



Città di Custonaci



United Nations  
Educational Scientific and  
Cultural Organization



UNESCO Chair on Karst Education  
University of Nova Gorica in cooperation with  
ZRC SAZU Karst Research Institute



CIRS

# Dentro e fuori la Montagna

Giornate di incontri, divulgazione ed escursioni su  
*Geologia - Carsismo & Paleontologia*

## Inside and outside the Mountain

Information and excursions days on  
*Geology - Karst & Palaeontology*

**Custonaci 23<sup>rd</sup> - 26<sup>th</sup> April 2015**

**PROGRAM & ABSTRACTS**

### **Scientific participations**

Unesco Chair for Karst education - University of Nova Gorica  
Karst research Institute ZRC SAZU, Postojna, Slovenia  
University of Catania, Italy  
University of Messina, Italy  
University of Palermo, Italy  
University of di Bristol, United Kingdom  
University of Patras, Greece  
Natural History Museum, United Kingdom  
Istituto Nazionale di Geofisica e Vulcanologia, Palermo, Italy  
Station Marine d'Endoume, Marseille, France  
Institut Català de Paleontologia, Barcelona, Spain  
Museo Scientifico e Speleologico Grotta Gigante, Trieste

### **Istituzional Patronages**

Regione Siciliana  
Assemblea Regionale Siciliana  
Comune di Custonaci

### **Cultural Patronages**

Società Geologica Italiana  
Consiglio Nazionale dei Geologi  
Ordine Regionale dei Geologi di Sicilia  
Unione Internazionale di Speleologia  
Società Speleologica Italiana  
Federazione Speleologica Regionale Siciliana  
Società Paleontologica Italiana  
Accademia Gioenia di Scienze Naturali in Catania  
Sigea - Società Italiana per la Protezione Ambientale

### **Comitato organizzatore**

Rosario Ruggieri  
Davide Messina Panfalone  
Paolo Vultaggio  
Flaminia Asta  
Giusi Adragna  
Andrea Barone  
Antonio Bambina  
Piero Panfalone  
Iolanda Galletti  
Giorgio Sammito  
Riccardo Orsini  
Antonello Ingallinera  
Tonino Trovato  
Francesco Criscione  
Claudio Tornello  
Roberto Gintoli  
Giovanni Gianni Noto



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## Dentro e fuori la Montagna

Giornate di incontri divulgazione ed escursioni su  
*Geologia - Carsismo & Paleontologia*

### Presentazione

Ad un anno dall'invito dell'Amministrazione di Custonaci di co-organizzare un evento che contemperasse aspetti divulgativi e aspetti rigorosamente scientifici su specifici argomenti delle Scienze della Terra riguardanti il contesto geologico Mediterraneo, in grado di attirare e coinvolgere una gamma quanto più variegata di appassionati, dall'escursionista naturalista allo speleologo, dallo studente al ricercatore fino al docente universitario, ed ancora, porre in essere una manifestazione che potesse, altresì, realizzare i presupposti per una sua riproposizione negli anni a venire, quale opportunità di incontri, discussioni, confronti e aggiornamenti sul continuo evolversi degli studi e scoperte sul mondo naturale che ci circonda, quale momento di conoscenza, sensibilizzazione ai temi di salvaguardia del territorio naturale considerato nel suo delicato equilibrio in relazione alla sempre crescente pressione antropica, pertanto, trascorso un anno dall'avvio della macchina organizzativa, eccoci ora qua ad onorare questo non poco arduo impegno, preso grazie al coinvolgimento di tanti amici del contesto universitario, sia italiano che estero, e del mondo dell'associazionismo, che per l'occasione voglio qui ringraziare. Amici, lieti di condividere questa comune avventura, per certi versi particolare, forse prima nel suo genere in Italia

Difatti, l'evento battezzato *Dentro e Fuori la Montagna*, per richiamare l'insieme suggestivo e singolare delle fantastiche morfologie carsiche superficiali e ipogee presenti in questo territorio dei Monti di Trapani, è stato strutturato, come si evince dal programma di seguito illustrato, con giornate didattiche tematiche, articolate in seminari ed escursioni riguardanti la geologia, la geomorfologia carsica e la paleontologia, cui farà seguito un simposio internazionale suddiviso in due sessioni specialistiche, una sulla paleontologia delle comunità faunistiche di grotte marine sommerse, l'altra su tematiche di protezione del patrimonio carsico.

I seminari sono indirizzati a geologi, paleontologi, biologi, naturalisti e professionisti che si occupano di studi ed indagini inerenti il carsismo, le grotte e la loro tutela, oltre che appassionati, speleologi, studenti universitari, dottorandi e giovani ricercatori che hanno interesse ad approfondire argomenti contemplati nel loro percorso formativo o professionale.

Infine, l'evento, non poteva trovare migliore collocazione calata com'è in uno degli scenari paesaggisticamente più affascinanti e spettacolari del contesto fisico siciliano costituito dai Monti di Capo San Vito, chiave di volta negli studi sulla storia geologica della Sicilia e del settore centro-mediterraneo, di particolare valenza geomorfologico-carsica per la ricca varietà di morfologie superficiali e ipogee presenti, queste ultime di rilevante valenza estetica, alcune rivelatesi di grande interesse scientifico in quanto rari archivi delle variazioni climatiche verificatesi nel corso del Pleistocene.

Concludo con l'eccellente opportunità propostaci dalla Casa editrice Springer di voler pubblicare in una edizione speciale della collana *Carbonate and Evaporites* un certo numero di presentazioni selezionate, come riconoscimento del valore scientifico e culturale dell'iniziativa posta in essere. Un sentito ringraziamento a tutti i partecipanti e a chi ci ha collaborato con l'auspicio che ci si possa ancora rivedere, essendone sicuramente valsa la pena.

Rosario Ruggieri  
*Presidente del CIRS*



Città di Custonaci

## Dentro e fuori la Montagna *Geologia - Carsismo & Paleontologia*



### **Inside and outside the Mountain** Information and excursions days on *Geology - Karst & Palaentology*

#### **Presentation**

A year after the Administration of Custonaci invited us to co-organize an event that could include both divulgation and strictly scientific aspects on specific topics of Earth Sciences concerning the Mediterranean geological context; able to attract and involve a wide range of enthusiasts, from the naturalist excursionist to caver, from the student to the researcher till the university professor, and again, to organize an event that could also create the prerequisites for its revival in the coming years, as an opportunity for meetings, discussions, comparisons and updates on the continuing evolution of the studies and discoveries about the natural world around us; as a moment of knowledge, awareness of themes of preservation of the natural territory taken as a delicate balance in relation to increasing human pressure. Therefore, after spending one year in the organization of the event, we are now here to honor this daunting commitment, taken by the involvement of so many friends in the university context, both Italian and foreign, and the association of the voluntary sector, which on this occasion I want to thank here. Friends, we are happy to share this common adventure, in some ways particular, perhaps the first of its kind in Italy.

In fact, the event called “Inside and outside the Mountain”, to draw all the suggestive and singular karst morphologies, superficial and underground, in this area of the Mountains of Trapani, was structured, as evidenced by the program shown below, with experience theme days articulated in seminars and excursions on geology, karst geomorphology and paleontology, to be followed by an international symposium divided into two specialist sessions, one on the paleontology of the communities of submerged caves, the other on issues of the protection of karst heritage.

The event is aimed at people (including geologists, palaeontologists, biologists, naturalists professionals, cavers, enthusiasts, university and PhD students, as well as young researchers) dealing with geology and, particularly, with caves and their protection.

Not surprisingly, the event will be held in one of the most fascinating and spectacular landscapes of the Sicilian physical context, the Capo San Vito Mountains. The area, which includes keystone sites for studies on the geological history of Sicily and the central Mediterranean Basin, is of particular geomorphological-karst value for the high variety of both its surface and hypogean morphologies. Some of these latter, having a considerable aesthetic value, proved to be of great scientific interest as rare archives of climate changes that occurred during the Pleistocene.

I conclude outlining the worthy opportunities proposed to us by the publisher Springer to publish a special issue of the *Carbonate and Evaporites* series dedicated to a selected number of presentations, as a recognition of the scientific and cultural value of this Symposium.

A heartfelt thanks to all the participants and those who have collaborated with the hope that we can keep in touch, I am sure it will be worth it.

Rosario Ruggieri  
*President of CIRS*



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## Dentro e fuori la Montagna Inside and outside the Mountain

Information and excursions days on geology, karst and palaeontology

### Programma / Program

Conference hall 'Stalla della Madonna Carmelo Solina Quartana'

April 23<sup>rd</sup> Thursday

**15.30:** Saluto delle autorità ai partecipanti / **Authorities welcome to the participants**

GIUSEPPE BICA, *Mayor of Custonaci*

On. PAOLO RUGGIRELLO, *Deputato Questore ARS*

Presentazione dell'evento "Dentro e fuori la Montagna"

**Introduction to the event 'Inside and outside the Mountain'**

ROSARIO RUGGIERI, *President of CIRS Ragusa*

Assetto idrogeologico e viabilità principale e secondaria

**Hydrogeological risk and main and secondary road condition**

GIOVANNI ARNONE, *Dirigente Generale Dipartimento Regionale Tecnico*

La promozione del patrimonio geologico: scienza, cultura, professione

**The promotion of geological heritage: science, culture, profession**

GIANVITO GRAZIANO, *President of the Ordine Nazionale dei Geologi*

**16.30:** Seminari su Geologia / **Lectures concerning Geology**

Nuovi dati sulla geologia della Sicilia orientale

**New data on the geology of western Sicily**

PIETRO DI STEFANO, PIETRO RENDA, GIUSEPPE NAPOLI, SIMONA TODARO, GIUSEPPE ZARCONE  
*Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Italy*

**17.00-17.30: Coffee break**



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## Dentro e fuori la Montagna *Geologia - Carsismo & Paleontologia*



Deformazioni plio-pleistoceniche nella Sicilia nord-occidentale

### **Plio-pleistocene deformations in NW Sicily**

GIUSEPPE NAPOLI

*Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Italy*

Paleocarsismo triassico dell'area di Custonaci

### **Triassic paleokarsts in the Custonaci area**

SIMONA TODARO

*Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Italy*

Criteri e vincoli geologici per la realizzazione della Carta Geologica della Sicilia  
1:250.000

### **Criteria and geological constraints for the construction of the Geological Map of Sicily 1:250.000**

FABIO LENTINI, SERAFINA CARBONE

*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*

Paleomagnetismo applicato all'evoluzione degli orogeni. Paleomagnetismo nelle maghrebidi siciliane: sintesi dei dati e implicazioni sugli stili tettonici

### **Paleomagnetism applied to the evolution of orogens. Paleomagnetism in the Sicilian Maghrebides: review of data and implications for tectonic styles**

ROSANNA MANISCALCO

*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*

Primi ritrovamenti di *Homo sapiens* in Sicilia

### **First *Homo sapiens* of Sicily**

LUCA SINEO

*Dipartimento di Biologia Ambientale e Biodiversità, Laboratorio di Antropologia, Università di Palermo, Italy*

**20.00: Welcome party**

**21.30: Video projections**



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**April 24<sup>th</sup> Friday**

Field trip: **Geology of the San Vito Peninsula,**  
lead by P. Renda & C. Di Maggio

**08.30:** Meeting point and departure at parking Hotel Il Cortile

**Conference hall ‘Stalla della Madonna Carmelo Solina Quartana’**

**15.00:** Seminari su Geomorfologia carsica\* / **Lectures concerning  
Karst geomorphology**

Litomorfofogenesi dei karren continentali: I casi studio dei Monti di Capo San Vito, Italia e dello Yunnan, Cina

**Lithomorphogenesis of continental karren: the study cases of Monti di Capo San Vito, Italy and Yunnan, China**

MARTIN KNEZ<sup>1</sup>, TADEJ SLABE<sup>1</sup>, ROSARIO RUGGIERI<sup>2,3</sup>

*<sup>1</sup>Institute of Karst Research, Postojna, Slovenia, <sup>2</sup>CIRS - Centro Ibleo di Ricerche Speleo-Idrogeologiche, Ragusa, Italy, <sup>3</sup>University of Nova Gorica, Slovenia*

Litomorfofogenesi di karren marini: I casi studio dell'isola di Minamidaito, Giappone

**Lithomorphogenesis of Sea karren: The study cases of Minamidaito island, Japan**

MARTIN KNEZ, TADEJ SLABE

*Institute of Karst Research, Postojna, Slovenia*

**17.00-17.30: Coffee break**

Genesi ed evoluzione di macro-morfologie carsiche: I casi studio di doline e polje della Slovenia

**Genesis and evolution of Macro karst morphologies:** The study cases of the doline and polje of Slovenia

MITJA PRELOVŠEK

*Institute of Karst Research, Postojna, Slovenia*

Genesi ed evoluzione di macro-morfologie carsiche: I casi studio del sistema carsico Polje di Purgatorio e delle grotte della fascia costiera dei Monti di Capo San Vito.

