

LIVE UNDERGROUND

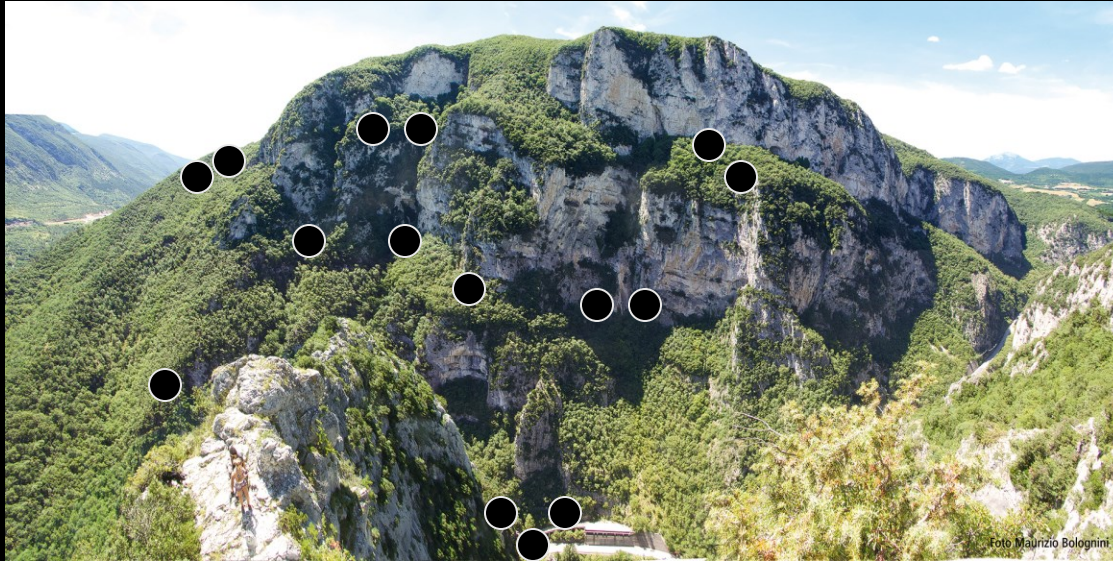
FROM FRASASSI

A POWER POINT SHOW BY ALESSANDRO MONTANARI

C'è nessuno... uno... uno... uno...



INFRA SAXA



Taglio del monte

**Fiume fermo
Sollevamento tettonico
del Calcare Massiccio**

INFRA EMMENTAL



Taglio del cacio

**Formaggio fermo
Abbassamento
del coltello**

Discepolo: “C’è vita nello spazio?”

Profeta di Quélo: “Sì ma solo il Sabato sera”



Discepolo: “C’è vita nelle grotte?”

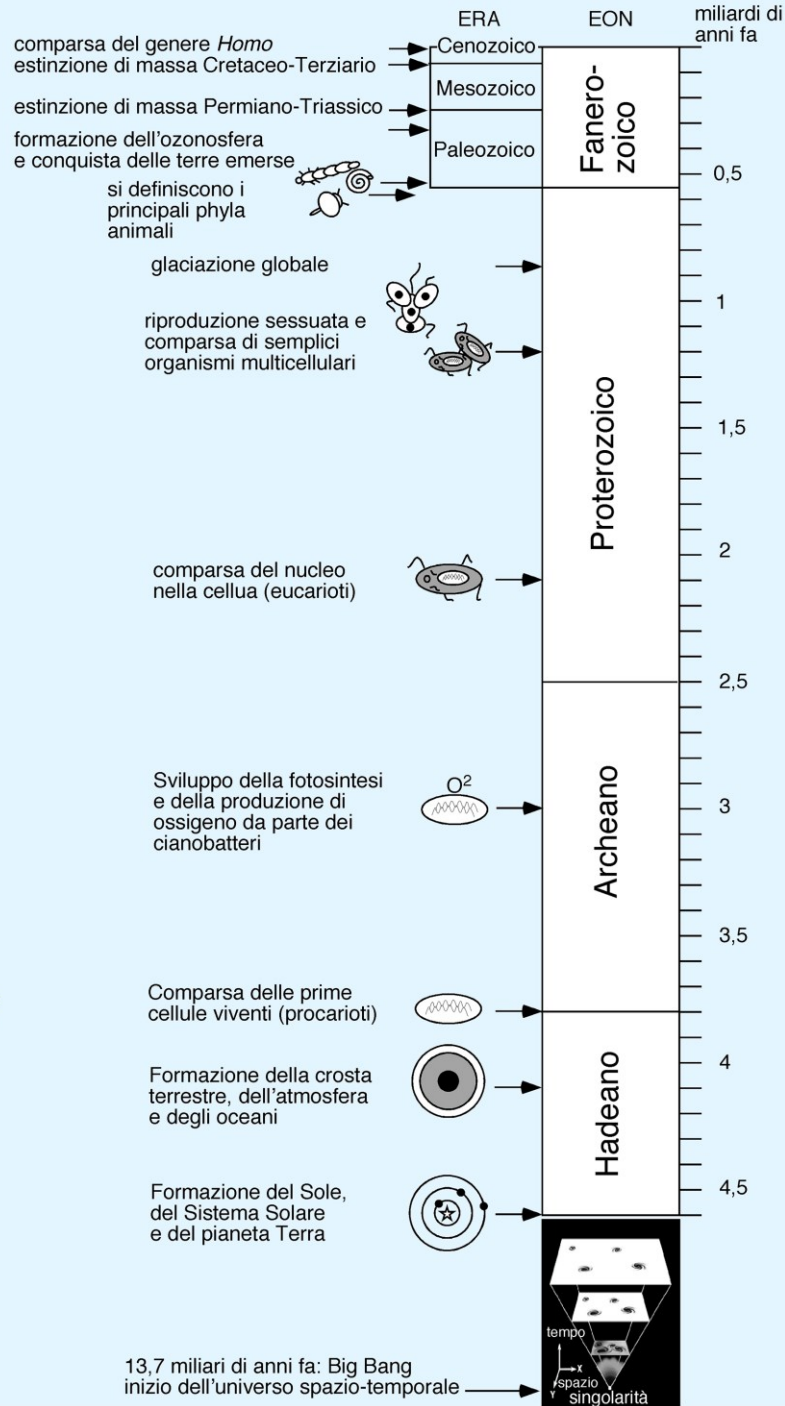
Guru Bashistha: “Sì sempre e da sempre”



La Vita

Quando, dove e come

aumento evolutivo di specie diverse e della complessità biologica



Mamma e Papà



Eucarioti



Ossigeno atmosferico

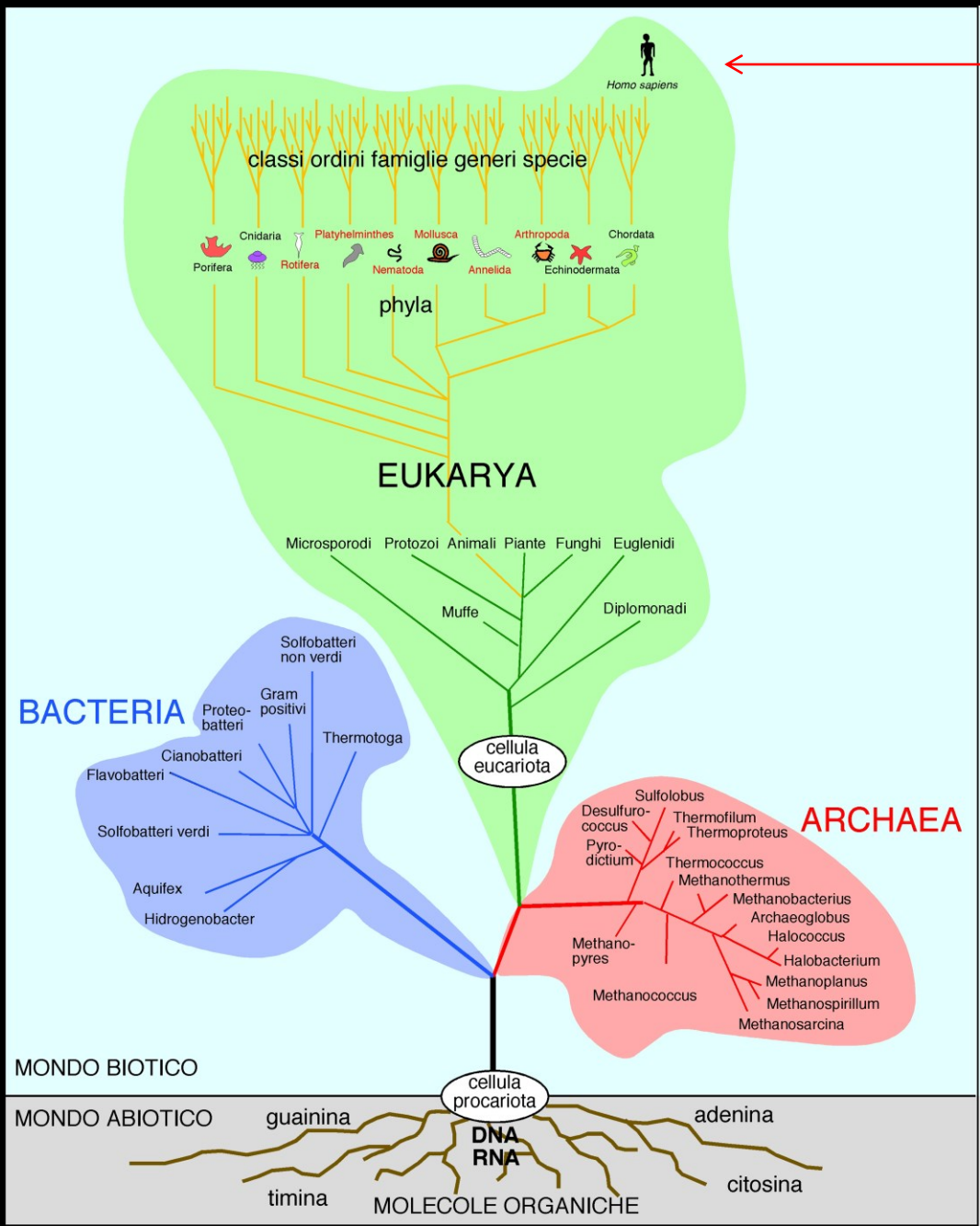


LUCA



Terra!

