “l” and the right digit as “r” to indicate their position with respect to the digit III.



Pl. I - Selected microfossils from the dinoturbated layer. a. *Sabaudia briacensis* Arnaud-Vanneau 1980. b. *Sabaudia minuta* (Hofker 1965). c. ?*Giraliarella prismatica*. d. *Salpingoporella* spp. Scale bar 500 μ.
Tav. I - Microfossili provenienti dal livello dinoturbato. a. Sabaudia briacensis *Arnaud-Vanneau 1980. b.* Sabaudia minuta *(Hofker 1965). c.* ?Giraliarella prismatica *Arnaud-Vanneau 1980. d.* Salpingoporella *spp. Scala 500 μ.*

Fig. 3 - View of the Esperia trampled surface. Ranging rod for scale.
Fig. 3 - Vista della superficie con orme di dinosauri di Esperia. La palina metrica è utilizzata come scala.

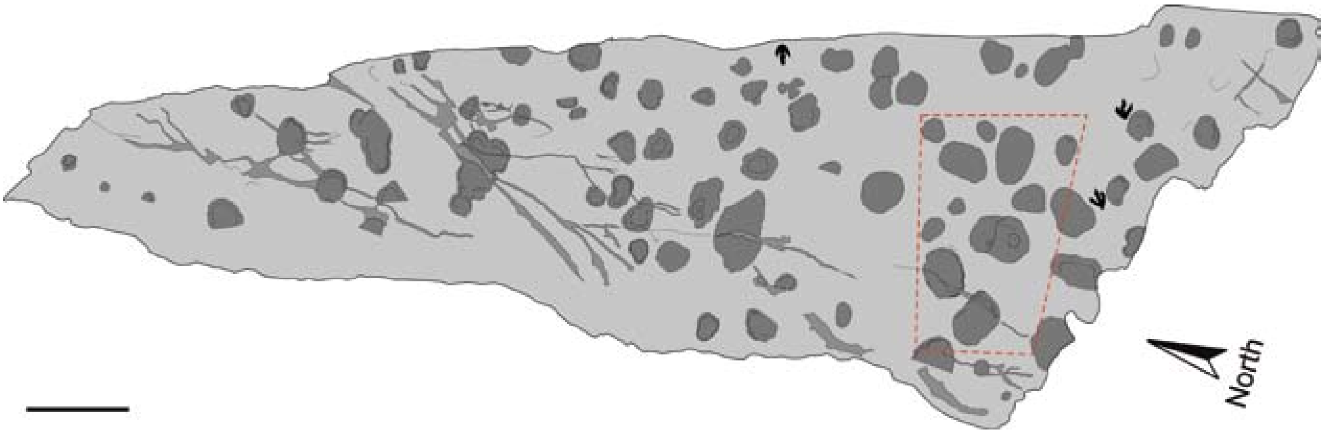


Fig. 4 - Map of the trampled level. Scale bar 0.5 m. The dashed outline encloses the area represented in figure 5.
Fig. 4 - Riproduzione del livello dinoturbato. Scala 0,5 m. Nel riquadro tratteggiato l'area rappresentata in figura 5.

ES 1 (Pl. II a, b) – This specimen is probably the best preserved tridactyl track from Esperia. The mesaxonic footprint (FL = 17.9 cm; FW = 12.7 cm) shows a straight digit III well-exceeding the length of lateral digits. The anterior half of the footmark preserves two clear pad impressions on digit III and one pad on each lateral digit. No clear claw marks are visible on the track. The hypices seem to lie at the same level even if the shortening of lateral digits is probably a consequence of preservational bias, thus making the evaluation of hypices uncertain. Total divarication (II^IV) is 58°, II^III = 21°, III^IV = 37°, te = 7.3 cm, about 41% relative to FL.