**Genesis and evolution of Macro karst morphologies: The study cases of the Purgatorio polje karst system and caves of the Monti di Capo San Vito coastal belt.**

ROSARIO RUGGIERI

*CIRS - Centro Ibleo di Ricerche Speleo-Idrogeologiche, Ragusa, Italy - University of Nova Gorica, Slovenia*



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## Dentro e fuori la Montagna *Geologia - Carsismo & Paleontologia*



**19.00:** Premiazione concorso fotografico / **Prizegiving naturalistic photo competition**

**20.00 - 21.00:** Pausa cena / **Dinner break**

**21.00:** Escursione notturna alla Grotta della Clava / **Night excursion in the Clava cave**

**21.00:** Teatro di Custonaci / **Custonaci theater**

Rassegna di Prosa “I beati anni dell’innocenza” / **Entertainmen “I beati anni dell’innocenza”**

### April 25<sup>th</sup> Saturday

#### Escursione\* / **Field trip: Karst morphology**

lead by T. Slabe - M. Knez & R. Ruggieri

**08.30:** Punto di incontro e partenza parcheggio Hotel il Cortile / **Meeting point and departure at parking Hotel Il Cortile**

Morfologie superficiali ed epicarsiche: dolina della Bufara – Valle secca Muciara - Polje di Purgatorio - Gole di Coipollazzo - karren e Stone forest di Piano delle Ferle - Noce (Monte Sparagio)

**Superficial and epikarst morphologies: Bufara doline - Muciara dry valley - Purgatorio polje - Cipollazzo gorge - karrenfields and Stone Forest of Mt. Sparagio.**

Morfologie carsiche ipogee / **Endokarst morphologies: Abyss of Purgatorio (for cavers)**

\* Il seminario di Geomorfologia carsica di giorno 24 e l’escursione del 25 sono stati riconosciuti dalla Commissione Scuole della Società Speleologica Italiana quale corso di 2° livello per A.I e I.T. Pertanto, i soci S.S.I. in regola con le quote di iscrizione possono richiedere l’ammissione al corso e usufruire della copertura assicurativa durante l’escursione.





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## Conference hall

### ‘Stalla della Madonna Carmelo Solina Quartana’

#### 15.00: Seminari su Paleontologia e datazioni di records di grotta **Lectures concerning Palaeontology & Dating of cave records**

Grotte sottomarine costiere: rifugi ecologici e hotspots molto speciali di biodiversità  
**Submarine caves in the coastal zone: ecological refuges and very special biodiversity hotspots**

JEAN-GEORGE HARMELIN

*Station Marine d'Endoume, M.I.O. (Mediterranean Institute of Oceanography) & GIS  
Posidonie, Marseille, Francia*

Associazioni a invertebrati fossili delle grotte sottomarine

**Fossil invertebrate associations from submarine caves**

ANTONIETTA ROSSO

*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*

Ruolo stabilizzante delle microbialiti in biocostruzioni di grotte sommerse

**Stabilization role of microbialite in bioconstructions from submerged caves**

ADRIANO GUIDO

*Dipartimento di Biologia, Ecologia e Scienze della Terra, Università della Calabria, Cosenza, Italy*

Datazione del livello marino ed evidenze faunistiche in ambienti costieri carsici del Mediterraneo

**Dating sea level and faunal evidence in Mediterranean coastal karst settings**

DAVID RICHARDS

*School of Geographical Sciences, University of Bristol, United Kingdom*

17.00 - 17,30: Coffee break

Mammiferi quaternari della Sicilia: il record delle grotte

**Quaternary fossil mammals of Sicily: the record from caves**

ANTONELLA CINZIA MARRA

*Dipartimento di Fisica e di Scienze della Terra, Università di Messina, Italy*

Invertebrati terrestri di grotta

**Cave terrestrial invertebrates**

GIORGIO SABELLA

*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*



Città di Custonaci

**Dentro e fuori la Montagna**  
*Geologia - Carsismo & Paleontologia*



Biocostruzioni attuali e fossili nell'area di Custonaci

**Fossil and modern bioconstructions organisms in the Custonaci area**

ROSSANA SANFILIPPO

*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*

Analisi paleoecologica e tafonomica delle associazioni microfaunistiche della Grotta Kleissoura I, Peloponneso, Grecia

**Palaeoecological and taphonomical study of the microfaunal assemblage from Kleissour Cave I, Peloponneso, Greece**

KOLENDRIANOU MARIA<sup>1</sup>, ILIOPOULOS GEORGE<sup>1</sup>, KOUMOUZELI MARGARITA<sup>2</sup>

<sup>1</sup>*Department of Geology, University of Patras, Patras Greece*

<sup>2</sup>*Ephoreia of Palaeoanthropology and Speleology, Ministry of Culture, Greece*

**21.30: Proiezioni video / Video-projections**

**April 26<sup>th</sup> Sunday**

**08.30: Posa targa: Geosito di importanza mondiale “Grotta Rumena”**  
Plate apposition: **Geosite of worldwide heritage ‘Grotta Rumena’**

Interverrà alla cerimonia di posa della targa

l'Assessore MAURIZIO CROCE, *Assessorato al Territorio e dell'Ambiente*

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Simposio Internazionale “Dentro e fuori la Montagna”  
**International Symposium ‘Inside and outside the Mountain’**

**11.30: Conference hall ‘Stalla della Madonna Carmelo Solina Quartana’**

1<sup>a</sup> Sessione: Ambienti di grotta: presente e passato

**1<sup>st</sup> Session: Cave environments: present and past**

Conveners: Antonietta Rosso & Rossana Sanfilippo

**11.30-13.30: oral presentations**



Città di Custonaci

## Inside and outside the Mountain *Geology - Karst & Palaeontology*



Chairperson: Marra A.C., Richards D.

Analisi tafonomiche di alcuni livelli archeologici nella grotta di San Lussurio (Romana, Sardegna, Italia). Ambiente e modi di vita in epoca preistorica

### **Taphonomic analysis of some archaeological layers in San Lussurio Cave (Romana, Sardinia, Italy). Environment and human lifestyle in prehistoric times**

CARENTI G.

*Dipartimento di Scienze della Natura e del Territorio. Università di Sassari, Italy*

Spugne litistidi di grotte sottomarine: sono relamente relitte?

### **Lithistid sponges from submarine caves: are they really relict?**

PISERA A.<sup>1</sup>, VACELET J.<sup>2</sup>, PEREZ T.<sup>2</sup>

<sup>1</sup>*Institute of Paleobiology, Polish Academy of Sciences, Warszawa, Poland*

<sup>2</sup>*Institut Méditerranéen de la Biodiversité et d'Ecologie marine et continentale, Station Marine d'Endoume, Marseille, France*

Nuovi dati su morfologia e distribuzione geografica del genere *Petrobiona* (Porifera: Calcarea)

### **New data on morphology and geographic distribution of the genus *Petrobiona* (Porifera: Calcarea)**

MELIS P.<sup>1</sup>, CADEDDU B.<sup>1</sup>, LEDDA F.D.<sup>2</sup>, MANCONI R.<sup>1</sup>

<sup>1</sup>*Department of Science for Nature and Environmental Resources (DIPNET), Università di Sassari, Italy*

<sup>2</sup>*Center of Integrative Biology (CIBIO), Università di Trento, Italy*

Siti a vertebrati quaternari della penisola di San Vito Lo Capo

### **Quaternary vertebrate sites from the San Vito Lo Capo peninsula**

MARRA A.C.<sup>1</sup>, DI MAGGIO C.<sup>1</sup>, MASINI F.<sup>1</sup>, PETRUSO D.<sup>2</sup>, RUGGIERI R.<sup>3,4</sup>

<sup>1</sup>*Dipartimento di Fisica e di Scienze della Terra, Università di Messina, Italy*

<sup>2</sup>*Dipartimento di Scienze della Terra e del Mare, Università di Palermo, Italy*

<sup>3</sup>*CIRS - Centro Ibleo di Ricerche Speleo-Idrogeologiche, Ragusa, Italy*

<sup>4</sup>*University of Nova Gorica, Slovenia*

Valutazione della biodiversità in grotte marine del Mediterraneo orientale

### **Evaluating marine cave biodiversity in the eastern Mediterranean Sea**

GEROVASILEIOU V.<sup>1,2</sup>, VOULTSIADOU E.<sup>1</sup>

<sup>1</sup>*Department of Zoology, School of Biology, Aristotle University of Thessaloniki, Greece*

<sup>2</sup>*Institute of Marine Biology, Biotechnology and Aquaculture, Hellenic Centre for Marine Research, Crete, Greece*



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## Dentro e fuori la Montagna Geologia - Carsismo & Paleontologia



Come lo studio delle grotte ha cambiato le nostre idee su come lavora l'evoluzione: esempi da tutto il Mediterraneo

### **How studying caves has changed our ideas of how evolution works: examples from across the Mediterranean**

HERRIDGE V.<sup>1</sup>, RICHARDS D.<sup>2</sup>, RHODES E.<sup>3</sup>, BONFIGLIO L.<sup>4</sup>, MANGANO G.<sup>4</sup>, INSACCO G.<sup>5</sup>, BORG J.J.<sup>6</sup>, ILIOPOULOUS G.<sup>7</sup>

<sup>1</sup>Department of Earth Sciences, Natural History Museum, London, SW7 5BD, UK

<sup>2</sup>School of Geographical Sciences, University of Bristol, Bristol, BS8 1SS, UK

<sup>3</sup>Department of Geography, University of Sheffield, UK

<sup>4</sup>Fauna Museum, Università di Messina, Italy

<sup>5</sup>Museo Civico di Storia Naturale, Comiso, Italy

<sup>6</sup>National Museum of Natural History, Mdina, Malta

<sup>7</sup>Department of Geology, University of Patras, Greece

La capra di grotta (*Myotragus* Bate, 1909) delle Isole Baleari: un modello per interpretare i trend evolutivi nelle isole

### **The Balearic Islands cave goat (*Myotragus* Bate, 1909): a model for understanding the evolutionary trends on islands**

JORDANA X.<sup>1</sup>, KÖHLER M.<sup>2</sup>

<sup>1</sup>Institut Català de Paleontologia Miquel Crusafont (ICP), Universitat Autònoma de Barcelona, Spain

<sup>2</sup>ICREA at ICP, Spain

Il prezioso corallo rosso, *Corallium rubrum* (Linnaeus), un affascinante componente delle comunità di grotta del Mediterraneo

### **The precious red coral, *Corallium rubrum* (Linnaeus), a fascinating component of Mediterranean cave communities**

HARMELIN J.-G.

Station Marine d'Endoume, M.I.O. (Mediterranean Institute of Oceanography) & GIS

Posidonie, Marseille, France

**13.30-15.00:** Pausa pranzo / **lunch break**

**15.00-17.00:** oral presentations

Chairperson: Sanfilippo R., Petricioli D.