2000 miliardi di galassie nell'Universo
1.000.000.000.000.000.000 di stelle nell'Universo
200 miliardi di stelle nella Via Lattea
6 miliardi di pianeti nella Via Lattea



Phylum: Chordata
Classe: Mammalia
Ordine: Primates
Famiglia: Hominidae
Genere: *Homo*
Specie: *sapiens*

Discepolo: “Ma che tipo di esseri viventi ci sono nelle grotte?”

Speleobiologo: “Ci sono 3 tipi di esseri viventi”

1) Troglaxeni



2) Troglifili



3) Troglobi & Stigobi



GEOLOGY AND BIOLOGY OF THE FRASASSI CAVES IN CENTRAL ITALY: AN ECOLOGICAL MULTI-DISCIPLINARY STUDY OF A HYPOGENIC UNDERGROUND KARST SYSTEM

Serban M. SARBU, Sandro GALDENZI, Marco MENICHETTI and Gabriele GENTILE

In: Ecosystems of the World, D. Wilkens, D. Culver, and W.F. Humphreys (Eds.), Elsevier, New York, 359-378.

Table 19.1
List of species of invertebrates found recently in the sulfidic sections of the Frasassi caves

ANNELIDA		ACARINA	
OLIGOCHAETA		Labidostomatidae	
Lumbriculidae		<i>Labidostoma cornuta</i>	endogeous
<i>Rhynchelmis n. sp.</i>	troglobite ¹	ARANEAE	
MOLLUSCA		Linyphiidae	
GASTROPODA		<i>Centromerus pasquini</i>	troglobite ²
Hydrobiidae		<i>Lepthyphantes pallidus</i>	troglophile
<i>Islamia pusilla</i>	troglophile population	<i>Lepthyphantes n. sp.</i>	troglobite ¹
CRUSTACEA		<i>Porrhomma n. sp.</i>	troglobite ¹
ISOPODA		Nesticidae	
Oniscidae		<i>Nesticus eremita</i>	troglophile
<i>Androniscus dentiger</i>	troglophile	INSECTA	
AMPHIPODA		COLLEMBOLA	
Gammaridae		Neelipleona	
<i>Niphargus ictus</i>	troglobite ¹	<i>Neelus murinus</i>	endogeous
ARACHNIDA		Onichiuridae	
PSEUDOSCORPIONES		<i>Deuteraphorura n. sp.</i>	troglobite ¹
Chthoniidae		COLEOPTERA	
<i>Chthonius n. sp.</i>	troglobite ¹	Carabidae	
		<i>Duvalius bensai lombardi</i>	troglobite ¹
		Pselaphidae	
		<i>Tychobythinus gladiator gladiator</i>	endogeous



Rhynchelmis n. sp.

TROGLOBI (lombrico)

¹ Species endemic to the Frasassi caves.

² Species endemic to northern Italy.

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MOLLUSCA		ARANEAE
GASTROPODA		Linyphiidae
Hydrobiidae		<i>Centromerus pasquini</i>
<i>Islamia pusilla</i>	trogломorphic population	troglobite ²
		<i>Lepthyphantes pallidus</i>
		<i>Lepthyphantes</i> n. sp.
		<i>Porrhomma</i> n. sp.
		troglobite ¹
		Nesticidae
		<i>Nesticus eremita</i>
		troglobite ¹
		troglobite
CRUSTACEA		INSECTA
ISOPODA		COLLEMBOLA
Oniscidae		Neelipleona
<i>Androniscus dentiger</i>	troglobite	<i>Neelus murinus</i>
		endogeous
AMPHIPODA		Onichiuridae
Gammaridae		<i>Deuteraphorura</i> n. sp.
<i>Niphargus ictus</i>	troglobite ¹	troglobite ¹
ARACHNIDA		COLEOPTERA
PSEUDOSCORPIONES		Carabidae
Chthoniidae		<i>Duvalius bensai lombardi</i>
<i>Chthonius</i> n. sp.	troglobite ¹	troglobite ¹
		Pselaphidae
		<i>Tychobythinus gladiator gladiator</i>
		endogeous



Labidostoma cornula (acaro)

TROGLOFILI e TROGLOBI

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<i>Islamia pusilla</i>	troglomorphie population	<i>Lepthyphantes</i> n. sp.	troglobite ¹
CRUSTACEA		<i>Porrhomma</i> n. sp.	troglobite ¹
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ARACHNIDA		Onichiuridae	
PSEUDOSCORPIONES		<i>Deuteroaphorura</i> n. sp.	troglobite ¹
Chthoniidae		COLEOPTERA	
<i>Chthonius</i> n. sp.	troglobite ¹	Carabidae	
		<i>Duvalius bensai lombardi</i>	troglobite ¹
		Pselaphidae	
		<i>Tychobythinus gladiator gladiator</i>	endogeous



TROGLOBI (scorpioni)

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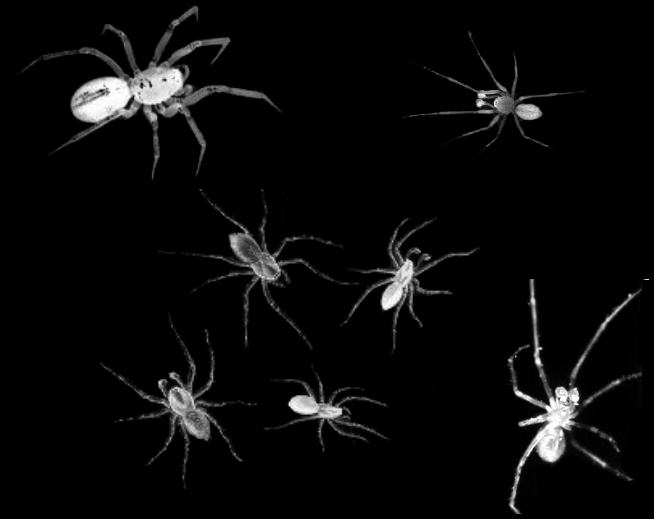
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		<i>Porrhomma</i> n. sp.
		troglobite ¹
		Nesticidae
		<i>Nesticus eremita</i>
		troglobite ¹
CRUSTACEA		troglobite
ISOPODA		INSECTA
Oniscidae		COLLEMBOLA
<i>Androniscus dentiger</i>	troglobite	Neelipleona
AMPHIPODA		<i>Neelus murinus</i>
Gammaridae		endogeous
<i>Niphargus ictus</i>	troglobite ¹	Onichiuridae
		<i>Deuteraphorura</i> n. sp.
		troglobite ¹
ARACHNIDA		COLEOPTERA
PSEUDOSCORPIONES		Carabidae
Chthoniidae		<i>Duvalius bensai lombardi</i>
<i>Chthonius</i> n. sp.	troglobite ¹	troglobite ¹
		Pselaphidae
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ragni e ragnetti

TROGLOBI e TROGLOFILI

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<i>Chthonius</i> n. sp.	troglobite ¹	Carabidae	
		<i>Duvalius bensai lombardi</i>	troglobite ¹
		Pselaphidae	
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Insetti vari