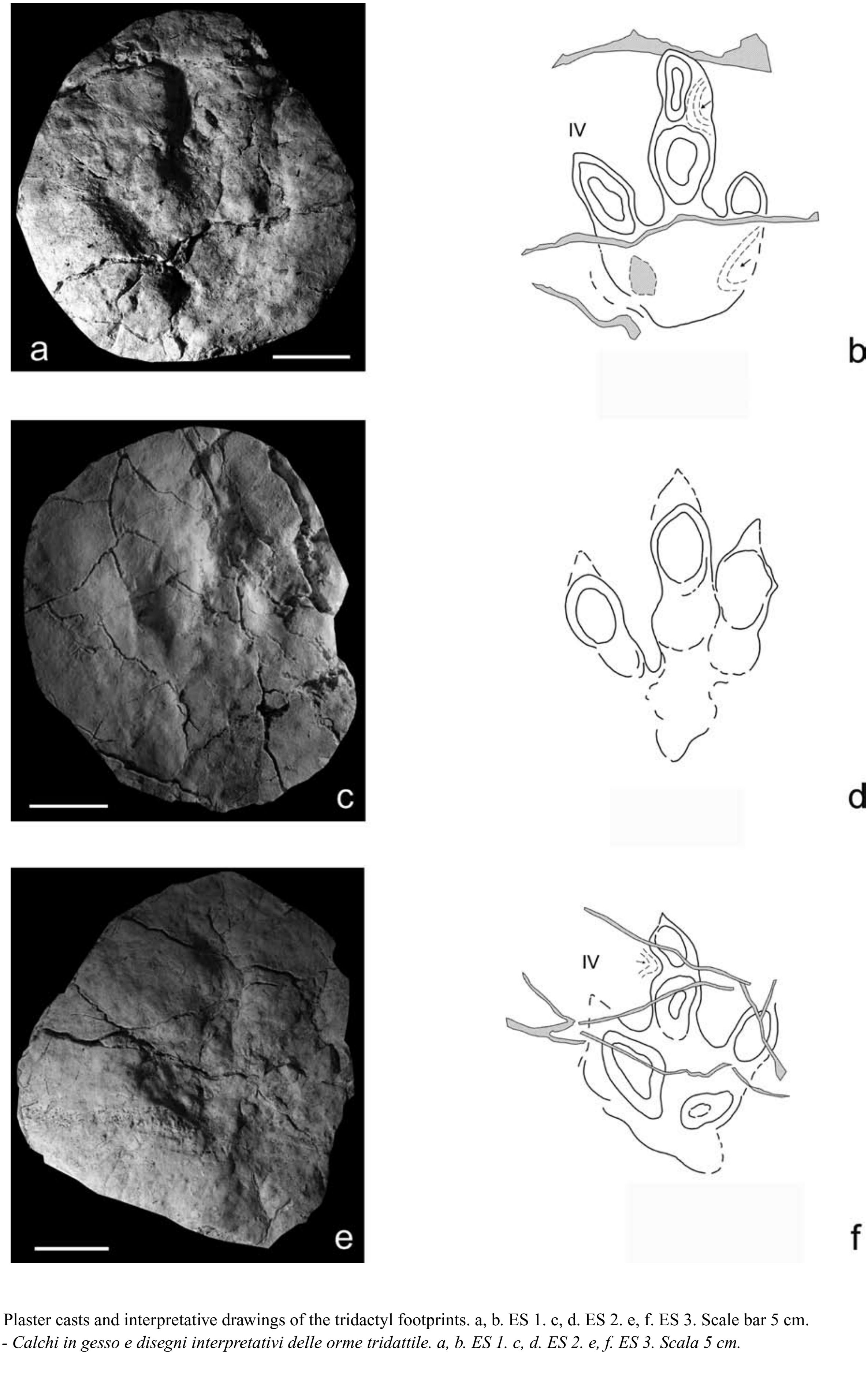
ES 2 (Pl. II c, d) – The specimen is a faint impression of an asymmetric tridactyl mesaxonic track (FL = 18 cm; FW = 13.2 cm). It is better preserved anteriorly, fading rapidly posteriorly and precluding the identification of digit IV. All the digit impressions show at least two clear pad impressions and probable claw traces. Total divarication (II^IV) is 48°, r^III = 18°, l^IV = 30°, te = 4.3 cm, about 24% relative to FL.