Briozoi delle Grotte marine di Capo Caccia (Sardegna, Italia)

### **Bryozoans from shallo-water submarine caves of Capo Caccia (Sardinia, Italy)**

DI MARTINO E.<sup>1</sup>, ROSSO A.<sup>1</sup>, SANFILIPPO R.<sup>1</sup>, DI MARTINO V.<sup>2</sup>

<sup>1</sup>Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy

<sup>2</sup>ISAFOM/Consiglio Nazionale Ricerche, OU Catania, Italy



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Fruizione e conservazione delle grotte marine

**Visitation and conservation of marine caves**

PETRICIOLI D.<sup>1</sup>, BUZZACOTT P.<sup>2</sup>, RADOLOVIĆ M.<sup>3</sup>, BAKRAN-PETRICIOLI T.<sup>3</sup>, GEROVASILEIOU V.<sup>4,5</sup>

<sup>1</sup>D.I.I.V. Ltd., Department for marine, freshwater and subterranean ecology, Croatia

<sup>2</sup>School of Sports Science, Exercise and Health, University of Western Australia M408, Australia

<sup>3</sup>University of Zagreb, Faculty of Science, Division of Biology, Zagreb, Croatia

<sup>4</sup>Department of Zoology, School of Biology, Aristotle University of Thessaloniki, Greece

<sup>5</sup>Institute of Marine Biology, Biotechnology and Aquaculture, Hellenic Centre for Marine Research, Crete, Greece

Evidenze morfologiche e biologiche di una linea di costa del Pliocene superiore in una grotta nei pressi di Taormina (Sicilia nord-orientale)

**Morphological and biological evidences of an Upper Pleistocene shoreline inside a cave near Taormina (north-eastern Sicily)**

BONFIGLIO L.<sup>1</sup>, SANFILIPPO R.<sup>2</sup>, ROSSO A.<sup>2</sup>, RICHARDS D.<sup>3</sup>

<sup>1</sup>Fauna Museum, Annunziata Academic Centre, Università di Messina, Italy

<sup>2</sup>Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy

<sup>3</sup>School of Geographical Sciences, University of Bristol, United Kingdom

Comunità di grotta pleistoceniche della Penisola di Capo Milazzo (Sicilia nord-orientale)

**Pleistocene cave communities from the Capo Milazzo Peninsula (north-eastern Sicily)**

ROSSO A.<sup>1</sup>, SANFILIPPO R.<sup>1</sup>, VERTINO A.<sup>2</sup>, ZIBROWIUS H.<sup>3</sup>

<sup>1</sup>Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy

<sup>2</sup>Dipartimento di Scienze della Terra e dell'Ambiente, Università di Milano-Bicocca, Milano, Italy

<sup>3</sup>Formerly at the Station Marine d'Endoume, Marseille, France

Micrite autoctona vs detritica in croste biotiche della Grotta Rumena (Custonaci, Sicilia)

**Autochthonous vs detrital micrite in the biotic crusts of the Rumena Cave (Custonaci, Sicily)**

GUIDO A.<sup>1</sup>, ROSSO A.<sup>2</sup>, SANFILIPPO R.<sup>2</sup>, MASTANDREA A.<sup>1</sup>, RUSSO F.<sup>1</sup>

<sup>1</sup>Department of Biology, Ecology and Earth Sciences, Università della Calabria, Italy

<sup>2</sup>Department of Biological, Geological and Environmental Sciences, Università di Catania, Italy

Le grotte sottomarine: un laboratorio naturale per lo studio dei brachiopodi

**The submarine caves: a natural laboratory to brachiopods study**

RUGGIERO E.<sup>1</sup>, GARGIULO M.<sup>2</sup>

<sup>1</sup>Università "Federico II", Napoli, Italy

<sup>2</sup>Corso Italia 246/h - Sorrento, Italy



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Successione faunistica endo- ed epilitica in una grotta plio-pleistocenica di Rodi, Grecia  
- record di una trasgressione

**Endo- and epilithic faunal succession in a Pliocene-Pleistocene cave on Rhodes, Greece - record of a transgression**

STEINTHORSDDOTTIR M.<sup>1</sup>, HÅKANSSON E.<sup>2</sup>

<sup>1</sup>*Department of Geological Sciences & Bolin Centre for Climate Research, Stockholm University, Sweden*

<sup>2</sup>*UWA Centre for Energy Geoscience, School of Earth & Environment, The University of Western Australia, Perth, Australia*

**17.00-18.00:** coffe break and poster session

2<sup>a</sup> Sessione: Conservazione Protezione e Fruizione di Geositi  
**2<sup>nd</sup> Session: Conservation Protection and Fruition of Geosites**

CONVENERS: TADEJ SLABE & ROSARIO RUGGIERI

**18.00-20.00**

Qualità delle acque in acquiferi carsici e strategie di protezione

**Quality of waters in karst aquifers and protection strategies**

ROCCO FAVARA

*Istituto Nazionale di Geofisica e Vulcanologia, Palermo, Italy*

Catalogo Regionale dei Geositi: prime istituzioni

**Regional Catalog of Geosites: first institutions**

ELGA ARINI, ROSANNA GIORDANO, GAETANA LO CASCIO

*Assessorato Territorio e Ambiente, Regione Siciliana, Palermo, Italy*

Geositi carsici di Custonaci (Sicilia nord-occidentale)

**Karst Gosites of Custonaci (north-western Sicily)**

ROSARIO RUGGIERI<sup>1,2</sup>, DAVIDE MESSINA PANFALONE<sup>1</sup>, PAOLO VULTAGGIO<sup>1</sup>

<sup>1</sup>*CIRS - Centro Ibleo di Ricerche Speleo-Idrogeologiche Ragusa, Italy*

<sup>2</sup>*University of Nova Gorica, Slovenia*

I diatremiti tardo miocenici dei Monti Iblei settentrionali (Sicilia sud-orientale): il geosito di Costa Giardini (Sortino - Siracusa)

**The Late Miocene Diatremes of Northern Hyblean Mts. (SE Sicily): The Geosite of Costa Giardini (Sortino - Syracuse)**

SERAFINA CARBONE<sup>1</sup>, ALBERTO PISTORIO<sup>2</sup>, FABIO C. MANUELLA<sup>1</sup>, V. SCRIBANO<sup>1</sup>

<sup>1</sup>*Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Italy*

<sup>2</sup>*Funzionario A.R.T.A., Regione Siciliana, Palermo, Italy*



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## Inside and outside the Mountain *Geology - Karst & Palaeontology*



Geodiversità dei siti carsici: Valorizzazione e fruizione turistica ecocompatibile

### **Geodiversity: Karst area. Environmentally friendly tourist development and enjoyment of geosites**

ALESSIO FABBRICATORE, *Direttore Museo scientifico speleologico Grotta Gigante Trieste*

Geositi mondiali della Catena dei Peloritani (Sicilia nord-orientale)

### **Worldwide geosites in the Peloritani chain (north-eastern Sicily, Italy)**

ANTONIA MESSINA., CATERINA GALLO, VERONICA MANZELLA, ROSARIO TORRE

*Dipartimento di Fisica e Scienze della Terra, Università di Messina, Italy*

From selected presentations given at the Symposium a special issue of Carbonates & Evaporites will be published by Springer Berlin Heidelberg.

### Conclusion / **Conclusion**

**20.30: Party di fine Simposio / Closing party at Grotta Mangiapane**

Degustazione di prodotti tipici locali / **Tasting of typical local foods**

(Associazione Museo Vivente - Gruppo Folk Cala Bukutu)

\*\*\*\*\*

### Eventi a margine della manifestazione / **Side Events (23-26 April)**

1. Mostra di foto del concorso "Dentro e fuori la Montagna"

**1. Exposure photo of "Sopra e sotto la Montagna"**

2. Stand di libri e documentazione a contenuto naturalistico

**2. Stand - Exhibition of popular and scientific books on natural themes**

3. Visita di grotte carsiche verticali (Abisso del Purgatorio)\*

**3. Visit of karst vertical caves (Abisso del Purgatorio)\***

4. Trekking /canyoning (Monte Cofano / Gole di Cipollazzo)\*

**4. Trekking / canyoning (Mt. Cofano / Cipollazzo gorge)\***

\*\*\*\*\*

### Escursioni post-Simposio\* / **Post Symposium field-trips\***

**April, 27<sup>th</sup> Monday**

Field-trip: **Karst morphology of the Zingaro Natural Reserve** (Lead by Riserva Zingaro guides and CIRS)

**April, 28<sup>th</sup> Tuesday**

Field trip: **Nebrodi Regional Park - Grotta del Lauro**. Lead by Ambiente Sicilia & CIRS Ragusa)



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## Dentro e fuori la Montagna *Geologia - Carsismo & Paleontologia*



### **April, 29<sup>th</sup> Wednesday**

Field trip: **Gypsums of the Agrigento area - Vallone del Ponte** (Lead by Gruppo Kamicos & CIRS Ragusa)

### **April, 30 Tuesday**

Field trip: **Iblei region** (south-eastern Sicily) - Lead by CIRS Ragusa

**Valle dell'Anapo e Pantalica - Cava Grande del Cassibile - Valle del Tellesimo - Gola della Stretta**

\* La partecipazione alle escursioni trekking e in grotta richiede una pre-iscrizione. Le escursioni verranno effettuate al raggiungimento di un minimo di partecipanti.

\* **Participation to the trekking and caves excursions requires a pre-registration and will be accepted if a minimum of participants is achieved.**

Il programma su esposto può essere soggetto a insindacabili variazioni da parte del Comitato organizzatore, se determinate circostanze lo richiederanno o per sopravvenuti motivi di forza maggiore.

**The above program may suffer irrevocable changes, by the Organizing Committee, due to reasons of force majeure**







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## ABSTRACTS



# INTERNATIONAL SYMPOSIUM

## **1<sup>st</sup> Session**

*Cave environments: present and past*



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## MORPHOLOGICAL AND BIOLOGICAL EVIDENCES OF AN UPPER PLEISTOCENE SHORELINE INSIDE A CAVE NEAR TAORMINA (NORTH-EASTERN SICILY)

BONFIGLIO L.<sup>1</sup>, SANFILIPPO R.<sup>2</sup>, RICHARDS D.<sup>3</sup>, ROSSO A.<sup>2</sup>

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On rocky coasts of the present-day Mediterranean, gregarious vermetid gastropods construct three-dimensional structures, with different morphologies, that are currently reported from sites located at or immediately below sea level, and exposed to considerable water energy needed for nutrition and respiration.

The record of vermetid incrustations within a cave in Sicily is thus unusual. The cave about 15 m long, 8 m wide and some 6 m high, is located at 131 m a.s.l. and carved in the Mesozoic carbonate rocks, which constitute the promontory of Taormina (Bonfiglio, 1981). Specimens of “*Dendropoma petraeum*” form crusts that can be traced along the walls for about 7 m from the entrance inward. Crusts are nearly continuous with a vertical covering of about 2 m and a thickness, difficult to be evaluated, but ranging from 1 to at least few centimetres. The occurrence of *Dendropoma* crusts points to a wide connection of the cave to the open sea. Crusts are associated to a barely visible knock, and locally to possible mollusc bore holes, as well as to a conglomerate partly filling the lower inner section of the cave. These features extend up to about 2.5 m above the present-day cave floor, indicating the cave was semi-submerged.

In north-eastern Sicily and the Messina Straits area, these morphological and biological markers, already known from outside caves, characterise the inner margin of Middle and Late Pleistocene marine terraces originated by the interaction between Pleistocene glacio-eustatic changes of the sea level and the general, intense, long-term uplift affecting the area. The elevation of the inner margin of the raised Pleistocene marine terraces has been used to evaluate the uplift rate of the region and to infer neotectonic events (Bonfiglio et al. 2010). In the Taormina massif a well-developed succession of marine terraces may be found associated with some caves. A fossiliferous marine conglomerate deposit on a terrace with an inner margin at 120 m, has been discovered at Taormina by Antonioli et al. (2006) and molluscs collected at +105 m indicated few metres palaeodepths. An age of  $124.5 \pm 15.0$  ka was established for the terrace, based on ESR



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methodology applied to *Patella* and *Venerupis* shells, and an attribution to MIS 5, probably MIS 5.5 substage, was given.

In this context and because of its both biogenic and abiogenic sea level indicators, and its location at 130 m a.s.l., well above the 120-90 m elevation of the terrace, the cave here reported is of paramount interest and could document a moment, in the Late Pleistocene evolution of the Taormina area, older than the MIS 5.5 substage. Ongoing taxonomic/paleoecological analyses of the gastropods combined with dating of their shells, will shed further light on this particular record and its bearing for a better understanding of the tectonic evolution of the area.

- ANTONIOLI F., KERSHAW S., Renda P., Rust D., Belluomini G., Cerasoli M., Radtke U., Silenzi S. 2006. Elevation of the last interglacial highstand in Sicily (Italy): a benchmark of coastal tectonics. *Quat. Int.*, 145-146: 3-18.
- BONFIGLIO L. (1981) - Terrazzi marini e depositi continentali quaternari di Taormina. *Quaternaria*, 23: 81-102.
- BONFIGLIO L., Mangano G., Pino P. 2010 - The contribution of mammal-bearing deposits to timing Late Pleistocene tectonics of Cape Tindari (North Eastern Sicily). *Riv. It. Paleont. Strat.*, 116(1): 103-118.

## **TAPHONOMIC ANALYSIS OF SOME ARCHAEOLOGICAL LAYERS IN SAN LUSSORIO CAVE (ROMANA, SARDINIA, ITALY). ENVIRONMENT AND HUMAN LIFESTYLE IN PREHISTORIC TIMES\***

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The rock-hewn of San Lussorio is located near Romana (Province of Sassari, NW Sardinia). The cave is situated in an isolated inland location, 16 km away from the nearest seacoast. The whole territory surrounding this site is formed by a volcanic platform covered by limestone formations showing a Karst topography.