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		Pselaphidae	
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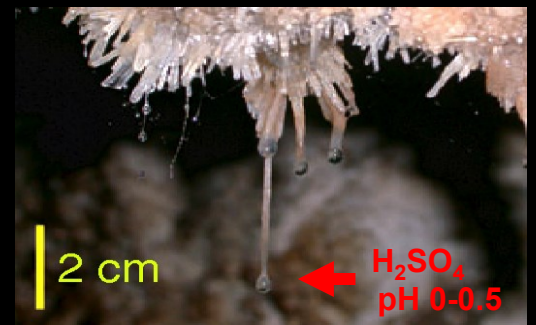
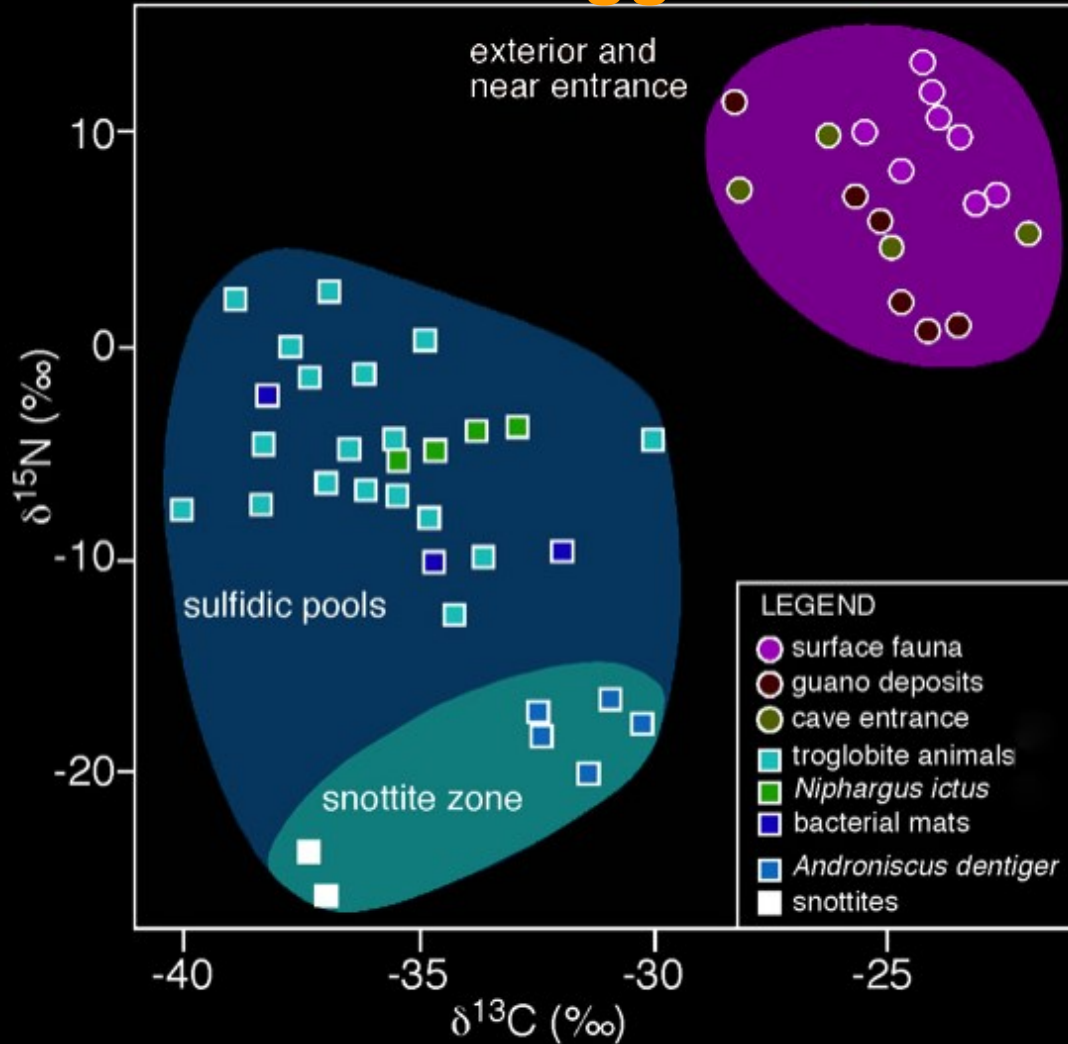
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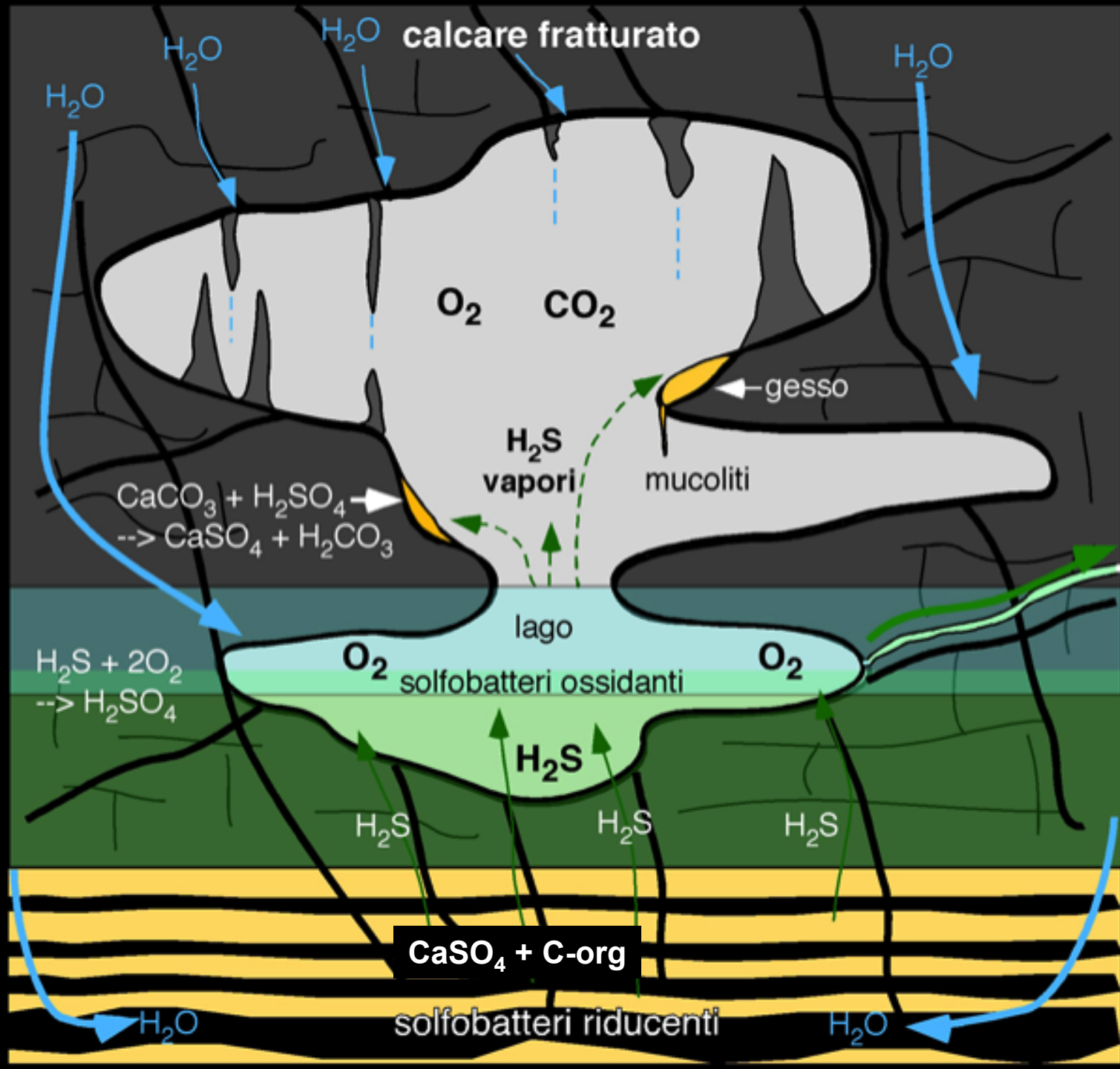


Molluschi e Crostacei

TROGLOBI e STIGOBI

Che si mangia oggi?





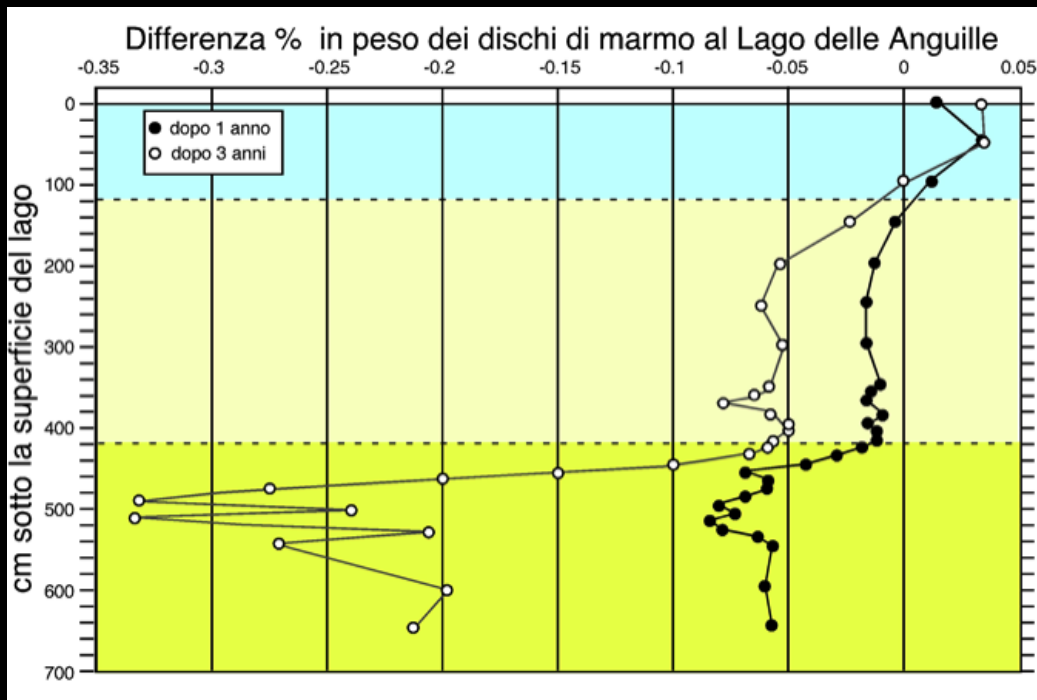


Le anguille perdue (trogloxene)

