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FAUNISTIC STUDY IN THE KARST COMPLEX OF FRASASSI (Genga, Italy)

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ABSTRACT

The cave fauna of the karst complex of Frasassi (Genga, Ancona, Italy), which includes a tourist attraction, was surveyed to provide detailed information on the hypogean animal populations. Indeed, for this area, only sporadic and limited studies are known in the literature to date. The bat populations, recently analyzed by Bassi and Fabbri (1986-87), were excluded from our study.

Ten collection campaigns were carried out in 12 different caves, including the tourist site, over a span of two years. Three caves were considered in all the collections and the others only on one or two occasions. The animals were captured for the most part on sight.

Faunistic analysis was supported by specialists in systematics for some animal groups. A total of 57 taxa were identified. Two endemisms were confirmed: the amphipod crustacean *Niphargus ictus* and the carabid beetle *Duvalius bensai lombardii*. Noteworthy are the histerid beetle *Gnathoncus cerberus*, to date only known in Sardinia, and a pseudoscorpion belonging to the genus *Roncus*, probably a new species, currently under study by a specialist. A karyological study on the plethodontid salamander *Speleomantes italicus* revealed the close similarity of the Frasassi population with others of the Italian peninsula.

Overall, the animal community appears relatively homogeneous, indicative of a very stable cave community throughout the entire karst complex of Frasassi. Only the show cave has an almost complete lack of animals, due to low organic supply. This homogeneity can be explained by the close geographical location and common origin of the caves. Moreover, the caves develop predominantly horizontally, located at 200 to 490 m asl. Our data are in agreement with the few available reports on other caves in central Italy.

According to our study, the low level of adaptation to cave dwelling was indicated by the 50% troglophile species, whereas only two species were troglobite. The large number of the first and the low number of the second types are related to the geological age of the complex, and they are the consequence of a relatively recent faunistic colonization.

RIASSUNTO [*Studio faunistico del complesso carsico di Frasassi (Genga, Ancona, Italia)*]

La fauna cavernicola del complesso carsico di Frasassi che include una parte attrezzata a grotta turistica è stata studiata per avere delle informazioni dettagliate sulla popolazione animale ipogea. Infatti, fino ad ora, erano noti in quest'area soltanto delle ricerche sporadiche e parziali. I chirotteri, che sono stati oggetto di uno studio recente di Bassi and Fabbri (1986-87), non sono stati presi in considerazione in questo lavoro.

Nel corso di due anni sono state svolte dieci campagne di raccolta in 12 grotte diverse, compresa la parte turistica. Tre grotte sono state visitate in tutte le campagne mentre le altre sono state visitate soltanto in una o due occasioni. La maggior parte degli animali è stata raccolta a vista.

L'analisi faunistica è stata effettuata con l'aiuto di specialisti nella sistematica di vari gruppi animali e sono stati identificati complessivamente 57. Sono stati confermati due

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specie endemiche: il crostaceo anfipode *Niphargus ictus* ed il carbide *Duvalius bensai lombardii*. Sono risultati particolarmente interessanti un isteride, il *Gnathoncus cerberus*, fino ad ora noto soltanto in Sardegna, ed un pseudoscorpione appartenente al genere *Roncus*, probabilmente una nuova specie attualmente allo studio di uno specialista. Uno studio cariologico della salamandra pletodontide *Speleomantes italicus* ha mostrato la grande somiglianza della popolazione di Frasassi con le altre della penisola italiana.
La comunità animale appare soprattutto omogenea e ciò è indicativo di una comunità cavernicola molto stabile nell'intero complesso carsico di Frasassi. Soltanto nella parte turistica vi è una quasi totale assenza di animale a causa della scarsa disponibilità di materiale organico. Questa omogeneità può essere spiegata dalla notevole vicinanza geografica delle grotte e dalla loro origine comune. Inoltre le grotte in questione si sviluppano perlopiù in orizzontale ad una quota compresa tra i 200 to 490 m s.l.m. I nostri risultati concordano con i pochi altri disponibili sulle grotte dell'Italiua Centrale. Secondo il nostro studio, lo scarso livello di adattamento all'ambiente cavernicolo è mostrato dalla presenza di specie troglofile nel 50% dei casi, mentre quelle troglobie sono soltanto due. Il grande numero delle prime e la scarsità delle seconde sono da attribuirsi all'età geologica del complesso e sono la conseguenza di una colonizzazione faunistica relativamente recente