Today San Lussorio cave is used as a Christian church. The cult of San Lussorio hermit was probably linked to the worship of water dripping inside the religious sanctuary.

During the excavation of the main room a great amount of sediment with *Prolagus* bone fragments, was recovered. *Prolagus sardus* (Wagner, 1829), also known as “sardinian pika”, is common in Sardinian paleontological deposits dated back to the Middle Pliocene (3.5 mya).



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*Prolagus sardus* remains from the Holocene are widespread in a great number of archaeological deposits. Prehistoric economy was influenced by this endemic animal: during Mesolithic and Neolithic *Prolagus* represented the staple diet for human population of Sardinia and Corsica. Archaeological bone samples are characterized by its presence up to the Roman era.

In this paper, osteological analysis using a taphonomical approach, provides main information about the ecology of this endemic mammal and the palaeo-diet during prehistory in Sardinia.

\* Research funded by RAS2012-CRP60215 “Conservazione e valorizzazione delle grotte sarde: biodiversità e ruolo socio-economico-culturale”

## **BRYOZOANS FROM SHALLOW-WATER SUBMARINE CAVES OF CAPO CACCIA (SARDINIA, ITALY)**

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<sup>2</sup>*ISAFOM/Consiglio Nazionale Ricerche, OU Catania, Conservatorio Vergini al Borgo, Via Empedocle, 58, - 95130 Catania, Italy*

A project has been undertaken in 2009-2010 on submarine caves from Italian Marine Protected Areas (MPAs) including E Sicily, the Pelagie Islands in the Sicily Channel, and NW Sardinia.

A preliminary account of the bryozoan faunas from the latter area is given here. Three caves from the MPA of Capo Caccia and Punta Giglio, namely the Galatea, Bisbe and Falco caves, have been studied. All caves have single large openings located between 4 and 10 m below the sea level. The Galatea and Falco caves consist of wide initial rooms, about 40 m long, from which narrow cavities develop for total cave lengths of 94 and 50 m, respectively. In contrast, the Bisbe cave only consists of a wide room of 36 x 30 m. Very obscure areas are present only along the inner part of the Galatea cave, whereas all other sectors fall within the semi-obscure areas, encompassing zones I-III introduced by Bianchi & Morri (1994).



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## Inside and outside the Mountain *Geology - Karst & Palaeontology*



A total of 16 samples were collected in June 2009, mostly from the walls and ceilings near the cave entrances, except for the Galatea cave where 6 samples are distributed from 10 to 80 m from the entrance. A single sample comes from the cave floor and one from the sediments accumulated inside the proximal part of the Galatea cave.

Bryozoan communities include 65 species belonging to 46 genera and 28 families. Cheilostomes largely prevail with 50 species (15 anascans and 35 ascophorans), whereas cyclostomes are represented by 15 species. No ctenostome was detected. The highest species diversity pertains to the Bisbe cave including 51 species, followed by the Falco cave with 49 species and the Galatea cave with only 33 species. Cyclostomes always account for large percentages (30-57%), much higher than in the known structure of Mediterranean bryozoan faunas (11-12%). They include 12-13 species, most being shared by all caves and usually frequent, particularly *Entalophoroecia gracilis*, *Annectocyma mayor*, *A. indistincta*, and *Crisia pyrula*. In contrast, the number of cheilostome species is comparable (and higher) for the Bisbe and Falco caves (36 and 39 species, respectively) but lower (21 species) in the Galatea cave, largely in relation to the decrease of anascans. Only some species are shared by all caves, some being also relatively frequent, namely *Aetea truncata*, *Crassimarginatella crassimarginata*, *C. maderensis*, *Onychocella mari- oni*, *Celleporina* cf. *caminata*, *Reteporella feuerbornii* and some *Puellina* species among which *P. venusta*.

Communities include taxa typical of the coralligenous biocoenosis, as well as species indicative of cave environments. Most species develop encrusting colonies from spots to small patches and rarely sheets. Erect taxa include both rigid and flexible species belonging to *Crisia* and to the Family Candidae. No evidence of particular distribution trend has been detected, except for the disappearance of large erect species in the inner sectors of the Galatea cave. This feature appears related to the morphology of the caves.

Some species, of biogeographical or taxonomic interest, are discussed.



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## EVALUATING MARINE CAVE BIODIVERSITY IN THE EASTERN MEDITERRANEAN SEA

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Marine caves have been surveyed for their biota in the Mediterranean Sea more extensively than in any other marine province. However, relevant biodiversity data from the eastern and southern Mediterranean coasts are generally scarce in relation to the well-studied caves of the western basin. The aim of this study was to (i) provide an assessment of the recorded biodiversity in marine cave ecosystems of the eastern Mediterranean basin (Aegean and Levantine ecoregions), (ii) evaluate existing knowledge for the local cave biodiversity in relation to that of the entire Mediterranean Sea, and (iii) highlight regional peculiarities and potential threats.

Original biodiversity data from marine caves of the Aegean Sea were coupled with a detailed bibliographic review. The analysis yielded a total of 525 taxa, corresponding to one fourth of the total marine cave biodiversity recorded in the Mediterranean Sea. Porifera (116), Mollusca (84), Polychaeta (79), Rhodophyta (53) and Osteichthyes (40) presented the highest number of species, while certain groups (i.e. macro-algae, hydrozoans, and bryozoans) were notably underrepresented (possibly understudied) in this area. Among the recorded species some were rare, including eastern Mediterranean endemics and protected species, and 46 (9%) were aliens, mostly of Indo-Pacific origin. Lessepsian migration and shipping were found to be the most likely pathways of introduction for the alien species. Meta-analysis revealed that data are scarce or lacking for some groups in certain areas. It was also evident that quantitative information describing the composition of marine cave communities in the eastern Mediterranean basin is practically inexistent.

Alien species are prominently present in certain eastern Mediterranean areas (25% of the recorded Levantine marine cave biota) and the lack of historic quantitative data on the structure of local cave communities makes it difficult to evaluate possible impacts. Further surveys and monitoring schemes in the Eastern Mediterranean are needed in order to (i) enhance scientific knowledge for the understudied cave habitat and (ii) assess regional individualities and potential impacts on the marine cave communities.



## AUTOCHTHONOUS VS DETRITAL MICRITE IN THE BIOGENIC CRUSTS OF THE RUMENA CAVE (CUSTONACI, NW SICILY)

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Biogenic crusts, developed in the Early Pleistocene Rumena Cave in NW Sicily, have been analyzed from the geomicrobiological point of view. The crusts are restricted to a few sectors of the cave and locally reach a thickness of few centimeters. They consist largely of scleractinians, mainly represented by dendrophylliids. Bryozoans and serpuloids are also present and the species *Hippaliosina depressa* and *Spiraserpula massiliensis* locally form multi-layered sheets and dense aggregates. Basing mainly on the composition of the encrusting community, notably scleractinians, bryozoans, serpuloids, cirripeds, foraminifera and brachiopods, and on morphological/morphometric features of some species, we hypothesized that at least part of the cave was blind when the crust formed, at relatively shallow depth in a sheltered setting or, more probably, at greater depths, below the fair weather swell zone (Rosso et al., 2014). All sampled fossils are typical of the present-day hard-surface submarine cave biota, at both species level and higher taxonomic rank.

Different micrite types were observed within the skeletal framework of the biogenic crusts. Autochthonous and, subordinately, detrital fractions were recognized among micrites. The syndepositionally lithified fraction occurs mainly as very fine-grained laminations. These laminations were interpreted as biofilm calcification derived from bacterial mat growing on the organic matter produced by the encrusting organisms. Clotted peloidal and aphanitic (structureless) textures were also observed in the micrites. Development of the autochthonous micrite is always associated with the preservation of significant amount of organic matter. Autochthonous microbial micrite, present in the biocostructions growing in the sea-cave of the Plemmirio area in Sicily, contains bacterial lipid biomarkers, including abundant compounds derived from sulfate-reducing bacteria (Guido et al., 2013). A similar microbial mediation could be suspected for the autochthonous micrite present in the biogenic crusts of the Rumena Cave.

- ROSSO A., SANFILIPPO R., RUGGIERI R., MANISCALCO R., VERTINO A. (2014) Exceptional record of submarine cave communities from the Pleistocene of Sicily (Italy). *Lethaia*, 48: 133-144. doi: 10.1111/let.12094.
- GUIDO A., HEINDEL K., BIRGEL D., ROSSO A., MASTANDREA A., SANFILIPPO R., RUSSO F., PECKMANN J. (2013) Pendant bioconstructions cemented by microbial carbonate in submerged marine caves (Holocene, SE Sicily). *Palaeogeography Palaeoclimatology Palaeoecology*, 388, 166–180.



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## **THE PRECIOUS RED CORAL, *CORALLIUM RUBRUM* (LINNAEUS), A FASCINATING COMPONENT OF MEDITERRANEAN CAVE COMMUNITIES**

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*Corallium rubrum* has fascinated humans for several millennia because of the beauty of its red calcareous skeleton used for high-priced jewels, its rarity and the mystery of its origin. It is also a very exciting material for scientific studies. Although being non endemic to the Mediterranean (also present in some areas of the NE Atlantic), it is one of the most typical component of the Mediterranean poorly-lit habitats, from coastal submarine caves to bathyal canyons and seamounts (up to 700 m off Malta).

In caves, red coral colonies can be found in dense aggregation at very shallow depth (< 5 m) in areas where summer temperatures remain below its tolerance threshold. Red coral is dioecious and sexual maturity starts when the colony size reaches 2-3 centimetres, a feature that allows this species to persist in harvested zones. However, harvesting eliminates all colonies which exceed the minimum commercial size. Moreover, growth of red coral colonies is extremely slow, as demonstrated by sclerochronology of the organic matrix and long-term monitoring of colonies. Permanent sanctuaries are thus required to restore the natural occurrence of this iconic species, i.e. with the full range of its spatial distribution and colony sizes.





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## HOW STUDYING CAVES HAS CHANGED OUR IDEAS OF HOW EVOLUTION WORKS: EXAMPLES FROM ACROSS THE MEDITERRANEAN

HERRIDGE V.L.<sup>1</sup>, RICHARDS D.<sup>2</sup>, RHODES E.<sup>3</sup>, BONFIGLIO L.<sup>4</sup>, MANGANO G.<sup>4</sup>,  
INSACCO G.<sup>5</sup>, BORG J.J.<sup>6</sup>, ILIOPOULOUS G.<sup>7</sup>

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<sup>3</sup>*Department of Geography, University of Sheffield, UK*

<sup>4</sup>*Fauna Museum, Università degli Studi di Messina, Messina, Italy*

<sup>5</sup>*Museo Civico di Storia Naturale, Comiso, Sicily, Italy*

<sup>6</sup>*National Museum of Natural History, Mdina, Malta*

<sup>7</sup>*Department of Geology, University of Patras, Patras, Greece*

Island biodiversity is closely related to island area and distance from the mainland: two characters unquestionably linked with eustatic sea level. Additionally, island populations typically have high evolutionary rates and are characterized by endemic taxa that are vulnerable to extinction. Thus we might expect island faunas to be affected to a greater extent, and at a faster rate, than those of the mainland – forming the ‘front-line’ of biotic response to global sea-level change. Quaternary island systems show great potential for quantifying the evolutionary response of faunas to climatically driven environmental and associated sea-level changes characteristic of that period. However, after more than a century of study, spatio-temporal patterns and rates of parallel mammalian evolution in Mediterranean island settings remain poorly constrained, hampered by the lack of robust taxonomic and chronological frameworks. Furthermore our current chronology relies on biostratigraphic correlations using the island endemic taxa themselves, raising the possibility of circular reasoning in our evolutionary interpretations. With ever-increasing interest in Mediterranean island faunas, it is becoming imperative that we find ways of building a robust chronology for the region and the *ex situ* fossil specimens housed in collections around the world.

Here we present new chronological data combining U-series and optically stimulated luminescence, for key dwarf elephant, dwarf deer and dwarf hippopotamus cave sites from Malta, Sicily and Crete. Our findings have implications for the timing and frequency of faunal turnover in the region in relation to past climatic change, and have influenced our understanding of the causes and correlates of insular evolution.



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## THE BALEARIC ISLANDS CAVE GOAT (*MYOTRAGUS BATE 1909*): A MODEL FOR UNDERSTANDING THE EVOLUTIONARY TRENDS ON ISLANDS

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<sup>2</sup>*ICREA at ICP meike.kohler@ict.cat*

The numerous caves of the islands of Mallorca and Menorca in the Balearic Islands (Western Mediterranean) contain thousands of fossil remains of the extinct bovid *Myotragus* Bate 1909. The ancestor of this goat-like bovid arrived on the Balearic Islands during the Messinian Salinity Crisis (about 5.6 mya) where it evolved and survived in isolated conditions until relatively recent times.