ES 3 (Pl. II e, f) – The specimen is an asymmetric tridactyl footprint; digit III is distinctly sigmoidal (FL = 17.8 cm; FW = 13.4 cm). Two phalangeal pads are impressed on digit III that terminates in a small and sharp claw imprint. Digit II is slightly shorter than digit IV which is clearly identifiable as it forms a projection in the rear margin of the track. Digit IV preserves a large digital pad impression and a feeble claw marks. Total divarication (II^IV) is 59°, II^III = 34°, III^IV = 25°, te = 5.38 cm, about 30% relative to FL.

4.1.1. Remarks

Esperia tridactyl footprints may be compared with other Cretaceous tracks from Central and Southern Italy (Sacchi *et al.* 2006; Nicosia *et al*. 2007; Petti *et al*. 2008).

The first comparison is with the early Aptian tridac-



Pl. II - Plaster casts and interpretative drawings of the tridactyl footprints. a, b. ES 1. c, d. ES 2. e, f. ES 3. Scale bar 5 cm.
Tav. II - Calchi in gesso e disegni interpretativi delle orme tridattile. a, b. ES 1. c, d. ES 2. e, f. ES 3. Scala 5 cm.

tyl tracks from Lama Paterno (late Bedoulian-early Gargasian; Apulia, Southern Italy, Sacchi *et al*. 2006) recently discovered in carbonate platform deposits referred to the Apulian carbonate Platform (AP). Foot length and width are similar (FL = 15-20 cm, FW = 13 cm) for tracks in both regions. In general digit impressions are wider in the Apulian tracks with not well-defined claw marks and digit IV less impressed and pulled slightly back with respect to the base of the other digits. Digit III in the Lama Paterno tracks is characterized by a longer protrusion.

Tracks from Esperia differ from tridactyl footprints found on three different levels from the Sezze tracksite (early Cenomanian; Lazio, Central Italy; Nicosia *et al.* 2007), also belonging to the Apenninic Platform domain. Tridactyl tracks from the II level are slightly larger, foot length varying from a minimum of 15 to a maximum of 24 cm, asymmetric and retain digit IV impression pulled back with respect to digits II and III. On the other hand the protrusion of digit III is similar to one observed in the Esperia ichnites. Tracks from the highest bedding plane (III level), preserve printing of both digitigrade and plantigrade gaits; tracks are tridactyl and in some cases show the entire metatarsal impression and the trace of digit I. In the III level, digit III extends the line linking the tips of digits II and IV by a greater amount in comparison with the Esperia tridactyl footprints.

A good match has been found with tridactyl tracks from Borgo Celano (late Hauterivian-early Barremian, Gargano Promontory, Apulia, Southern Italy; Petti *et al.* 2008) from the Apulian carbonate Platform deposits. Even if these latter tracks are sometimes posteriorly elongated, retaining the partial or the entire impression of the metatarsal, they show some similarities with the present specimens from which differ mainly in absolute dimensions, the Borgo Celano footprints being larger (FL varies from a minimum of 23 cm to a maximum of 35 cm and up to 56 cm in the elongated tracks; FW from 23 cm to 36 cm). However, the protrusion digit III values (less than half the foot length), and the position of digit IV points to a close resemblance with ES 1, ES 2 and ES 3.

4.1.2. Attribution to track maker

Based on the features described above, the tridactyl footprints from Esperia could be attributed to a bipedal dinosaur, digitigrade, probably a small-sized theropod. The height at the hip of these dinosaurs is 82.5 cm ($h = 3.06 \times (FL)^{1.14}$; Thulborn 1990) while body length is 3.30 m (L = 4h; Paul 1988). Body-mass could be estimated at about 60 kg (Thulborn 1990).

4.2. Non tridactyl footprints

The second morphotype consists of round and elliptical footprints. The non-tridactyl material is even less well-preserved than the theropod footprints and no diagnostic features, useful to refer the specimens to existing ichnotaxa, have been observed. Nevertheless, and despite the trackways not being recognised, some features have allowed attribution of the morphotypes to possible zoological taxa. It is worth noting the occurrence of two or three probable *manus*-*pes* couples located in the right (southern) part of the trampled surface (Figs 3-5) recognized by their constant relative positions (the *manus* print in front or just lateral to the *pes* print). They probably are *manus*-*pes* sets made by a quadrupedal dinosaur, with sub-elliptical *pes* imprints, posteriorly-anteriorly elongated, and a *manus* trace sub-circular in shape. The *pes* imprints are larger than the *manus* ones (heteropody index about 1/3). The sub-elliptical *pes* prints are longer (25-29 cm) than wide (16-20 cm). The *manus* impressions are as long as wide (8-13 cm). Larger footprints (FL around 40 cm) with irregular shape have also been noticed on the Esperia bedding plane, probably caused by the coalescence of two or more tracks, whose relationships are difficult to discern.