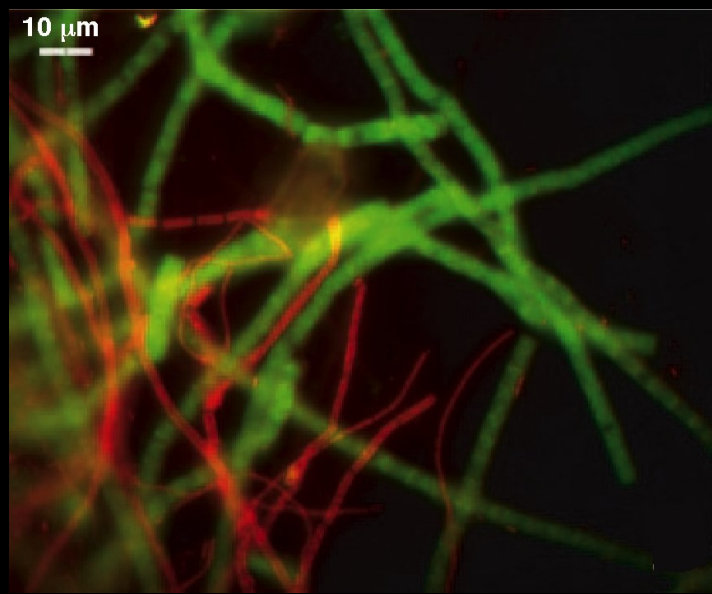


GSM & GSF (2001)

Mariani et al. (2007)



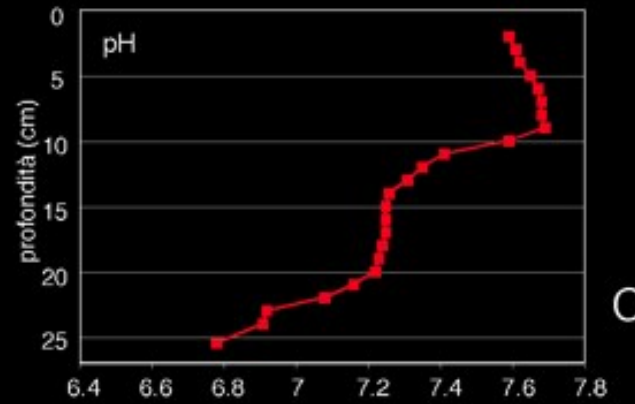
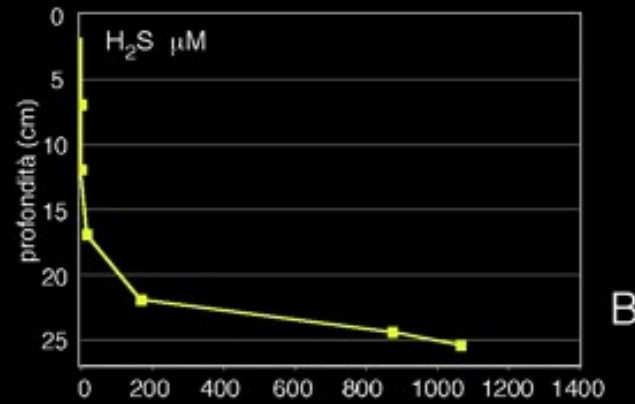
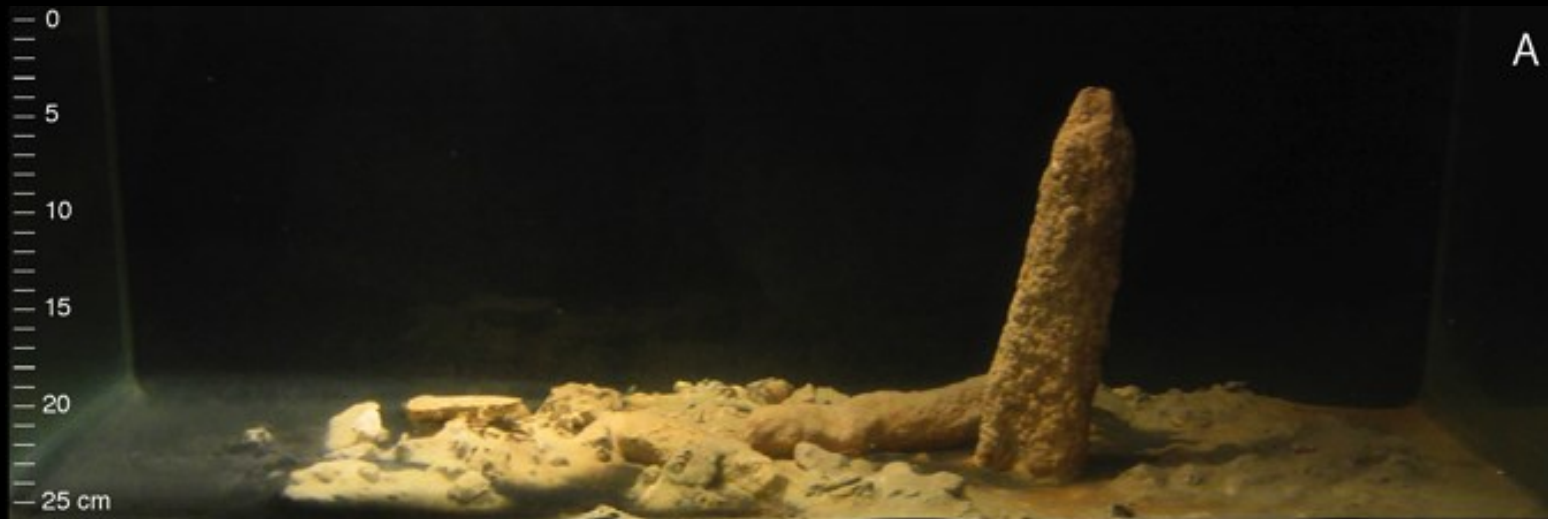
Mariani et al. (2007)

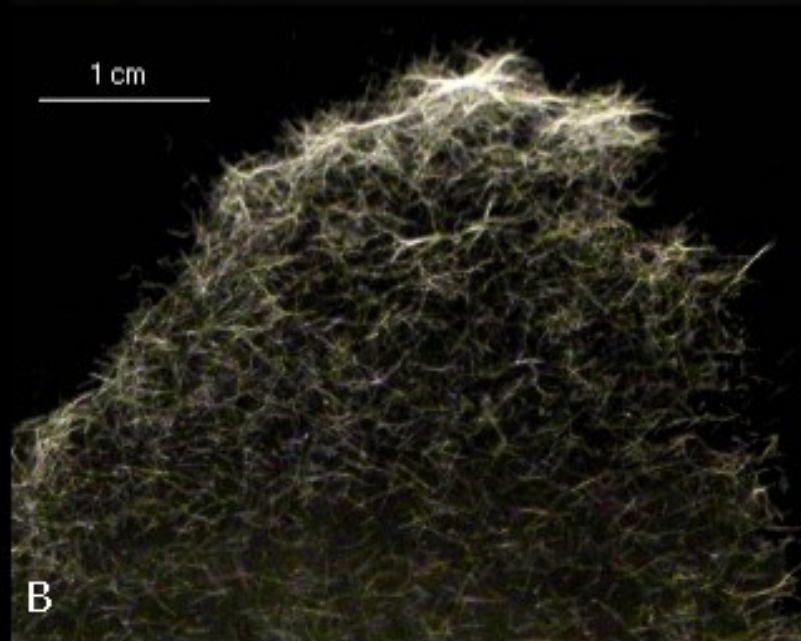


Macalady et al. (2008)

Campionamenti specialistici e sistematici (2005 - 2010)