During its anagenetic evolution, *Myotragus* underwent significant changes in body size (dwarfism), locomotion system, nervous system (brain size and sense organs reduction) and dentition. Some of these derived traits are shared by a large number of island endemic species, a phenomenon coined the 'island syndrome'. The explanation for this is due to the unique characteristics of island ecosystems. Islands are intrinsically resource limited because their restricted landmass can only support a narrow number of primary producers, which in turn affects the energy flow at higher trophic levels. Island ecosystems, therefore, are impoverished of interspecific competitors and of predators, conditions leading to a density-dependent selective regime. In an ecological context of high intraspecific competition for scarce resources and of low predation pressure, it is predicted that selection favors those traits related to more efficient energy intake and energy use.

Our research on *Myotragus* agrees with this prediction and shows that some of their derived features are closely related to changes in physiology and life history traits. The Balearic Islands cave goat *Myotragus* can be considered an ideal model to study the evolutionary trends on islands.



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## QUATERNARY VERTEBRATE SITES FROM THE SAN VITO LO CAPO PENINSULA

MARRA A.C.<sup>1</sup>, DI MAGGIO C.<sup>2</sup>, MASINI F.<sup>2</sup>, PETRUSO D.<sup>2</sup>, RUGGIERI R.<sup>3</sup>

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A good number of Quaternary vertebrate sites are known from the San Vito Lo Capo peninsula. Several of them were described in Di Maggio et al 1999.

Mammal's remains related to the “*Elephas falconeri*” Faunal Complex (early Middle Pleistocene) have been recorded at Piana di Sopra: at Semaforo site they are preserved in reworked paleosoils overlying a coastal conglomerate deposited in an ancient wave cut notch at 45 m a.s.l.; at Isolidda 2 site a dental remain of *Palaeoloxodon falconeri* were recovered within a beach conglomerate resting on the floor of a marine cave opened at about 72 m a.s.l in the palaeocliff bordering the southern side of Piana di Sopra. The sites lies on a marine terrace, correlated to an isotopic stage comprised between MIS 15 and MIS 11.

Sites releasing fossils of the “*Elephas mnaidriensis*” F.C. have been found resting in the marine terrace attributed to MIS5: at Seno dell’Arena site scant remains of *Dama carburangelensis* are encrusted above the Eutyrrhenian abrasion surface (MIS 5e) at 10 m a.s.l.; at Caletta Cofano remains of *Elephas mnaidriensis*, *Bos primigenius* and *Crocota crocuta* occur within a continental succession (reworked paleosoil sediments with stone lines overlying marine calcarenites) lying on a wave-cut surface correlated with MIS 5a or 5c.

Important new finds, recovered in year 2004, came from the lower deposits at Grotta Racchio (=Torre Isolidda 3) consisting in the occurrence of a new species of *Microtus (Terricola)* associated with endemic glirids (*Leithia* and *Maltamys*) and large mammals common to the “*E. mnaidriensis*” F.C. The association seems intermediate between the “*Elephas mnaidriensis*” F.C. And the Pianetti - San Teodoro FC (Locatelli, 2011; Petruso et al., 2011).

Recent investigations in a small karst cavity in the Macari coastal plane, attributed to MIS 5e, yielded *Homo sapiens* remains associated with *Vulpes vulpes*, preserved in small hollow's deposits. Other mammals' remains are embedded in the middle and inner part of the cave. The assemblage is chaotic, with a high percentage of broken bones. No tools and/or handcrafts seem to be present. In the inner portion of the cave, bones and teeth still included in the deposit and partly calcified have been observed and they can preliminar-



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ily attributed to ovicaprines, cervids (the size is likely in the variability of *Cervus elaphus*), suids (probably *Sus scrofa*) and small equids (maybe attributable to *Equus asinus*). At the state of knowledge, the assemblage can tentatively be attributed to Holocene.

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## NEW DATA ON MORPHOLOGY AND GEOGRAPHIC RANGE OF THE GENUS *PETROBIONA* (PORIFERA: CALCAREA) \*

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The Mediterranean genus *Petrobiona* Vacelet & Lévi 1958, and the family Petrobionidae Borojevic, 1979, both monotypic, are problematic taxa apparently related to the Mesozoic fossil order Pharetronida. At present, it is believed that this genus is composed of two cave-dweller species, *P. incrustans* Sarà, 1963, and *P. massiliana* Vacelet & Lévi, 1958. The taxonomic position of *P. incrustans*, never recorded after the first description, is problematic because it fluctuated over time between the status of valid species and junior synonym. The highly fragmented geographical range of *P. massiliana*, including part of the Eastern Mediterranean and part of the western basin, and the life cycle characterized by short larval phases and low power of dispersal of lecithotrophic larvae, suggest a high isolation between populations. The morphological comparative analysis versus previous data from the entire geographic range highlighted that spicular traits of *P. massiliana* seem to be highly conservative in contrast with a notable plasticity of growth form.

To investigate variation in size and shape of skeletal spicules of this two cave-dweller



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species, we applied the traditional morphometric and geometric morphometric methods. Our aims are to clarify the problematic taxonomic status of *P. incrustans* Sarà, 1963 and investigate in spicule's shape and size variation of *P. massiliana* Vacelet & Lévi, 1958 in distant cave populations. We present here new records of *P. massiliana* that enlarge the geographic range of this species to the eastern basin. Data indicate significant differences in the spicules shape of a) 10 distant and scattered Mediterranean localities, b) between *P. massiliana* and *P. incrustans*, and c) more generally between encrusting and massive growth forms.

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## VISITATION AND CONSERVATION OF MARINE CAVES

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Marine caves are vulnerable ecosystems of special conservation interest. These poorly investigated habitats support rich assemblages, including fragile long-living species as well as several protected, rare and bathyal faunal elements.

Due to their rich biological diversity and complex geomorphology, marine caves are important SCUBA diving hotspots. Internationally, there are various models of management of visitation and conservation of marine caves.

The aim of this study is to present a preliminary comparison of different protocols for marine cave visitation, and to examine case studies from marine regions worldwide.



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Although marine cave habitats have been included in international environmental directives and conservation action plans (e.g. EU and Mediterranean countries) in most countries no specific regulations or management plans are implemented, even for caves located in Marine Protected Areas (MPAs). Surprisingly, few MPAs (e.g. Rowley Shoals Marine Park in Australia and National Park of Svalbard in Norway) have set specific limitations with regard to divers' visitation levels in their caves (e.g. annual number of divers). In some cases special official permits are prerequisite for divers to visit marine caves located in protected areas (e.g. Ecological Network of the Republic of Croatia); though this regulation is not strictly followed for several caves. The large number of marine caves in coastal areas with extensive rocky outcrops (e.g. eastern Adriatic Sea, Aegean islands) coupled with the fact that few attempts of detailed mapping of their geographical location have been made make it practically impossible to manage human activities (e.g. SCUBA diving, spear fishing, tourist boat tours) and evaluate possible impacts on cave biota. Therefore numerous marine caves are currently exposed to unregulated visitation levels and potentially deleterious practices (e.g. souvenir collection, damage to sessile marine organisms).

## LITHISTID SPONGES FROM SUBMARINE CAVES: ARE THEY REALLY RELICT?

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Demosponges are important element of submarine cave communities. A polyphyletic group of demosponges called lithistids, characterized by the presence of articulated choanosomal skeleton composed of desmas that are usually known from deep-water from tropical-subtropical areas, are often occurring in shallow-water caves, sometimes in great abundance. Our best knowledge of such cave lithistid demosponges is from the Mediterranean Sea, where several species were found, both in the eastern (*Discodermia*, *Gastrophanella*, *Neophrissospongia*, *Microscleroderma*) and western basins (*Discodermia*, *Neophrissospongia*, *Neoschrameniella*, *Aciculites*). We are aware of other undescribed



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occurrence of lithistids, and we are focusing now on Sardinia caves where 3 species of lithistids were described. Especially interesting is the occurrence there of fossilized specimens, reported so far only from the Marseille region. Investigations have shown that lithistids occur in such caves worldwide and were recently reported from Philip-pines (*Gastrophanella*, *Microscleroderma* and new sphaerocladine sponge), Marquesas (*Microscleroderma*), Tahiti (*Microscleroderma*, *Aciculites* and new sphaerocladine sponge). From the Caribbean area there is only one published record of *Gastrophanella* from Belize.

Here we report for the first time lithistid demosponges from shallow submarine caves of Sao Vicente (Cap Vert Islands), Teneriffe (Canary Islands), central northern Atlantic, and from la Herradura (Granada, south of Spain) in the Alboran Sea (Western Mediter-ranean). Lithistid from the Sao Vicente cave is a new species of *Neophrissospongia*, that from Teneriffe belongs to *Neophrissospongia nolitangere* (known from deep-water in the Atlantic, and shallow submarine caves in the Mediterranean), and that from the la Herradura cave is *Neophrissospongia radjae*, that was previously known only from another cave in the Adriatic Sea.

This is particularly striking that most of these cave-dwelling lithistids belong to the same genera all over the world, i.e. *Microscleroderma*, *Gastrophanella*, *Aciculites* (all rhizoclone-bearing) *Neophrissospongia*, and undescribed sphaerocladine lithistids. Most of these genera are also typical inhabitants of deep ecosystems in the open ocean. The reason why only these lithistid genera colonized submarine cave environment has yet to be found. Due to the fact that they occur in shallow caves, colonization of these caves must be relatively recent, i.e. after the last glacial maximum (26 000 to 19-20 000 years ago) during which the sea level was over 120 m below today sea level, thus all these caves were emerged. For this reason lithistid sponges cannot be considered as simple relict fauna of the Mesozoic, as is often supposed, that survived in submarine cave refugia.

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## PLEISTOCENE CAVE COMMUNITIES FROM THE CAPO MILAZZO PENINSULA (NORTH-EASTERN SICILY)

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Fossil submarine cave communities have rarely been examined. Noteworthy examples are from the Devonian of Morocco and the Jurassic of France. In more recent geological times, reports are sparse and exclusively related to faunas of few Pleistocene caves. These caves are often located above the present-day sea level because of the interplay of regional tectonics and general sea level changes. Consequently, these occurrences have been used to reconstruct the evolution of the coastal areas where caves open.

Recently, a spectacular sciaphilic association has been described from the Rumena Cave, south of Custonaci (NW Sicily) where corals dominated, associated to bryozoans, serpulids and further subordinate skeletonised encrusters and borers during Early Pleistocene (Rosso et al. 2014).

A new cave association is here documented from the Capo Milazzo Peninsula in the northeastern sector of Sicily. The cave was probably curved by sea erosion, in polygenic breccias mostly consisting of metamorphic and subordinate carbonate blocks and cobbles of different ages, including Pliocene-Pleistocene limestones containing deep-sea faunas. Only a section of the cave is visible along a cut, roughly parallel to the presumed paleo-seashore, 53 m above present-day sea level. Skeletons of encrusting organisms and borings mark the ceiling of the cavity, which can be followed for about 10 metres and has a height ranging from 1 to 2 metres. The cavity is sealed by polygenic marine conglomerates, which are widespread along the peninsula, dated back to the Tyrrhenian and including several molluscs among which the gastropod *Patella ferruginea*.

Fossil remains mostly consist of exceptional dendrophyllid coral colonies, possibly belonging to an elongated morphotype of *Astroides calycularis*, whose subcylindrical corallites colonised the cave ceiling and grew downwards. The coral biocostruction is the substratum for specimens of the vermetid gastropod *Petalococonchus intortus* and the bivalve *Spondylus gaederopus*, as well as for serpulids (mostly *Semivermilia crenata* and *Vermiliopsis labiata*) and the spirorbid *Janua pagenstecheri*. Borers include the bivalve *Lithophaga lithophaga* whose valves are still preserved inside the *Gastrochanoletes* traces they produced, and clionoid sponges, documented by *Entobia* traces, mostly produced in carbonate blocks contributing to the ceiling formation.





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The association points to a colonisation in shallow-water semidark conditions, possibly in a portion of the cave behind the entrance and well connected to the sea, falling within the Zone III of Bianchi & Morri (1994).

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## THE SUBMARINE CAVES: A NATURAL LABORATORY TO BRACHIOPODS STUDY

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Brachiopods are sessile benthic organisms with a calcite shell. They live by filtering food from the water current, under low-light conditions. In the past, brachiopods lived in a variety of environments, from reefs to carbonate platforms, down to abyssal depths. Nowadays, brachiopods occur in the Mediterranean by a fairly limited number of species, which live in shallow waters in restricted environments such as caves and clefts, and tend to be more abundant in the circalittoral zone and at the shelf edge.