Fig. 5 - Close-up of sauropod footprints, showing probable manus-pes couples. Hammer (33 cm) for scale.

Fig. 5 - Particolare delle orme non-tridattile, dove risultano evidenti probabili coppie manus-pes. Il martello (33 cm) *è utilizzato come scala.*

4.2.1. Attribution to track maker

The non-tridactyl footprints are probably the expression of *pes* and *manus* impression of a dinosaur with quadrupedal gait. *Pes* morphology varies from sub-elliptical to sub-circular, *manus* impression are always sub-circular, in one case showing a notch at the middle of the rear margin. Although an ichnotaxonomic analysis is hampered by poor preservation and by the lack of trackways, *manus-pes* couples arrangement, shape and heteropody strongly suggest an attribution to medium-sized sauropods.

4.3. Palaeocological interpretation

From a paleoecological point of view the Esperia ichnoassemblage reveals the contemporaneous occurrence of flesh-eating theropods and plant-eating sauropods. Although most of theropods could be considered meat-eaters (carnivorous) some of them preferred a diet of fish and molluscs as a consequence of their living nearby shallow marine environments (Martin 2001). This is probably the case for Esperia where theropods, dwelling or wandering around a tidal flat environment, hunted fish by picking them up from the water. Sauropods were herbivorous, browsing on high vegetation.

5. PALAEOGEOGRAPHIC IMPLICATIONS

The Esperia outcrop is the second ichnosite discovered in Latium and dates back to the Aptian dinosaurs occurrence in the ACP. To date, two other dinosaur occurrences have been recognised on this palaeogeographic domain: the sauropod and theropod footprints from the lower Cenomanian Sezze tracksite (Nicosia *et al*. 2007) and *Scipionyx samniticus* Dal Sasso & Signore 1998, a complete theropod (Coelurosaur) skeleton, from Pietraroia (Benevento, southern Italy) in the south-eastern portion of the Matese Mountains (Simbruini-Ernici-Matese structural unit, according to Patacca & Scandone 2007; see also Fig. 1). This skeleton comes from lower Albian cherty limestone ("*Plattenkalk*" or "calcari selciferi ed ittiolitiferi di Pietraroia" *sensu* Catenacci & Manfredini 1963) deposited in an intraplatform anoxic basin (Leonardi & Teruzzi 1993; Dal Sasso & Signore 1998; Dal Sasso 2003; Nicosia *et al*. 2005; Carannante *et al*. 2006). Hence, the dinosaur footprints from Esperia are the oldest recorded in the ACP platform.

The Esperia outcrop is coeval with the Bisceglie (Sacchi *et al*. 2006) dinotracksite, from the Apulian carbonate Platform (AP), where the most diversified italian ichnoassemblage has been recently found. The Bisceglie outcrop yielded saurischian (small theropods and sauropods) and ornithischian (ornithopods and thyreophorans) tracks dated to the early Aptian interval (late Bedoulian-early Gargasian).

The ACP and AP domains, belonging to the so-called Periadriatic Carbonate Platforms (*sensu* Zappaterra 1990, 1994), have been usually considered as topographically isolated platforms like the present-day Bahama Banks, Maldive and Bermuda (Dercourt *et al*. 1993, 2000; Yilmaz *et al.* 1996; Patacca & Scandone 2004, 2007; Fig. 6), pulled apart and separated by deep pelagic basins (Lagonegro-Molise Basin, Mt. Genzana-Mt. Greco trough) and well-separated from the mainland (both Gondwana and Laurasia). The recent finds of Italian dinosaur tracks and bones gave rise to new paleogeographic models (Bosellini 2002; Dalla Vecchia 2002, 2005; Conti *et al*. 2005; Petti 2006; Nicosia *et al*. 2007; Turco *et al*. 2007) of the western Tethys.