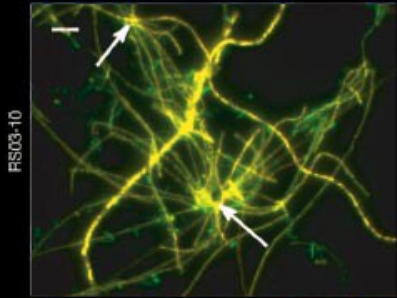






Stigobionti

GAM42A, EUBMIX



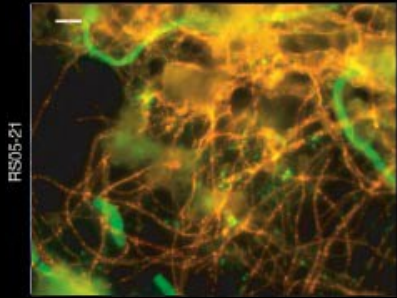
FIS03-10



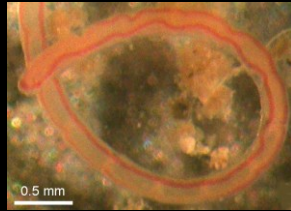
Protozoi

Platelminti

Rotiferi



FIS05-21



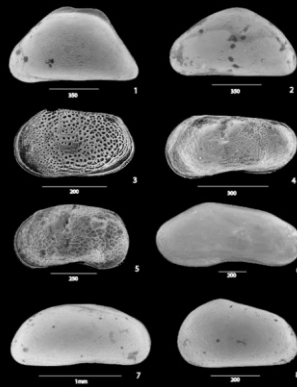
Batteri e Archaea

Anellidi

Nematodi



Gasteropodi



Ostracodi



Copepodi

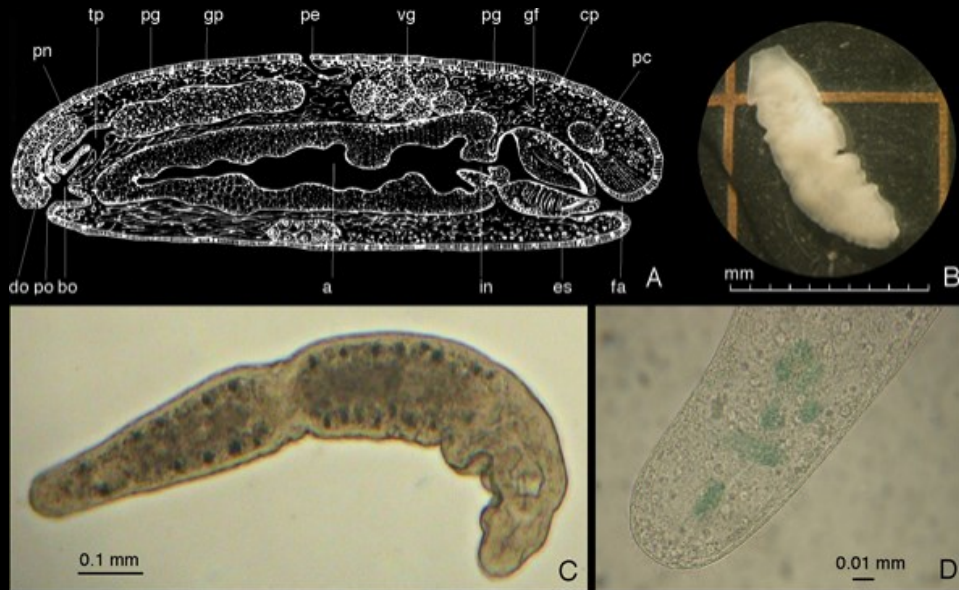


10 mm

Anfipodi

Vermi Platelminti

Tricladide

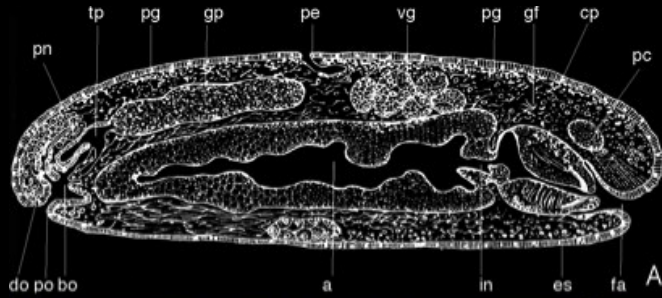


Catenulide

Dendrocoelum leporii n. sp.
Stocchino et al. (2017)

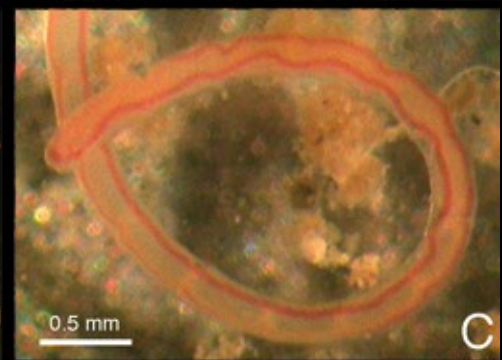
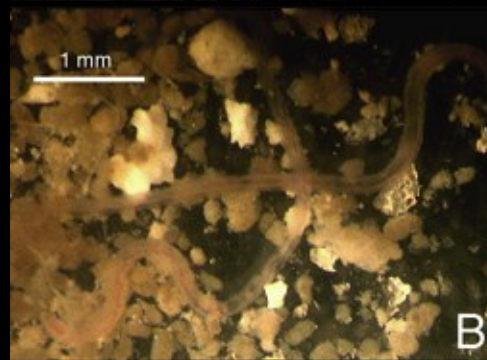
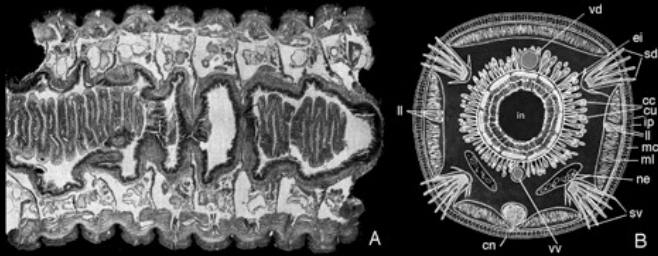
Vermi Platelminti

Tricladide



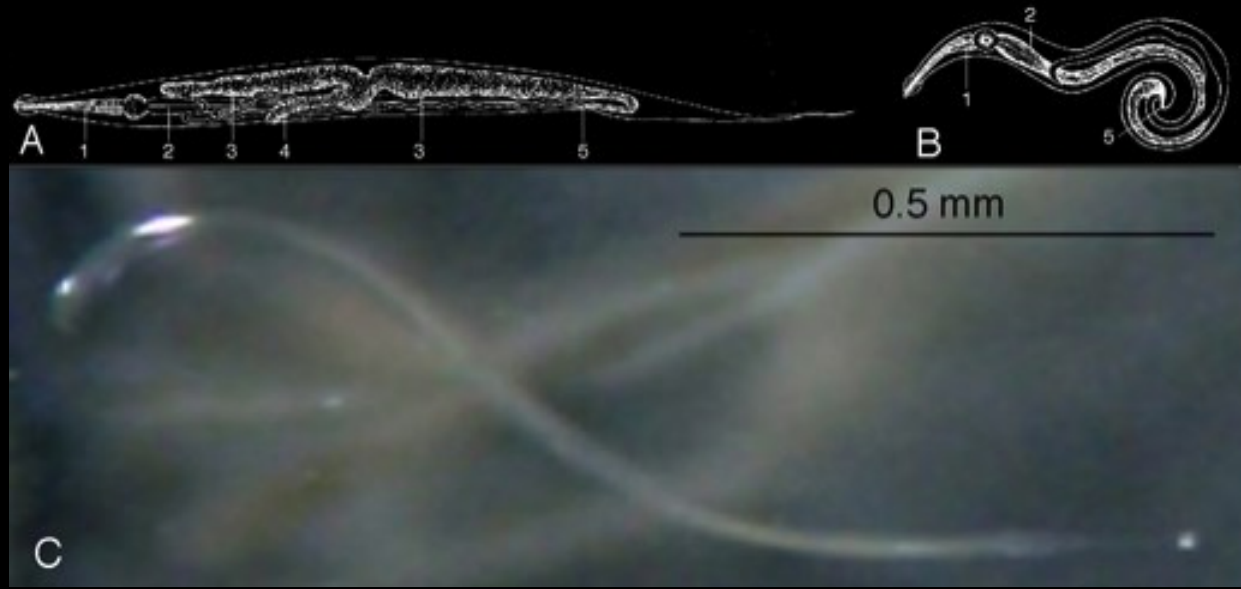
Stenostomum n. sp.?
Jondelius (2008) p.c.

Vermi Anellidi



Potamothrix cf. heuscheri n. sp.
Erseus (2008) p.c.

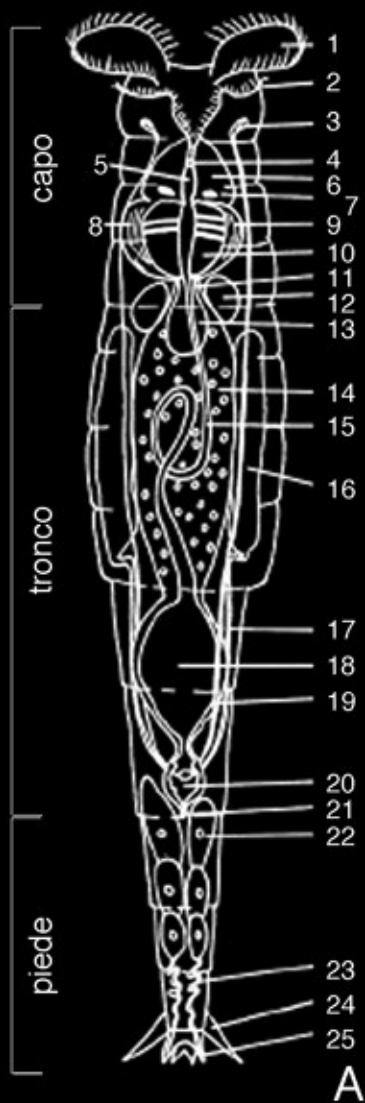
Vermi Nematodi



Montanari (2009)

Rotiferi

Mille cellule nel corpo di un rotifero
30mila miliardi di cellule nel corpo umano



Rotaria laticeps
Ricci (2008) p. c.