Cave environments are relevant for marine biodiversity because of the great variety of physical conditions they present over few meters. Brachiopods may be as common in caves to pave cave walls with density of up to 600 specimens per square meter. Innovation in diving technology made easier direct observation of this astounding diversity of brachiopods, and monitoring such dense populations.

We studied seven brachiopod species currently living in marine caves along the western Italian coast: *Novocrania anomala* (Müller), *Thethyrhynchia mediterranea* Logan, *Megathiris detruncata* (Gmelin), *Argyrotheca cuneata* (Risso), *A. cistellula* (Searles-Wood), *Joania cordata* (Risso), and *Megerlia truncata* (Linnaeus).

The analysis of such species include several aspects:

1- Range distribution as correlated to change in the physical conditions (Isca cave).



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Sampling by removal of the substratum in six standard plots 30 x 30 cm<sup>2</sup>, at a distance of 10 m. The brachiopods are only present in cave innermost samples.

**2- Direct observation of individuals growth rate Isca cave).**

From 1991 to 2000 population analyses were carried out on *Novocrania anomala* and growth assessments was made on several specimens by means of photographic surveys. In this well-protected environment, the population of *N. anomala* remained virtually unchanged through the 10 years of observation. Growth rate evaluated using shell areas, is very low and shows that these organisms probably live more than 50 years. In 2015 this observation on growth will be resurrected, fifteen years after the latest sampling to look for confirmation to previous insights. In 2014 we found an area extremely rich in *A. cuneata*, that will allow studying growth in this species as well.

**3- Population demography over time.**

We analysed population size variation (thanatocoenoses) in all the studied caves, by sampling plots on the cave bottom and sediment cores.

**4- Oxygen isotopic composition of the shell.**

Modern brachiopods incorporate  $\delta^{18}\text{O}$  into the shell carbonate in equilibrium with seawater. The  $\delta^{18}\text{O}$  archive is a valuable record of paleotemperatures. These studies have been accomplished on brachiopods from 34 different localities, covering shallow-waters from the poles to the tropics. We proved individuals of *N. anomala* from the Isca cave to be a particularly reliable sample.

## ENDO- AND EPILITHIC FAUNAL SUCCESSION IN A PLIO-PLEISTOCENE CAVE ON RHODES, GREECE - RECORD OF A TRANSGRESSION

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Caves often provide unique insights into the geological past by having been partly shielded from the destructive effects of taphonomy, thus preserving endo- and epi-faunal fossils as well as sedimentary successions that may have been lost in the surrounding, more exposed, deposits. Therefore, fossil evidence from caves may record in great detail eco-



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logical and environmental changes that took place during the period of active deposition. The cave complex reported here is located in the interstitial space between basement boulders up to 1.500 tons. The depositional history of the cave comprises eight stages. From initial flooding the basin experienced a continuous transgression reaching water depths in excess of 500 m, followed by a rapid, forced regression of similar magnitude. The eight stages recognized in the cave development are:

- Cave formation through a seismically triggered combination of rock-fall and sub-aerial mass movement.
- Initial, gradual transgression with endolithic faunas documenting water depth at around 1 m progressively up through the cave complex. Fossil community characterized by *Gatrochaenolithes torpedo* (bivalve boring) and *Entobia gonioides* (sponge boring).
- Advanced transgression with water depth approaching 40 m documented through a second suite of endolithic faunal elements. Fossil community characterized by the sponge borings *Entobia gonioides* and *E. magna*.
- Peak transgression with water depth probably exceeding 150 m documented through a third suite of endolithic faunal elements. Fossil community characterized by the deep-water sponge boring *Entobia gigantea*.
- Maximum flooding conditions documented by epilithic faunal elements compatible with water depth approaching 500 m. Fossil community characterized by the 'sclero-sponge' *Merlia normani*, the inarticulate brachiopod *Novocrania anomala* and various encrusting bryozoans.
- High stand conditions coincide with the cave being sealed off from the sea water through sedimentation.
- Late high stand, calcium carbonate scalenohedra precipitated on cave walls.
- Forced regression followed by erosion eventually re-opens the cave in a sub-aerial environment, limited development of stalactites & stalagmites



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## **SUBMARINE CAVES IN THE COASTAL ZONE: ECOLOGICAL REFUGES AND VERY SPECIAL BIODIVERSITY HOTSPOTS**

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Knowledge of marine cryptic habitats is of major interest for understanding the organization of life in the coastal zone. The UW cave habitat is now recognized as a prominent biodiversity hotspot in the coastal zone. This concentration of species is mainly due to the high diversity of ecological situations at small spatial scale within caves and between them. In cavities, regardless of their size, abrupt environmental changes occur, mainly light, water motion and temperature, linked to internal topography. Variations of these physical parameters generate profound modifications in the composition of benthic assemblages. Biotic changes are all the more acute from the entrance to recessed parts as light and water circulation are declining rapidly toward a situation of total obscurity and severe reduction of exchanges with the open water. The assemblages of cave dwellers are also shaped by the thermal regime of the water body enclosed by the cave walls, which depends on the slope of the cave floor (upward vs. downward), i.e. on warm vs. cold water trapped in the back of the cave. Light reduction, the first and most obvious physical change, entails the rapid exclusion of photosynthetic organisms, which are the most efficient competitors for space in well-lit habitats. The reduction of water movements in the semi-dark zone, more or less severe according to cave topography, leads to the exclusion of large erect passive filter-feeders (e.g. sea-fans), and thereafter in the dominance of sponges, which are most efficient active filter-feeders, and other sessile invertebrates (mainly scleractinian corals, bryozoans, ascidians). In this zone, the biotic cover of walls is complete and biomass is high. In remote dark places, confinement can be severe and the supply of food from outside sources considerably depleted and stochastic, resulting in strong decrease of biomass, partial cover of walls, general reduction of individual sizes, and extremely low production. An extreme situation is found in anchialine caves where life is mainly represented by some rare animals able to move to seek for food.

Submarine caves may function as permanent or temporary refuges for poorly competitive species, conservatory of living fossils and enclaves of deep-water habitats. This last function results from similarities in darkness, weak water circulation, fine sediment deposits, low energy inputs from productive layers and, in some cases, thermal regime. Submarine caves are a typically fragmented habitat, with consequences on the population genetics of resident species and vulnerability to threats. The poor resilience of this



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habitat makes it particularly exposed to damages caused by pollution, global warming, harvesting (red coral), human attendance (divers). For all these reasons, UW caves are of great concern for environment managers. These various aspects of life in submarine caves are illustrated by examples supplied by sponges, cnidarians, crustaceans, bryozoans and fish.

## A REVIEW OF DEPOSITS FROM THE NORTHERN SIDE OF MONTE GRIFONE (PALERMO)

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On the north side of Monte Grifone, just outside the city of Palermo, there are some interesting Pleistocene deposits, that represent a transition between a marine coastal and a continental environment.

Specifically, on the northern side of the mountain opens the famous Grotta di San Ciro (in which the vertebrate paleontology in Sicily was born after the excavations of 1831), known for its abundant fossil remains of the typical continental *Elephas mnaidriensis* faunal complex (late Middle Pleistocene – early Late Pleistocene). A short distance from the cavity a Late Pleistocene marine section is also exposed.

This paper aims to provide an attempted correlation between the sediments inside and outside the Grotta di San Ciro and, at the same time, to describe what has been observed and (re) discovered in a minor cavity near this cave.



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**CONTRIBUTION TO THE ASSESSMENT AND CONSERVATION  
OF BIODIVERSITY: INVENTORY OF SOME MODEL TAXA  
FROM SARDINIAN CAVES \***

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This contribution aims to increase the dissemination of the knowledge on subterranean fauna and to support the sustainable development of the Sardinian karstic areas. Biodiversity conservation is a worldwide priority and Sardinia is one of the 10 hotspots of global significance for the Mediterranean area. A rational management of caves, as vulnerable extreme environments, play a key role for the biodiversity conservation and the RAS (Regione Autonoma Sardegna), according to European Union guidelines, promoted and approved the LR n. 4 07/08/2007 on rules for the protection of the Sardinian speleological heritage (3175 terrestrial and marine caves registered in the Regional Speleological Register).

The Sardinian caves are characterized by highly specialized endemic species and relict fauna survived to the palaeogeographic, geological and climatic events of the Mediterranean basin. The terrestrial and marine Sardinian caves are characterized by high faunal diversity and high values of endemism with more than 500 recorded taxa.

The basic scientific knowledge is required in the planning process of measures for conservation, enhancement and sustainable use of biodiversity and vulnerable biotopes. One of our main goals is the production of checklists and databases as useful tools for regional/national/international agencies and the public sector. Management and effective protection of habitats and their wildlife (Habitats Directive 92/43/CEE) requires the identification of biodiversity hotspots i.e. areas with highest values of taxonomic richness and endemism.

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## INCREASING BIODIVERSITY KNOWLEDGE OF CAVE-DWELLING PLANARIANS FROM SARDINIA (PLATYHELMINTHES, TRICLADIDA) \*

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Although more than 3000 terrestrial and marine karstic caves are reported from Sardinia the biodiversity of the subterranean triclad fauna is largely unknown. The first record of a cave-dwelling planarian dates back to the 1952 with the report of *Atrioplanaria* sp. from a cave in Northern Sardinia.

Recent studies on newly collected samples were performed, leading to the description of three new species of freshwater planarians and the record of other 3 taxa including both freshwater and terrestrial species, bringing the species richness of cave-dwelling triclads for Sardinia to  $S=7$ . However, these poor knowledge do not seem to reflect the real taxonomic richness and geographic range of the subterranean planarians for the island, but are the result of the sampling scarcity. The number of records is very likely underestimated. In fact collection of cave-dwelling planarians are often due to occasional sampling by speleologist specialist of others animals groups, mainly arthropods. Only recently new sampling financially supported by the Regione Autonoma della Sardegna resulted in the discovery of freshwater and land planarians belonging to Dendrocoelidae, Planariidae and Geoplanidae respectively from caves in North-East and South Sardinia. This biodiversity assessment focused specifically to triclads results in nearly doubling the number of records for the island in a couple of years. Data suggest the necessity of further sampling effort.

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## CAVE-DWELLING SPONGES FROM MARINE PROTECTED AREAS OF SICILY, PELAGIE AND SARDINIA \*

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Marine caves are fragile, cryptic and fragmented environments whose conservations measures and protection planning are promoted by the European Union's Marine Strategy Framework Directive (MSFD). This study deals with marine caves from three MPAs (Capo Caccia-Isola Piana MPA, Plemmirio MPA, Pelagie Islands MPA) within karst systems of Sardinia, Sicily and Pelagie Archipelago. Faunistic surveys were carried out in seven caves in the Sardinia Sea, Ionian Sea and Sicily Channel focusing on cave-dwelling sponges. Taxonomic richness resulted notably high. Comparative analyses of sponge assemblages indicate that although all caves have similar values of species richness, the taxonomic composition notably differs at the species level between karstic areas. Only four species are shared by all seven caves. The biogeographic analysis of the dataset shows that species are Atlanto-Mediterranean, Mediterranean endemics, and few cosmopolitan species. The cave-dwelling sponge fauna of the three MPAs comprises four species protected by the SPA/BIO protocol of the Barcelona Convention. The high values of species richness recorded despite the relatively low sampling effort (non invasive techniques) suggest that further sampling may highlight a higher biodiversity in all investigated caves, particularly for not conspicuous or boring sponges. Sponge species richness confirms that caves are an extremely suitable biotope for sponge assemblages characterized by species with successful preadaptive strategies such as a skiophilic behaviour that favour a tendency towards stygophily.

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## **COVERAGE AND DIVERSITY OF SESSILE BENTHOS IN A SEMI-SUBMERGED MARINE CAVE (AEGEAN SEA): DOES POSITION MATTER?**

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Various morphological types of marine caves have been identified across the Mediterranean rocky coasts. Morphological complexity inside caves creates abiotic gradients, which are reflected in the spatial heterogeneity of sessile benthos. To date, distinct patterns of biotic zonation have been described in different cave types of the northwestern and central Mediterranean basin. Relevant studies mainly investigate differentiation across the longitudinal cave axis, in relation to the distance from the entrance.