Some of these reconstructions (Conti *et al*. 2005; Petti 2006; Nicosia *et al*. 2007; Turco *et al*. 2007), also supported by geological and geophysical data (Ciarapica & Passeri 2002; Rosenbaum *et al*. 2004; Stampfli & Borel 2004; Milia *et al*. 2007; Schettino & Turco 2007; Zarcone & Di Stefano 2007), draw structural and geographical connections among the different periadriatic platforms.

Recently on the basis of sedimentological and stratigraphical data Rusciadelli *et al*. (2006) and Ricci *et al*. (2006) confirmed the hypothesis, proposed by other authors (Mostardini & Merlini 1988; Ciarapica & Passeri 1998, 2002; Passeri *et al*. 2005), of a northward narrowing and ending of the Lagonegro-Molise Basin, suggesting that pelagic deposits recognized in the Maiella, Morrone and Genzana mountains (Abruzzo, central Italy; see Fig. 1) correspond to intraplatform seaways furrowing the Lazio-Abruzzi sector of the ACP platform and the northernmost portion of the AP platform. In this reconstructions the Lazio-Abruzzi sector of the ACP is viewed as a series of banks (archipelago) separated from each other by an irregular system of pelagic basins, narrower and probably shallower in comparison with the northern Tuscan-Umbro-Marchean and southern Lagonegro-Molise basins. The Lazio-Abruzzi platform domain is thus considered as a promontory of the Apulian main bank that probably acted as a barrier between the northern Tuscan-Umbro-Marchean basin and the southern Lagonegro-Molise Basin. Within this hypothesis of a structural connection between AP and the ACP, the faunal affinity between the Esperia and the coeval Lama Paterno ichnosite (Bisceglie), such as the co-occurrence of theropods and sauropods, could be interpreted as an evidence of a possible geographical connection between the Apenninic and the Apulian platforms during the Aptian and, consequently, the existence of at least temporary land-bridges between the two platforms. These land-bridges probably have allowed dinosaurs, able to swim only for a short time and distance as most of the terrestrial animals (Ezquerra *et al.* 2007), to overcome by walking the above mentioned intraplatform seaways; the alternative hypothesis is that the Lazio-Abruzzi sector of the ACP had a fringed outline, inherited from the Early Jurassic tectonic phase, and that the troughs were probably closed towards their southern area.

Nevertheless the new finding raises again the question if the dinosaur tracks record from the Periadriatic region is a stratigraphic window of a more or less prolonged dwelling or a record of repeated immigrations. A carbonate platform depositional system is influenced by several controls such as biogenic (evolutionary changes, carbonate factory),