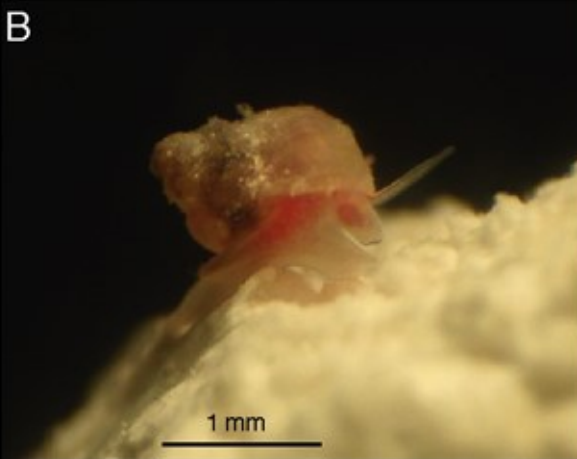
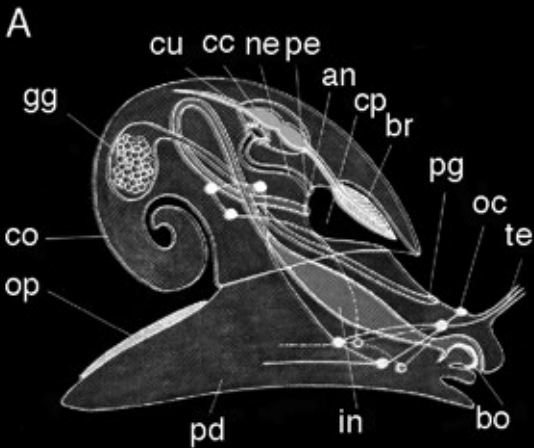
Gasteropodi

Tabella 3 - Specie di gasteropodi rinvenute a Frasassi

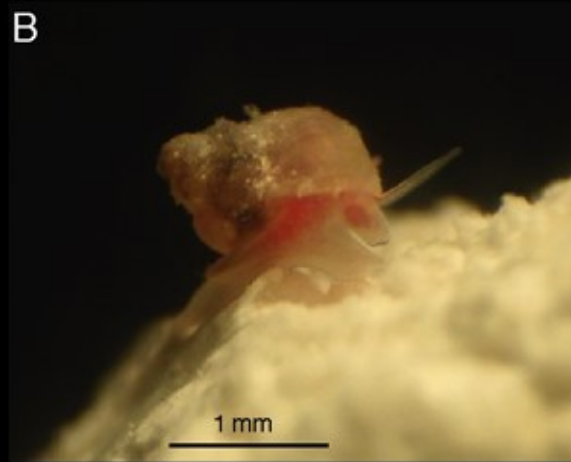
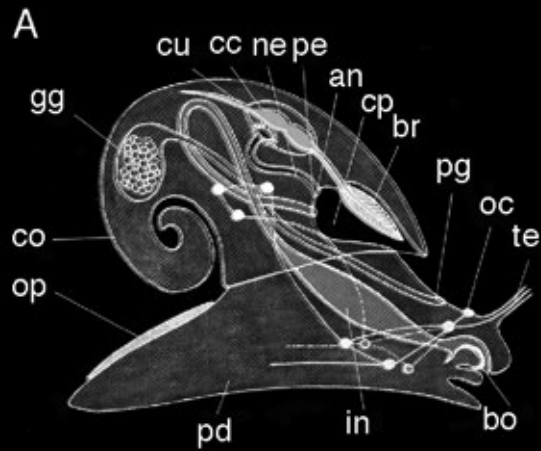
data	Sorgente Solfurea	Lago Verde	Pozzo dei Cristalli	Lago Stratificato	Lago Bianco	Lago delle Anguille	Lago Infinito	Lago Claudia
09/05/1983	<i>Bythinella cf. opaca</i> <i>Islamia sp. 2</i> <i>Haitia acuta</i> <i>Radix peregra</i>							
07/08/2005						<i>Islamia sp. 2</i>		
04/06/2006	<i>P. antipodarum</i> <i>Haitia acuta</i>	<i>P. antipodarum</i> <i>Haitia acuta</i>						
09/06/2006	<i>Islamia sp. 2</i> <i>P. antipodarum</i>				<i>Islamia sp. 2</i>		<i>Islamia sp. 2</i>	
21/12/2006	<i>P. antipodarum</i> <i>Haitia acuta</i>	<i>Islamia sp. 2</i> <i>P. antipodarum</i>						
06/04/2007	<i>P. antipodarum</i> <i>Ancylus fluviatilis</i>	<i>Islamia sp. 2</i>		<i>Islamia sp. 2</i>	<i>Islamia sp. 2</i>			
27/06/2007	<i>Bythinella cf. opaca</i> <i>P. antipodarum</i> <i>Ancylus fluviatilis</i> <i>Galba truncatula</i> <i>Haitia acuta</i> <i>Gyraulus albus</i> <i>Pisidium casertanum</i> <i>Pisidium personatum</i> <i>Pisidium subtruncatum</i>	<i>Islamia sp. 2</i>			<i>Islamia sp. 2</i>			
04/07/2008								<i>Islamia sp. 2</i>
21/10/2009			<i>Islamia sp. 2</i>					

ambiente esterno
 ambiente ipogeo
 non campionato
 esemplari vivi

Gasteropodi - *Islamia solfurea* (Bodon & Cianfanelli, 2012)



Gasteropodi - *Islamia solfurea* contro *Potamopyrgus antipodarum*



Mo' me te magno tutto



Crostacei

TASSONOMIA DEL SUBPHYLUM CRUSTACEA

CLASSE	SOTTOCLASSE	ORDINE	
Branchiopoda			
Ostracoda	Myodocopa	Myodocopida	26 famiglie con circa 65.000 specie 16 specie individuate nelle grotte di Frasassi
	Podocopa	Halocyprida	
		Platycopida	
		Podocopida	
Remipedia		Calanoida	24 famiglie con circa 2.000 specie 1 specie individuata nelle grotte di Frasassi
Maxillopoda	Thecostraca	Galielloida	52 famiglie con circa 3000 specie 1 specie individuata nelle grotte di Frasassi
	Tantulocarida	Misophrioida	
	Branchiura	Harpacticoida	
	Copepoda	Monstrilloida	18 famiglie con migliaia di specie 6 specie individuate nelle grotte di Frasassi
	Pentastomida	Mormonilloida	
	Mystacocarida	Cyclopoida	
	Platycopioida		
Cephalocarida		Poecilostomatoida	
		Syphonostomatoida	
Malacostraca	Phyllocarida	Stomatopoda	Subordine Gammaridea con 125 famiglie 1.000 generi e 5.700 specie 4 specie individuate nelle grotte di Frasassi
	Eumalacostraca	Isopoda	
		Amphipoda	
		Decapoda	
	Hoplocarida	Euphausiacea	

Ostracodi

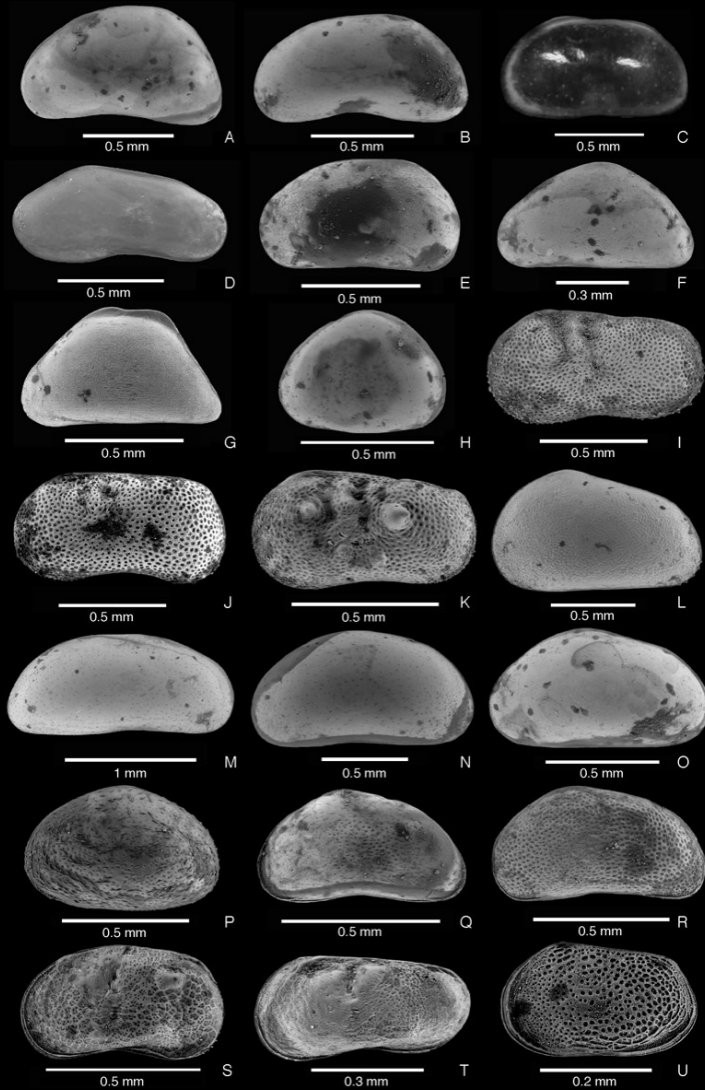


Tabella 4 – Ostracodi di Frasassi

GENERE E SPECIE	SITO CAMPIONATO										TOTALE
	FSS	FSR	LVE	LDB	LST	LTR	LDA	LBL	LIN	LCL	
<i>Vestalenula</i> cf. <i>V. boteai</i> Danielopol 1980							2				2
<i>Mixtacandona cavernicola</i> n.sp.	3		36	50/11	7	6	13	383	13	121/6	632
<i>Mixtacandona</i> sp. 2	3										3
<i>Mixtacandona</i> sp. 3	1										1
<i>Fabaeformiscandona fabaeformis</i> Fischer 1851	299/3	46/8	61		5		5	383		1	800
<i>Candona neglecta</i> Sars 1887	63	11	26		1			1			102
<i>Candona candida</i> Muller 1776	96	31	1								128
<i>Candona</i> sp.	30	2									32
<i>Cryptocandona?</i> sp.	2										2
<i>Pseudocandona</i> sp.	73/1	6	82						1	3/1	165
<i>Pseudocandona parallela</i> Muller 1776	131	39	3		2						175
<i>Pseudocandona albicans</i> Hartwig 1901	45	8	11/1								64
<i>Pseudocandona frasassiensis</i> n.sp.	7/2	1									8
<i>Herpetocypris chevreauxi</i> Sars 1896	687	21	36					4			748
<i>Heterocypris salina</i> Brady 1868	99	9	1								109
<i>Prionocypris zenkeri</i> Chyzer & Toth 1858	1541/6	131	7								1679
<i>Cypridopsis vidua</i> Muller 1776	347/4	11	8		1			1			368
<i>Cypria reptans</i> Brohnstein 1928	4	4	5								13
<i>Potamocypris zschokkei</i> Kaufmann 1900	56/2	26									82
<i>Potamocypris fulva</i> Brady 1868	28	9									37
<i>Ilyocypris gibba</i> Ramdohr 1808	60	7									67
<i>Ilyocypris monstifica</i> Norman 1862	9/3	6									15
<i>Ilyocypris bradyi</i> Sars 1890	6										6
<i>Psychrodromus olvaceus</i> Brady & Norman 1889	193	15	2								210
<i>Limnocythere inopinata</i> Baird 1850	191/10	15	2								208
<i>Pseudolimnocythere phreatamicus</i> n.sp.	9	3			2	14	448	176	505	3	1160
<i>Paralimnocythere</i> sp.	2										2
<i>Genere e specie non determinati</i>	4										4
TOTALE PER SITO	3986	401	281	50	18	20	468	949	518	128	6822