As part of a broader recent attempt to study cave biotic zonation in the Aegean ecoregion, we investigated the spatial variability of sessile benthos in a tunnel-shaped semi-submerged cave of the northern Aegean Sea. The studied cave is located on Agios Efstratios Island, which is part of the Greek Natura network (GR4110002 Site of Community Importance). A non-destructive photographic method and advanced image processing software (photoQuad) was used for the study of benthic communities. A total of 63 photoquadrats (25 x 25 cm) were photographed at 3 different positions (3 quadrats on each vertical wall, left and right, and 3 on the floor) in seven distinct cave sectors. Image analysis, along with identifications of sponges from additional qualitative samples, revealed the presence of 47 taxa, 26 of which were classified in the phylum Porifera, 10 were macroalgae (mainly Rhodophyta), 5 Anthozoa, 3 Bryozoa, 1 Foraminifera, 1 Polychaeta, and 1 Tunicata. Different patterns were observed between the walls and the floor with regard to the biotic coverage and diversity indices. Specifically, we observed a decline of the mean biotic coverage from the entrances to the inner part of the cave. The floor exhibited strong sedimentation and was therefore differentiated from the walls. Species richness, Shannon-Wiener diversity and evenness showed similar fluctuation patterns on the opposite walls, but were differentiated on the floor, where lower values of the aforementioned indices were recorded. Similarity analysis separated the luminous entrance floors from the rest of the photoquadrats, revealing groups that roughly corresponded to the sciaphilic algal-dominated entrance zone and the intermediate semidark cave sectors where sessile invertebrates dominated; in the latter zone local variations were observed due to the development of different invertebrate facies (e.g. sponges, scleractinians and encrusting bryozoans).



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In conclusion, both the distance from the entrance and the position inside the cave had an impact on the spatial biodiversity patterns. It would be interesting to investigate patterns of spatial variability in caves of different types and in different areas of the Aegean ecoregion, which, despite its biogeographical interest, has been poorly studied for its marine cave biodiversity.

## **PRELIMINARY NOTES ON EXPLORATION OF UNDERWATER ENVIRONMENTS OF THE MARGIONE CAVE (RG)**

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The Margione cave, which takes its name from a place situated near the karst zone of Modica (RG), is situated on the western bank of the Tellesimo river. It was first explored by the caving Club of Ragusa who drew up the first topographic map in 1993. It is situated on the Hyblaean Foreland, a carbonate plateau located on the south-eastern sector of Sicily.

It is very difficult to enter the cave. Access to the cave is by way of a 9-metre deep artificial well, which fills with water after heavy rain. The real exploration of the various ‘rooms’ into which the cave is divided, characterized by concretions and partial falls, begins at the bottom.

After walking for about 70 metres you reach the lake which marks the end of the superficial area, where the underwater exploration with ARA equipment begins. The first underwater exploration was made in May 2014, but it was possible to explore only the first 50 metres due to a rock fall.

Particular attention is being given to new topography techniques, especially the 3D techniques. This choice was dictated by the fact that a 3D model, integrated with structural geological information, could provide important links between the geological structures observed on the surface and their continuation in the subsurface.



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## **FAUNAL REMAINS FROM GROTTA VERDE, ALGHERO (SARDINIA)**

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Grotta Verde (Green Cave) is located in the promontory of Capo Caccia near Alghero in the northern Sardinia. It's an articulated coast cave with an emerged entrance hall and some submerged rooms.

The site was excavated since the fifties of the XX century and large numbers of Holocene faunal remains have been recovered from different areas and levels.

The cave was frequented by man during the early Neolithic to Chalcolithic periods. In a more recent phase of the Early Middle ages, the cave become a church with an altar vowed to Saint Erasmus.

The faunal assemblage presented here was collected in 2011, mainly from two areas dated to the Middle and Final Neolithic. Zooarchaeological analysis shows predominance of domestic mammals, mainly caprines, and in lower number swine and bovine. Among wild fauna, the extinct Sardinian pika *Prolagus sardus* is present in all levels. Bird remains are also interesting while marine products were not of great importance.

The collected bone material includes several bone tools, artifacts and some human remains. These associations (animal, humans and worked bones) suggest that this faunal sample is the result of different human activities.

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## A CAVE DWELLING *PROTOSUBERITES* (PORIFERA: DEMOSPONGIAE: SUBERITIDAE) FROM SARDINIA \*

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The Bue Marino Cave of Sardinia (Orosei Gulf, Eastern Sardinia, Western Mediterranean Sea) is an estuarine cave, matching only in part the definition of anchialine environment.

In this semi submerged cave the physico-chemical parameters, e.g. water salinity, vary dramatically during the year depending on both the underground river flow rhythm and tides.

The few sponge species discovered in Bue Marino Cave are different from those reported in other marine caves and their identification needs to be defined at genus and species level.

To contribute to the biodiversity assessment and to increase information available on sponge fauna from anchialine caves, we investigated a species belonging to the genus *Protosuberites* (Porifera: Demospongiae: Suberitidae) from the Bue Marino Cave using a morphological approach. Micro and macro-morphological traits of the Sardinian specimens were studied and compared vs. all congeneric species, covering the geographic range of the genus worldwide. From a morphological point of view the *Protosuberites* of Bue Marino Cave is similar to *P. denhartogi* van Soest & de Kluijver, 2003, and to *P. epiphytum* (*sensu* Topsent, 1900). Morphological analysis suggests *Protosuberites* from Bue Marino Cave as a probable new species, making it necessary to deepen investigation by using also a molecular approach, to acquire additional evidence.

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## CAVE ENVIRONMENTS AS A REFUGE FOR THE CONSERVATION OF THE BRYOPHYTE FLORA: A STUDY ON THE CAVES OF THE MT ETNA

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Among plants colonizing caves, the bryophytes are the most significant taxonomical group able to adapt to the hard environmental conditions of this peculiar habitat. The caves are characterized by many physical and ecological factors leading to a selection of the flora, especially in less enlightened parts. This involves the establishment of specialized sciaphilous, hygrophilous, cryptophilous entities, with different pioneer degree. However, this is not a troglobite flora but a troglophile flora represented by highly specialized entities.

The Etna caves here studied are included in a wide altitudinal range, between 280 m and 1750 m a.s.l., and host a well diversified bryoflora with a set of species of great phytogeographical value. Among these noteworthy species we quote the *Fossombronia wondraczekii* (Corda) Lindb., a liverwort very rare in the Italian territory, found in the Micio Conti Cave. Among the remarkable mosses, exclusively found in some high altitude caves (eg Palombe cave, Ladri cave, Coniglio cave, Lamponi cave), we quote *Amphidium mougeotii* (Schimp.) Schimp., *Aulacomnium androgynum* (Hedw.) Schwägr., *Bartramia ithyphylla* Brid., *Cynodontium bruntonii* (Sm.) Bruch & Schimp., *Grimmia decipiens* (Schultz) Lindb., *G. montana* Bruch & Schimp., *G. torquata* Drumm., *Isoperigyopsis pulchella* (Hedw.) Z.Iwats., *Rhabdoweisia fugax* (Hedw.) Bruch & Schimp., *Timmia bavarica* Hessel.; for these mosses the caves represent a refuge station. At present, these species are considered among the most interesting glacial relicts of the Sicilian bryophyte flora.

For their rarity in the Mediterranean region, the ecological peculiarities and distribution area, the above mentioned species, even if colonize a conservative habitat, deserve safeguard and protection over time. Indeed, they represent an important component of the valuable bryophyte diversity, contributing to enrich the Sicilian and Italian naturalistic heritage.



## MICO-SPELEOLOGIC FINDS OF BASIDIOMYCETES IN SICILY

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During the past, caves were considered the home of spectral creatures (vampires, dragons, etc.), today we know that they are a very interesting and important environment from different ecological points of view. Characteristics of hypogean environment are light's absence, high humidity, constant temperature and a food deficiency; all the organisms who live inside caves need particular adaptations for the hypogean environment.

Fungi grow almost everywhere, even inside caves and they do not need light. They grow in the top soil and they grow in cave clay, especially if there is a piece of wood. So as a result cave fungi are not fungi adapted to caves, but simply normal fungi, at least several species, where caves are a general part of their habitat. Fungi are growing as a mycelium, in fact they do not need sunlight for this but just enough rotting plants. As caves are close to the natural habitat of fungi, although there is generally not enough food for them.

The authors describe some Basidiomycetes fungi that have been found in natural volcanic caves of Mt. Etna ("Grotta Immacolatella" R.N.I., San Gregorio di Catania), and in natural karst caves of Iblei's Mountains area.

These first records for Sicily of "mushrooms' caves", from two different localities, are reported. The species, together with the collection sites, are described and illustrated, with a discussion on the adaptations they show. The authors especially underline the depigmentation of fruiting bodies founded and the growth movement they have in response to gravity. A growth response to gravity is called gravitropism (also known as geotropism) and fungal gravitropism was poorly known until recently (Moore, 1991).

In order to achieve perfect positioning of their lamellae or tubes in boletes for spore dispersal, fruiting bodies of higher fungi rely on the omnipresent force gravity. Only accurate negatively gravitropic orientation of the fruiting body cap will guarantee successful reproduction. Most likely every hypha in the transition zone between the stipe and the cap region is capable of sensing gravity.



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## ABSTRACTS



# INTERNATIONAL SYMPOSIUM

## **2<sup>nd</sup> Session**

*Conservation Protection and Fruition of Geosites*



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## REGIONAL CATALOG OF GEOSITES: FIRST INSTITUTIONS

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Three years from the promulgation of law, the Regional Catalog of Geosites includes:

- a) Seventy-nine geosites (instituted according to the D.A. 87/12)
- b) Six geosites still being decreed
- c) Two hundred “Sites of geological interest”, that are sites of recognize scientific interest that will be progressively instituted
- d) About two thousand “Sites for care”, that are sites whose requisites of rarity and representation must be confirmed by scientific studies to be successively inserted among the “Sites of geological interest”.

Of the geosites already decreed, three have been instituted singularly providing laws of specific protection:

- “GSSP del Piacenziano” a Punta Piccola (Porto Empedocle) “Stratigraphic” interest, “Worldwide” grade of interest;
- “Lave brecciate a fluoro-edenite e fluoroflogopite di Monte Calvario” (Biancavilla) of “Mineralogic” interest, Worldwide” grade of interest;
- “Grotta Rumena 1” (Custonaci) of “Speleologic”, interest, “Worldwide” grade of interest.

The other seventy-six, which are in natural reserves instituted for geological motives, have been instituted with a cumulative decree. The institution of these seventy-six geosites, including several of worldwide and national importance, has had the aim of underlining their specific scientific peculiarities, as they are in areas already protected.

The geosites waiting for decrees are:

- “Sistema delle Salinelle del Monte Etna - Area 1 Salinelle dei Cappuccini” (Paternò) of “Vulcanologic/Geochemic”, interest, Worldwide” grade of interest;
- “Sistema delle Salinelle del Monte Etna - Area 2 Salinelle del Fiume” (Paternò) of “Vulcanologic/Geochemic” interest, Worldwide” grade of interest;
- “Sistema delle Salinelle del Monte Etna – Area 3 Salinelle di San Biagio” (Belpasso) of “Vulcanologic/Geochemic”, interest, Worldwide” grade of interest;
- “Travertino della Cava Cappuccini (Alcamo)” of “Paleontologic/Stratigraphic” interest, Worldwide” grade of interest;
- “Collina storica” (Paternò) of “Vulcanologic” interest, “National” grade of interest;
- “Fonte Maimonide” (Paternò) of “Geochemic” interest, “National” grade of interest.





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## KARST GEOSITES OF CUSTONACI (NORTH-WESTERN SICILY)

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The territory of Custonaci, situated in the north-west of Sicily, consists of Mesozoic limestones that have undergone intense karstification processes from the early stages of lifting that have occurred since the end of the Miocene. The overall purity of the limestones and the state of fracturing resulting from the orogenic processes that have affected this area of the Apennine-Maghrebian chain, have favored the formation of a widespread and varied range of both surface and underground karst morphologies over most of its mountain territory constituted by ridges (Mt. Sparagio and Mt. Monte Palatimone), a depressed landlocked area (Plain of Purgatory) and coastal belt (Cornino).

In this regard, starting from the latter, it is possible to observe a continuous rim of sharp and tormented sea karren originated, both by abrasive marine action and corrosive biogenic factors, both on calcarenites of Lower Pleistocene, in the Mt. Cofano - Cornino plain - Rocche del Tuono cliffs, and in the fossil dunes of neighboring plain of Castelluzzo. Going up these coastal belts, modeled in paleo-marine terraces sited at different levels and carved by paleo-sea notches on their inner margins, in the relict paleo-sea-cliffs several entrances of caves (both marine and *flank margin caves*) are present (Ruggieri & De Waele, 2014). Among these, in addition to the famous *Grotta Mangiapane*, of archaeological importance, a special place is occupied by the *Rumena cave*, today a geosite of worldwide importance as a rare example of a paleo-climatic archive and records of Pleistocene eustatic variations, as well as for its spread presence of fossil invertebrate associations on walls and ceilings (Ruggieri, 2013).