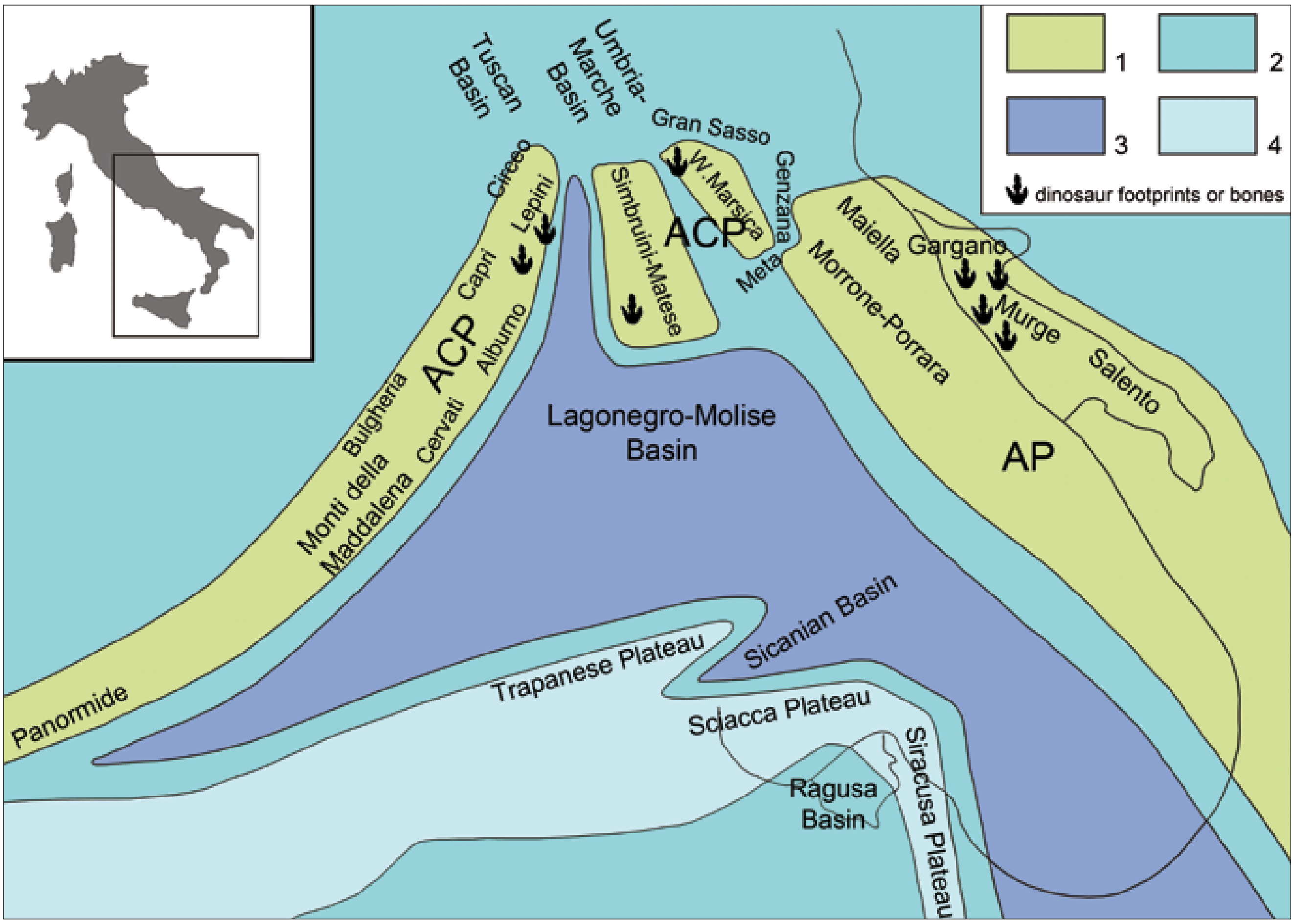


Fig. 6 - Palaeogeographic restoration of the Central-Southern Apennines during the Jurassic-Cretaceous interval according to Patacca & Scandone (2004), redrawn and modified. Outcrops with dinosaur footprints or bones are highlighted. 1. Shallow-water carbonate platforms. 2. Deep-water basins floored by oceanic or thinned continental crust. 3. Pelagic plateau. 4. Pelagic basins. ACP= Apenninic carbonate Platform; AP= Apulian carbonate Platform.

Fig. 6 - Ricostruzione paleogeografica dell'Appennino centro-meridionale durante l'intervallo Giurassico-Cretacico, secondo Patacca & Scandone (2004), ridisegnato e modificato. Nella figura sono evidenziati gli affioramenti con orme o resti scheletrici di dinosauri. 1. Piattaforme carbonatiche di mare poco profondo. 2. Bacini profondi pavimentati da crosta oceanica o da crosta continentale assottigliata. 3. Plateau pelagici. 4. Bacini pelagici. ACP= Piattaforma carbonatica Appenninica; AP= Piattaforma carbonatica Apula.

oceanographic (climate, temperature and salinity, nutrients, light penetration, water circulation and oxygenation), tectonic (subsidence and uplift) and obviously eustatic changes. In a carbonate platform succession, cyclic turnover of subaerial, subtidal and tidal flat facies is readily distinguishable and the stratigraphic record is the result of the continuous effort of the carbonate platform to counterbalance the combined effect of all the above-mentioned controls, that sometimes could lead to geologically sudden environmental changes as the emersion or the drowning of the platform. These repeated variations probably have also influenced the dinosaur persistence in the Periadriatic area, so that a continuous occupation through most of the Cretaceous seems difficult to imagine, and the hypothesis of repeated immigrations more likely. Within this frame it is more parsimonious to justify the co-occurrence of sauropods and theropods during the Aptian on the ACP and AP platforms with their geographical connection than with two distinct migratory ways from the nearby continental mass. In this model the Periadriatic area is interpreted as a wide epicontinental shelf, characterized by the persistence of shallow water conditions, connected to the main landmass and locally cut by shallow or deep basins.