NOTE

Le specie sigobitiche o interstiziali sono indicate in grassetto

I numeri in nero si riferiscono alle valve singole

I numeri in rosso si riferiscono a esemplari trovati vivi

Al Lago delle Anguille sono state trovate solo valve singole tra i resti di anguille subfossili

SITI CAMPIONATI

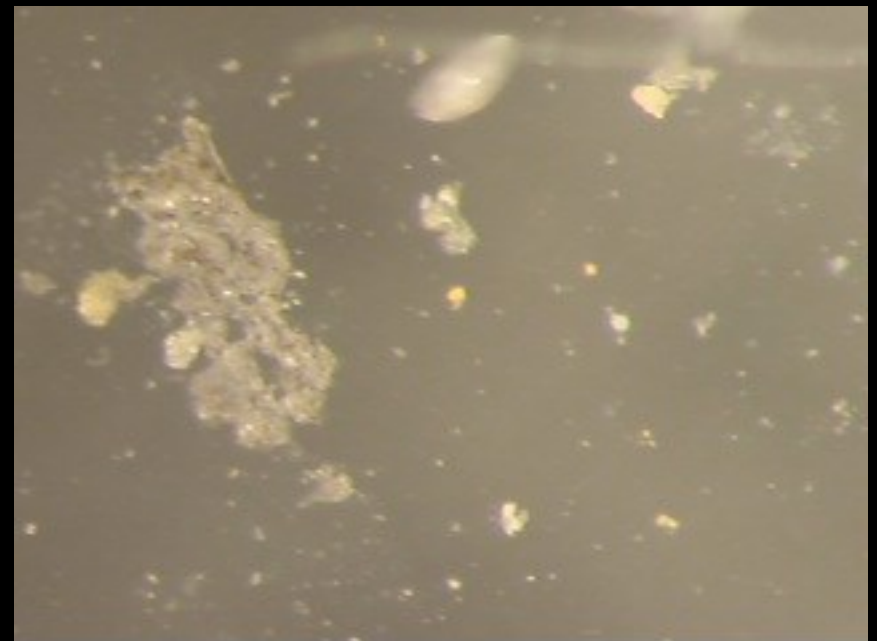
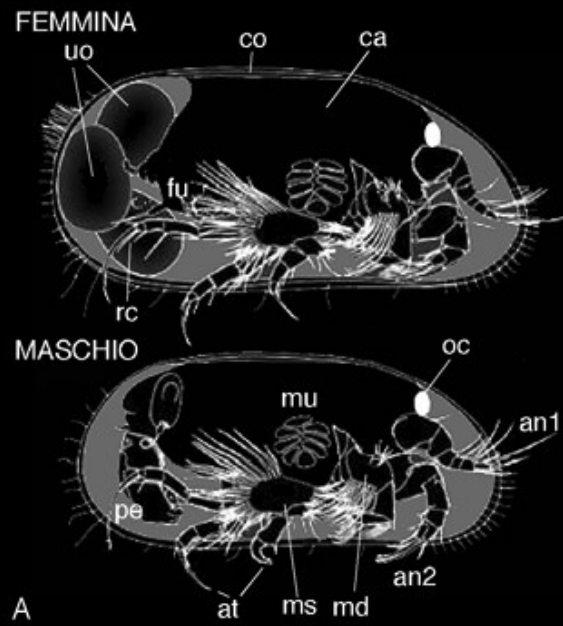
Fuori della grotta::

FSS = Frasassi Sorgente Solfurea; FSR = Frasassi Fiume Sentino

Siti ipogei, in laghi freatici progressivamente più distanti dall'ingresso naturale:

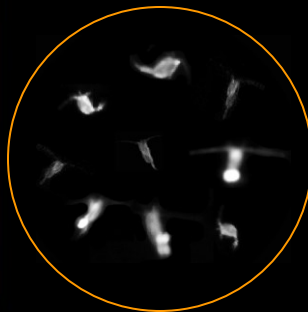
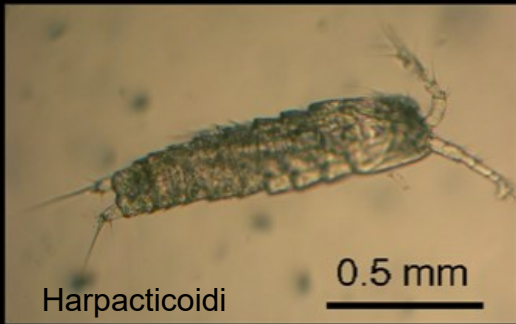
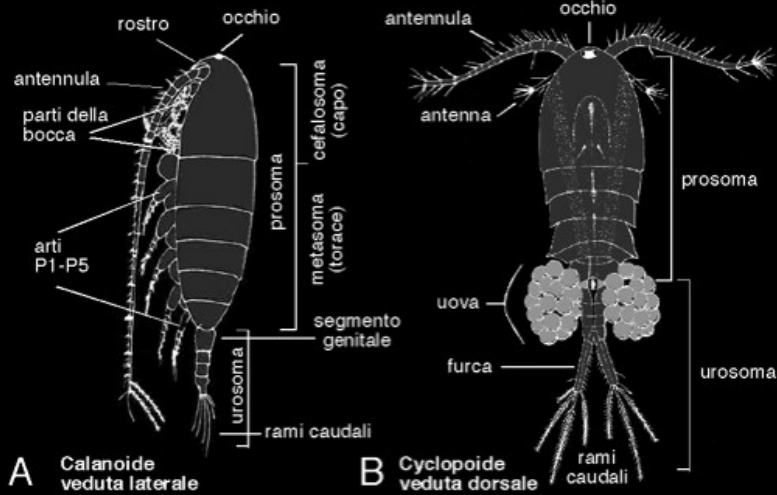
LVE = L. Verde; LDB = L. della Bottiglia; LST = L. Stratificato; LDA = L. delle Anguille; LBL = L. Bianco; LIN = L. Infinito; LCL = L. Claudia

Ostracodi

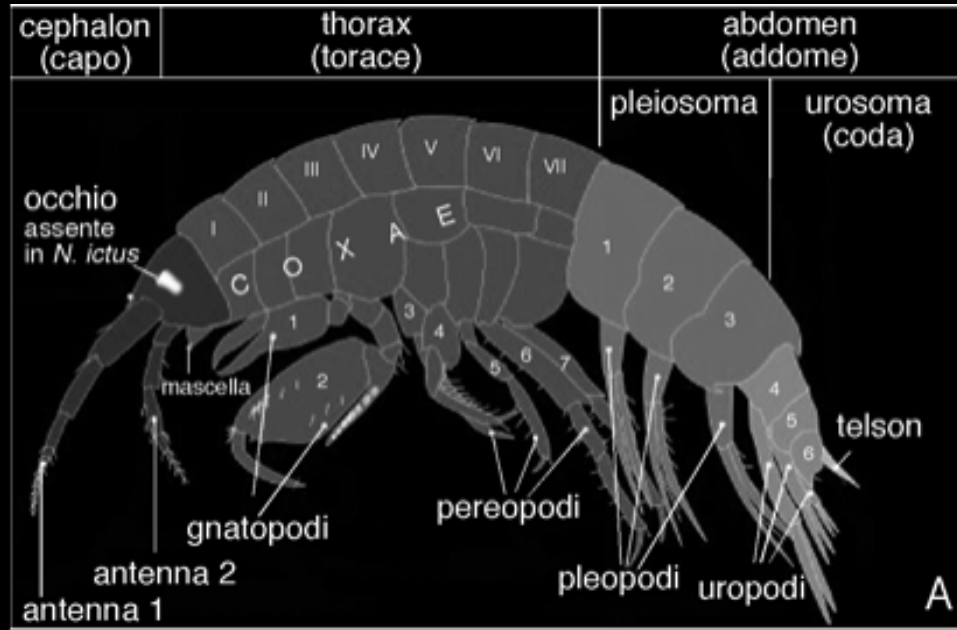


Mixtacandona petersonae n. sp.