And again, climbing the cliffs, in the hinterland of Piano Zubbia, an area of particular karst importance, both scientific and aesthetic, is present consisting of the karst complex "Ghost Cave - Clava cave - Maria SS. di Custonaci cave" (Ruggieri & Messina Panfalone, 2010).

The three caves, at a relatively short distance from one another, have such a rich and diversified set of morphologies of calcite deposit, also monumental in size, particularly beautiful to leave spellbound anyone got to visit them. Returning to the surface and climbing the slopes of Mt. Sparagio, it is possible to observe a striking and fascinating karst landscape first constituted by the *Stone forest* of Piano delle Ferle: pinnacles and spiers several meters high emerging among a lush and fragrant mediterranean maquis; then, heading westward in Contrada Noce, a subsequent area which consists of a large variety of karst morphologies with deep crevasses, carved on mild slopes, furrowed by wide grooves and dotted with solution pans of various sizes; and finally great monoliths of the most extravagant shapes.



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## Dentro e fuori la Montagna *Geologia - Carsismo & Paleontologia*



Having left the Mt. Sparagio along the extreme north-west area of Polje of Purgatory, one can reach the striking fluvio-karst *Gorges of Cipollazzo*: an area of great landscape appeal for its high sheer cliffs, which in some places seem to close in on themselves, and for all its karst morphologies from big potholes, at the base of the falls active in the rainy season, swallow holes, including the Gorge Abyss, to end after 500 m about in a spectacular narrow balcony suspended 50 meters above the plain of Castelluzzo below.

The karst morphologies described above constitute singularity of geological and geomorphological importance in several aspects (aesthetic, natural, scenic and scientific), and therefore represent a great resource for the community of Custonaci both in terms of natural heritage that as regards their use as an offer, in a larger user increase, of nature and hiking tourism.

This having been said, the adoption of urgent measures of valorization and protection follows naturally, such as the institute of Geosite under the Regional Law 25/2012, to ensure their preservation for future generations.

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## THE LATE MIOCENE DIATREMES OF NORTHERN HYBLEAN MTS. (SE SICILY): THE GEOSITE OF COSTA GIARDINI (SORTINO - SYRACUSE)

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The geosite “Diatrema di Costa Giardini” lies to the east of Sortino (Siracusa), in the northern Hyblean Mts. This is a multiple geosite, of areal type, which is at the institution stage by the Assessorato Regionale del Territorio e dell’Ambiente of the Regione Siciliana (L.R. 11.04.2012 n. 25 e dal D.A. attuativo n.87 del 11/06/2012).

The Late Miocene diatremes are located only in the northern region of the Hyblean Plateau, between the Siracusa-Sortino-Mt. Lauro alignment south and the Catania Plain north. Diatremes are cone-shaped pipe with a sub-circular edge, set in the Miocene limestones of the Monti Climiti Fm. (Calcari di Siracusa Mb.). Early external morphology of the Hyblean diatremes is often obliterated by recent volcanic and sedimentary products; the edges can be cross-cut by faults, or covered by volcanoclastic deposits that expand over the edges of the diatreme, shrouding the neighbouring eruptive centres.

The volcanoclastic deposits of the Carlentini Fm. consist of three lithofacies, exhibiting latero-vertical heteropy: tuff-breccia deposits occur inside or near the pipes, cross-bedded thin levels are set on the edges or near the conduits, and parallel/undulated-bedded levels are the most distal facies. On the basis of the distribution of these lithofacies, Carbone & Lentini (1981) and Carbone et al. (1986) recognized about 20 eruptive centres, whose diameters range from 200 m to 1 km (Cuppodia Mts. diatreme, east of Pedagaggi).

The Costa Giardini diatreme represents one of the best examples for its preservation state and fruition. This diatreme shows a funnel-shaped morphology, semi-circularly edged, opened south, with a diameter of about 700 m. The edges are formed by the Calcari di Siracusa Mb., overlaid with volcanoclastic levels, instead the crater is filled with volcano-sedimentary material consisting of tuff-breccia deposits, lava and calcareous blocks (of decametric dimensions) collapsed from the walls of the crater. The walls show an undulated surface, slightly sloping down to the eruptive centre.

The tuff-breccia deposits and the cross-bedded facies of the Costa Giardini diatreme, and more diffusely the Valle Guffari center (Buccheri), are characterized by the presence of deep-seated xenoliths (Scribano, 1987, 1988), which are ovoidal fragments of 2-30 cm in diameter, and are sometimes coated with the host lava. Hyblean xenoliths consist of dominant peridotites and pyroxenites and rare gabbroic rocks (Sapienza &



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Scribano, 2000), in addition to sedimentary and volcanic lithologies belonging to the Meso-Cenozoic succession (Bianchi et al., 1987). These xenoliths have a role of primary relevance in the study of the lithosphere beneath south-eastern Sicily, which lies upon an ancient serpentinized oceanic basement (Scribano et al., 2006a,b; Manuella, 2013, 2014, 2015), being a remnant of the Paleo-Mesozoic Ionian-Tethys Ocean that form the present Ionian-Hyblean-Pelagian domain.

Although diatremes do not represent a peculiarity in time and the country (see Eocene diatremes in the southern Trento region; Castellarin, 1966; Castellarin & Piccoli, 1966), Hyblean diatremes are unique in the regional country, and their scientific interest for the Italian and international community is unquestionable due to the aforementioned deep-seated xenoliths.

The Costa Giardini geosite is near to the archeologic area of the Necropolis of Pantalica. The degradation risk of the area is only natural. The geosite does not need interventions for the safety, up to date, except the proposed valorization of the area.

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## **GEODIVERSITY: KARST AREA. ENVIRONMENTALLY FRIENDLY TOURIST DEVELOPMENT AND ENJOYMENT OF GEOSITES**

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The term geodiversity, coined more than a decade ago (1993 Sharples), is mainly used in Anglo-Saxon environment, in Tasmania and Australia where the geo-diversity is considered a basic element of the ecosystem.

Geodiversity is all around us, it is everywhere even in the underground world: landforms, soils, rocks, fossils, minerals show the past and the changes suffered; while weather and climate continue to shape, consume and expose new rocks and sediments. Geodiversity influences our way of life and perform the connection between people, landscape, culture through the geological environments.

In fact, geodiversity should help us choose the best solutions for management especially in the Karst and in all those natural resources that do not have easy reproducibility: its sustainable use is critical both for the future welfare of our environment and for ourselves.

My ten years of experience as a director of the *Grotta Gigante*, (cave used for tourism from over 100 years), and now as the director of the *Scientific Speleological Museum of Grotta Gigante*, has led me to consider the complex relationship that exists between geodiversity and biodiversity. The management of geosites for tourism imposes both a commercial value and an environmentally friendly tourist development, through technical and scientific professional skills. This development should be ecologically compatible, spreading the scientific culture, as the basis of a conscious and environmentally sustainable tourism in order to hand down the karst, the geosite, to future generations as part of natural heritage. The execution of the *Outdoor Museum path*, with the visit of various geosites induces the knowledge of nature but mostly provide an inspiration for the care and conservation of our geodiversity. Geodiversity, as with the rest of our natural environment, needs to be cared for and carefully managed.

The geological sites of the Classical Karst will be also considered.



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## WORLDWIDE GEOSITES IN THE PELORITANI CHAIN (NORTH-EASTERN SICILY, ITALY)

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The actual works of the Scientific Technical Regional Committee for the Conservation of the Sicilian Geological Heritage (R.L. No 25 - April 11, 2012) have the aim to propose methodologies on selecting, managing, protecting and the sustainably use of the Sicily's Geosites. The high value of the Geological Heritage of Sicily is correlated to its complex architecture. In the NE Sicily, the Peloritani Chain (PC), belonging to the *Orogenic Domains of the Calabria-Peloritani Arc*, extends from the Messina Straits to the Taormina-S. Agata di Militello alignment and consists of 9 Alpine tectonic units (*Aspromonte, Mela, Piraino, Mandanici, Ali, Fondachelli, S. Marco d'Alunzio, Longi-Taormina* and *Capo S. Andrea, Units*). Units involve Proterozoic and Paleozoic crystalline basements, affected by a Variscan L- to HT metamorphism and by a localized MHP Alpine overprint, in addition to Meso-Cenozoic covers, also locally interested by a MLP Alpine overprint. Lower Miocene to Recent sedimentary deposits unconformably cover Alpine Units. The PC, delimited by the Tyrrhenian and Ionian Seas, exhibits a very heterogeneous morphology. *The ionian coast* from the Cape Peloro to the Cape Taormina, shows long beaches cut by the S. Raineri Peninsula and Ali, S. Alessio, S. Andrea and Taormina promontories. *The Thyrrhenian coast* from the C. Peloro to S. Agata di Militello-Acquedolci coast is marked by an irregular alternation of long and wide beaches and promontories, of which, the Milazzo Peninsula is the most important. The coastal morphology includes *the brackish lagoon systems* (natural reserves) of the C. Peloro (NE of Messina Straits) comprising the Ganzirri and Faro Lakes, and of the Marinello Lakes, located on the central Tyrrhenian coast. The *crystalline hilly to mountainous inland* is made up of Proterozoic to Paleozoic metamorphics and plutonics, unconformably covered by Lower Miocene to Recent sediments. The Peloritani main ridge has an average altitude of 1000 m. These reliefs are cut by deep valleys and show steep versants, acute peaks and marine terraces. A hierarchized hydrographic network, with seasonal water-courses (*Fiumare* and *Torrents*) completes the Peloritani's morphology. Symbols and documents of the Proterozoic to Holocene evolutive history of the Peloritani Geological Domain are represented by several Geosites proposed to the Regional STC for the conservation. Are here discussed the Worldwide Geosites (Tab. 1) which "narrate" the oldest evolution of the Peloritani Chain.

**Table 1**

PROTEROZOIC POLYMETAMORPHIC GREEN ROCKS SYSTEM OF THE ASPROMONTE UNIT	
Geosites	Evolutive History
<ol style="list-style-type: none"> <li>1. Variscan Migmatitic Metahornblendites of Milazzo Peninsula</li> <li>2. Variscan Metahornblendites of Dinnammare</li> <li>3. Alpine Metahornblendites of Badiazza</li> </ol>	<p>Paleo-Proterozoic (1700 Ma) Upper Crustal Segment, with mantel ultramafics, involved in three <i>Orogeneses</i>: the <i>Pan-African</i> (800-600 Ma), responsible for a Granulite Facies metamorphism (T= 750°C); the <i>Variscan</i> (320-300 Ma), with an Amphibolitic Facies riequilibration (T&gt;680°C); the <i>Alpine</i> (28-24 Ma), correlated to the emplacement of the Peloritani Chain (24 Ma), accompanied by a Greenschist (1<sup>th</sup> stage at T=480°C and P=8-7Kbar) to Amphibolitic (2<sup>nd</sup> stage at T&gt;550°C and P=5Kbar) Facies; and at last, interested by the Plio-Pleistocene (max 3 Ma) tectonics related to the exhumation of the PC and of the entire Calabria-Peloritani Arc.</p>
PALEOZOIC TO HOLOCENE EVOLUTIVE SYSTEM OF THE MELA UNIT	
Geosites	Evolutive History
<ol style="list-style-type: none"> <li>1. Eo-Variscan Marble of Pizzo Croce</li> <li>2. Eo-Variscan Eclogites of Pizzo Rosarello</li> <li>3. Eo-Variscan Silver Schists of Pizzo Muliciano</li> <li>4. Holocenic Karst Valley of F.ra di Santa Lucia</li> </ol>	<p>Variscan Intermediate Crustal Segment made up of Paleozoic sedimentary-volcanic (Cambrian? Na-Alkaline Ocean Basalts) sequence interested by a Lower Carboniferous subduction process, responsible for an Eo-Variscan (340 Ma) Eclogite Facies metamorphism (T=600°C, P=16Kbar), followed by Upper Carboniferous exhumation processes, accompanied by a Variscan (310 Ma) metamorphic riequilibration from Amphibolite (T&gt;550°C, P=8-7 Kbar), to Greenschist (T=480°C, P&lt;5 Kbar) Facies and, at last, by the Plio-Pleistocene (max 3 Ma) tectonics related to the exhumation of the PC, responsible for both remobilisations of metallic deposits and Karst phenomena , which continue up to the Actual (Holocene).</p>