The hypothesized geographical connection between the AP and the ACP (Fig. 7) probably lasted throughout most the Cretaceous, and their intermittent link with the southern continental margin (see Nicosia *et al*. 2007 for this hypothesis) at least until the early Cenomanian, probably through the Panormide Platform and west of the Trapanese and Saccense pelagic carbonate platforms, or through other palaeogeographic elements nowadays not recognizable due to tectonics, (Petti 2006; Turco *et al*. 2007; Zarcone

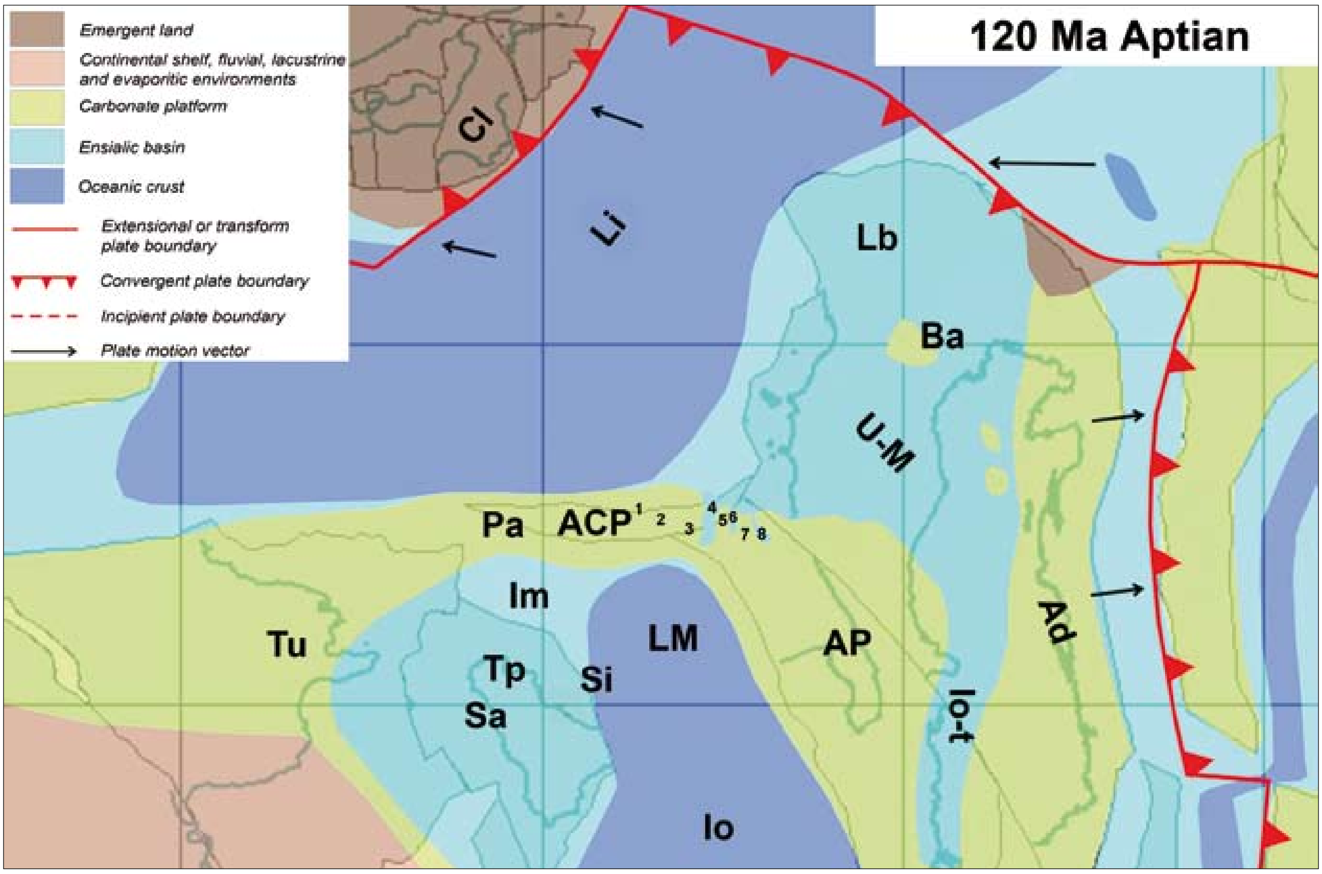


Fig. 7 - Palaeogeographic map of the Central Mediterranean area during the Aptian (120 Ma). After Turco *et al*. 2007, slightly modified. Ad= Adriatic-Dinaric carbonate Platform; AP= Apulian carbonate Platform; Ba= Bagnolo carbonate Platform; Cl= Calabria; Io= Ionian Tethys Ocean; Im= Imerese Basin; Io-t= Ionian trough; ACP= Apenninic carbonate Platform; Lb= Lombard basin; Li= Ligure-Piemontese Ocean; LM= Lagonegro-Molise Basin; Pa= Panormide carbonate Platform; Si= Sicanian Basin; Tp= Trapanese pelagic plateau; Sa= Saccense pelagic plateau; Tu= Tunisia; U-M= Umbria-Marche Basin; 1= Lepini-Ausoni-Aurunci Mts; 2= Simbruini-Ernici-Matese Mts; 3= Velino-Montagna Grande Mts; 4= Genzana-Greco trough; 5= Morrone Mts; 6= western Maiella seaway; 7= Maiella Mts; 8= eastern Maiella Mts.

Fig. 7 - Carta paleogeografica dell'area centro-mediterranea durante l'Aptiano (120 Ma). Da Turco et al. *2007, leggermente modificata. Ad= Piattaforma carbonatica Adriatico-Dinarica; AP= Piattaforma carbonatica Apula; Ba= Piattaforma carbonatica Bagnolo; Cl= Calabria; Io= Oceano Ionian Tethys; Im= Bacino Imerese; Io-t= Solco Ionico; ACP= Piattaforma carbonatica Appenninica; Lb= Bacino Lombardo; Li= Oceano Ligure-Piemontese; LM= Bacino Lagonegrese-Molisano; Pa= Piattaforma