INTRODUCTION

The "Consorzio Frasassi" commissioned an in-depth, prospective scientific investigation on the cave fauna of the hypogean complex of Frasassi (Genga, Ancona, Italy). We appreciated the initiative and were glad to accept this project; indeed environmental impact studies such as these should one day become a normal practice in all show caves. Currently available data on the biological aspects of the hypogean complex of Frasassi are limited to reports on individual animal groups (Straneo, 1939; Lanzá, 1954; Magistretti, 1956, 1965; Baccetti and Capra, 1959; Roewer, 1962; Dresco, 1963; Ruffo and Vigna Taglianti, 1968; Vigna Taglianti, 1970; Brignoli, 1972, 1977, 1985; Bordoni, 1974; Cola and Freude, 1974; Teobaldelli, 1982; Karaman, 1985; Bassi and Fabbri, 1986-87). However, a comprehensive survey of the permanent and transient animal communities inhabiting this zone is still lacking, and our study directly addresses that gap in our knowledge. Moreover, we took this as an opportunity to collect data on the plethodontid salamander *Speleomantes* [1] of Central Italy, using karyological and electrophoretic techniques on the population from Frasassi. In fact, plethodontid amphibians have a peculiar species and population distribution bearing remarkable biogeographic interest.

The material for electrophoretic study was supplied by Professor Benedetto Lanza of the University of Florence; the other studies were carried out by one of us and Professor Irma Nardi of the University of Pisa, already experienced in some aspects of these problems (Nardi *et al.*, 1986).

[1] Dubois (1984) and Lanza (personal communication) assert that the name *Speleomantes* must be used instead of *Hydromantes* for the European plethodontids.

MATERIALS AND METHODS

The karst complex of the Grotta Grande del Vento and Grotta del Fiume is developed almost entirely in limestone ("calcare massiccio") attributed to the Lias or Giura. Only the eastern tip of the Grotta del Fiume reaches the Cretaceous limestone ("calcare maiolica").

The system tectonics includes the anticline of Mount Valmontagnana and is crossed by important fractures running NNW-SSE (Cristiani *et al.*, 1976). The karst system is developed on these fractures; its was formed by three types of waters: neutral, percolated water of high origin; weakly acidic sulfurous water of deep origin, and water from the Sentino River which penetrates laterally through fissures in the limestone rock (Dragoni and Verdacchi, 1993).

The Sentino River cuts deeply into the anticline, forming the Gola of Frasassi and establishes the water table which is fed by percolation down of water from above and the rising up sulfurous waters from below. The development and deepening of the karst system follows the altimetric variations of the river, well recognized by erosion of the gorge.

The three characteristic phases of speleogenesis can be identified in the karst complex: an erosive phase is still evident in the lower zone; a phase of collapse, typically represented in the Abisso Ancona; an encrustation phase, extending throughout the cave and still active.

Dating of the cave was performed with the ^{230}Th techniques and indicates that the first concretions date back 190,000 years and continue up to current times (Taddeucci *et al.*, 1987).

The wall temperature of show cave measured by the monitoring system remains constant at 14°C, with a slight increase on the order of 0.4°C over the period of heaviest visitor presence, namely, July, August, and early-mid September. The concentration of carbon dioxide also increased, from 600 up to 970 ppm (Bertolani & Cigna, this issue).

Five sampling campaigns were carried out in the karst complex of Frasassi over 1988 and another 5 in 1989. The first series considered the following caves (Fig. 1): natural entrance of the Grotta Grande del Vento (450 m), Grotta Bella (210 m), Grotta del Fiume (205 m), Grotta di Frasassi (340 m; also called Grotta del Santuario della Beata Vergine) The last three were surveyed during both field trips. Samples were also taken in the show cave. In the second year, a periodic check of the zoocenoses of the three caves sampled the preceding year was performed in order to obtain a true picture of the populations of the karst complex. The investigation was extended to other caves: Grotta dell'Orso Bruno (425 m), Caverna dei Baffoni (255 m), Grotta del Mezzogiorno (490 m), Caverna dell'Inferno (480 m), Grotta del Paradiso (420 m), Caverna della Fatticchiana (430 m) and Grotta dell'Infinito (480 m).

Bats were not included in the investigation because recently studied by Bassi and Fabbri (1986-87).