Copepodi



Anfipodi



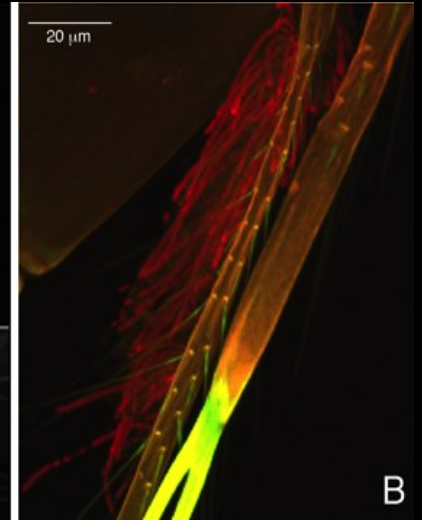
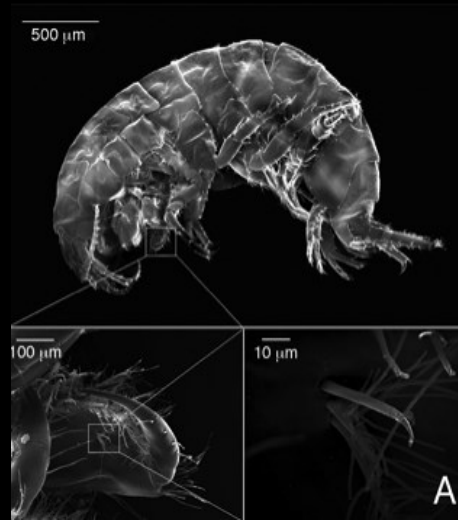
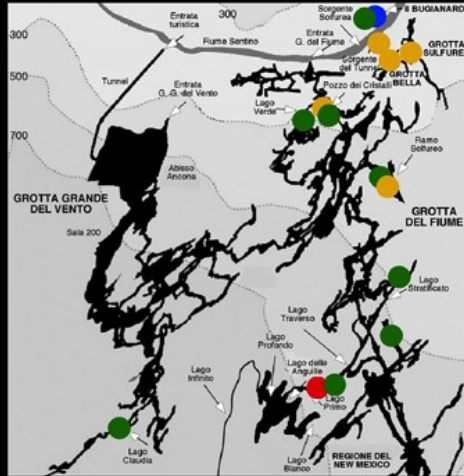
Anfipodi



Niphargus ictus ●



Niphargus frasassianus ●



Niphargus montanarius ●



Niphargus sp. 4 ●

1 cm



Niphargus ictus 200 m in 60' 10" e 58 centesimi
 Federica Pellegrini 200 m in 1' 52" e 98 centesimi

- Karaman (1985)
- Dattagupta et al. (2009)
- Karaman et al. (2010)
- Flot et al. (2010)
- Borowsky (2011)
- Karaman (2016); Stoch (2017) p. c.

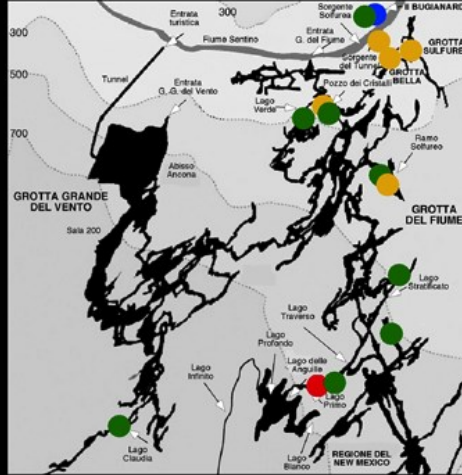
Anfipodi



Niphargus ictus ●



Niphargus frasassianus ●



Niphargus montanarius ●



Niphargus sp. 4 ●

1 cm



Niphargus frasassianus



Niphargus stalking

Dattagupta et al. (2009)

Karaman et al. (2010)

Flot et al. (2010)

Karaman (2016); Stoch (2017) p. c.

Phylum/Classe/Ordine	Specie	Referenza
OLIGOCHAETA	<i>Rhynchelmis</i> n. sp.	Sarbu et al. 2000
PLATELMINTA	<i>Dendrocoelum leporii</i> n. sp.	Stocchino et al. 2017
PLATELMINTA	<i>Stenastomum</i> n. sp.	Montanari 2010
NEMATODA	n. sp. ?	Montanari 2010
ANNELIDA	<i>Potamothrix</i> n. sp.	Montanari 2010
ROTIFERA	<i>Rotaria</i> n. sp.?	Montanari 2010
GASTROPODA	<i>Istania sulfurea</i> n. sp.	Bodon and Cianfanelli 2012
ISOPODA	<i>Androniscus dentiger</i>	Sarbu et al. 2000
GASTROPODA	<i>Potamopyrgus antipodarum</i> allochthonous	Montanari 2010
AMPHIPODA	<i>Niphargus ictus</i>	Karaman et al. 2010
AMPHIPODA	<i>Niphargus frassianus</i>	Karaman et al. 2010
AMPHIPODA	<i>Niphargus montanarius</i>	Karaman et al. 2010
AMPHIPODA	<i>Niphargus frontalis</i>	Karaman 2016; Stoch 2018
ACARINA	<i>Labidostoma cornuta</i>	Sarbu et al. 2000
PSEUDOSCORPIONES	<i>Chthonius sulphureus</i> n. sp.	Sarbu et al. 2000
ARANEAE	<i>Centromerus pasquinii</i>	Sarbu et al. 2000
ARANEAE	<i>Leptyphantis pallidus</i>	Sarbu et al. 2000
ARANEAE	<i>Leptyphantis</i> n. sp.	Sarbu et al. 2000
ARANEAE	<i>Porriomma</i> n. sp.	Sarbu et al. 2000
ARANEAE	<i>Nesticus eremita</i>	Sarbu et al. 2000
COLLEMBOLA	<i>Neelus marinus</i>	Sarbu et al. 2000
COLLEMBOLA	<i>Deuteraphorura pierolucci</i> n. sp.	Sarbu et al. 2000
COLLEMBOLA	<i>Onychiurus</i> cf. <i>banii</i>	Mariani 2003
COLEOPTERA	<i>Duvallus bensai lombardi</i>	Sarbu et al. 2000
COLEOPTERA	<i>Tychobythinus gladiator gladiator</i>	Sarbu et al. 2000
Copepoda / Calanoida	<i>Eudriopomus intermedius</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Eucyclops intermedius</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Paracyclops imminutus</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Macrocyclops albidus</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Acanthocyclops gr. venustus</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Acanthocyclops robustus robustus</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Diacyclops casanus</i>	Galassi et al. 2016
Copepoda / Cyclopoida	<i>Speocyclops</i> sp. 1	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Attheyella</i> (<i>Attheyella</i>) <i>crassa</i>	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Morarra</i> (<i>Morarra</i>) <i>poppei meridionalis</i>	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Morarra</i> (<i>Morarra</i>) <i>stankovitchi</i>	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Morarra</i> sp. 1	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Maraenobiotus</i> sp. 1	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Nitacrella stammeri</i>	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Nitacrella psammophila</i>	Galassi et al. 2016
Copepoda / Harpacticoida	<i>Byacampetus</i> (<i>Rheocampetus</i>) <i>zschakkei</i>	Galassi et al. 2016
OSTRACODA	<i>Candona neglecta</i>	Peterson et al. 2013
OSTRACODA	<i>Fabaeformiscandona</i> ex gr. <i>F. fabaeformis</i>	Peterson et al. 2013
OSTRACODA	<i>Pseudocandona albicans</i>	Peterson et al. 2013
OSTRACODA	<i>Pseudocandona</i> ex gr. <i>P. eremita</i>	Peterson et al. 2013
OSTRACODA	<i>Mixtocandona</i> sp.	Peterson et al. 2013
OSTRACODA	<i>Cyprina</i> cf. <i>C. ophthalmica</i>	Peterson et al. 2013
OSTRACODA	<i>Prionocypris zenkeri</i>	Peterson et al. 2013
OSTRACODA	<i>Herpetocypris chevreuxi</i>	Peterson et al. 2013
OSTRACODA	<i>Psychrodromus olivaceus</i>	Peterson et al. 2013
OSTRACODA	<i>Heterocypris</i> cf. <i>H. reptans</i>	Peterson et al. 2013
OSTRACODA	<i>Cypridopsis vidua</i>	Peterson et al. 2013
OSTRACODA	<i>Limnocythere inopinata</i>	Peterson et al. 2013
OSTRACODA	<i>Pseudolimnocythere</i> sp.	Peterson et al. 2013
OSTRACODA	<i>Vestalenula botzal</i>	Peterson et al. 2013
OSTRACODA	<i>Heterocypris sabina</i>	Peterson et al. 2013
PROTOZOA CILIATA	<i>Paramecium</i> sp.	Montanari 2010
PROTOZOA CILIATA	<i>Euplotes aedicutatum</i>	Montanari 2010
PROTOZOA CILIATA	<i>Vorticella</i> sp.	Montanari 2010
PROTOZOA CILIATA	<i>Stentor corebicus</i>	Montanari 2010
PROTOZOA CILIATA	<i>Urocentrum</i> sp.	Montanari 2010
PROTOZOA CILIATA	<i>Coleps hirtus</i>	Montanari 2010
PROTOZOA CILIATA	<i>Climacostomum virans</i>	Montanari 2010

habitat terrestre
habitat sulfidico
specie terrestre
specie acquatica

Il bestiario delle grotte di Frasassi

Gruppo N. specie

Protozoi	7
Vermi.....	5
Rotiferi	1
Gasteropodi.....	1
Isopodi.....	1
Acari	1
Scorpioni	1
Ragni	5
Collemboli	3
Copepodi	16
Ostracodi	16
Anfipodi	4

TOTALE	63



Speleo Sandro 1972 (troglodilo)