carbonatica Panormide; Si= Bacino Sicano; Tp= Plateau pelagico Trapanese; Sa= Plateau pelagico Saccense; Tu= Tunisia; U-M= Bacino Umbro-Marchigiano; 1= Lepini-Ausoni-Aurunci; 2= Simbruini-Ernici-Matese; 3= Velino-Montagna Grande; 4= bacino Genzana-Greco; 5= Morrone; 6= bacino della Maiella occidentale; 7= Maiella; 8= bacino della Maiella orientale.*

& Di Stefano 2007). The Panormide Platform (Pa) geodynamics seems, in fact, to be consistent with the presence of a crustal sector connecting the Gondwana and the Apenninic Platform and separating the Ionian Tethys from the Alpine Tethys (Rosenbaum *et al*. 2004; Zarcone & Di Stefano 2007). The present-day separation of the Panormide and Apenninic platforms is probably the result of the splitting of a NNE oriented huge carbonate platform (including Pa and ACP) induced by the south-eastward drift of the Calabrian block (Cl in Fig. 7) during the Neogene, as suggested by the opposite palaeomagnetic rotation of Sicily and Southern Apennines (Gattacceca & Speranza 2002, 2007). This scenario could explain the occurrence of co-evolved faunas in different places, not invoking parallel or endemic evolution, and preference given to the dispersion model rather than to the vicariance one.

6. CONCLUSIONS

The Esperia outcrop is the first evidence of Aptian dinosaur in the Apenninic Platform. Tridactyl tracks are referred to small-sized theropods, while non tridactyl footprints are ascribed to medium-sized sauropods. The dinosaur assemblage shows affinities with the coeval one of Bisceglie referred to the Apulian carbonate Platform domain.

This paper thus proposes a geographical connection between the Apenninic and the Apulian platforms during the Aptian as also suggested by geological and geophysical data.

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