The animals were captured on sight utilizing aspirators or tweezers. A limited number of free-falling traps baited with pieces of bone were set up in the tourist cave, Grotta Bella, Grotta del Fiume and Grotta di Frasassi. The

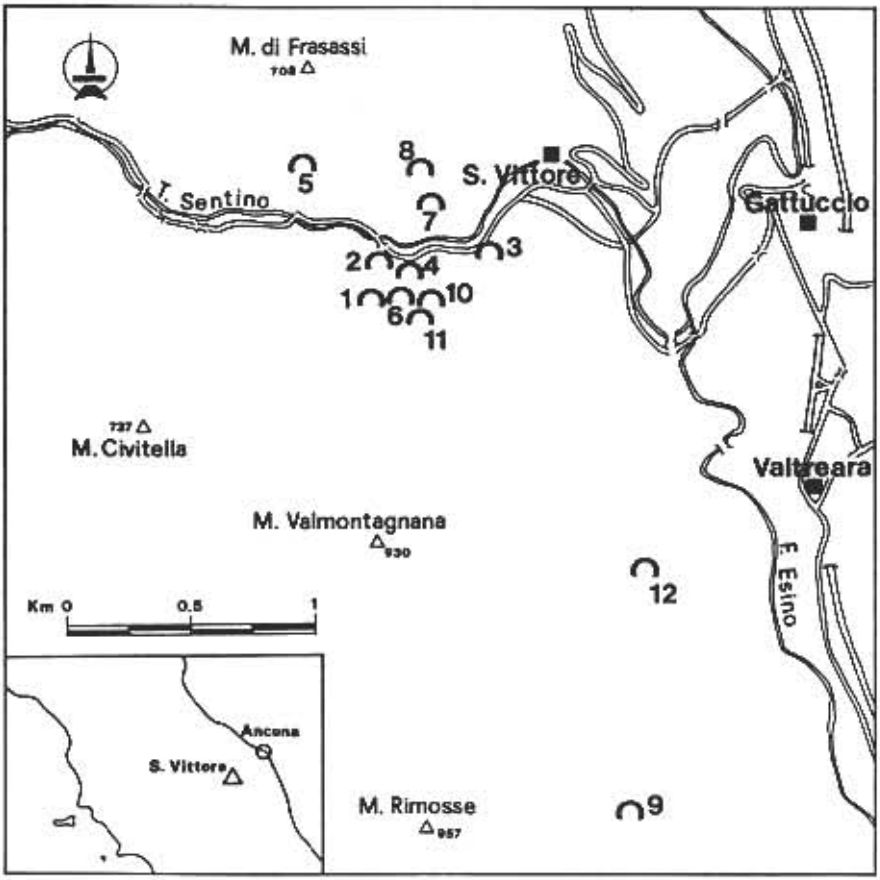

Fig. 1 - Map of the cave sites considered in the biospeleological study. 1: Natural entrance of the Grotta Grande del Vento; 2: show cave; 3: Grotta Bella; 4: Grotta del Fiume; 5: Grotta di Frasassi; 6: Grotta dell'Orso Bruno; 7: Caverna dei Baffoni; 8: Grotta del Mezzogiorno; 9: Caverna dell'Inferno; 10: Grotta del Paradiso; 11: Caverna della Fatticchiana; 12: Grotta dell'Infinito.

guano-feeding mesofauna was studied in the laboratory after extraction with a Tullgren selector. The cave fresh-water animals were captured using a fine mesh net.

The collected material was supplemented with specimens kindly provided by Professor A. Antonucci, Chieti.

Some species were referred to specialists in the specific groups for systematic analysis. We wish to thank the following scientists for their collaboration: Professors Giusti (Siena) for the molluscs; Caruso (Catania) for the isopods; Ruffo (Verona) and Karaman (Titograd, Yugoslavia) for the amphipods; Minelli (Padova) for the centipedes and millipedes; Gardini (Genoa) for the pseudoscorpions; Sabatini (Modena) for the Collembola; Sbordoni (Rome) and La Greca (Catania) for the Orthoptera, Casale (Turin) for the carabid beetles; Vienna (Venice) for the clown beetles (Histeridae); Bordoni (Florence) for the rove beetles (Staphilinidae); Lanza (Florence) for the amphibians.

Karyotype analysis was performed on 6 males and 4 females of *Speleomantes italicus* from Frasassi. Mitotic and meiotic chromosomes were obtained by squashing pieces of gut and testicle. These pieces came from animals previously injected with colchicine solution (3 mg/ml, two times). For the squash technique see Kezer and Sessions (1979). C-banding method was performed according to Gall and Pardue (1971).

RESULTS

a) Faunistic results

Faunistic analysis identify 57 taxa, listed below:

MOLLUSCA

Gastropoda, Pulmonata

Oxychilus draparnaudi (Beck, 1837)

Grotta di Frasassi, Grotta del Fiume.

Species common in central-western Europe. Hygrophilous element which can be considered eutroglophile.

ARTHROPODA

Arachnida, Scorpionida

Euscorpius carpathicus (Linneo, 1767)

Grotta Bella, Grotta del Fiume.

To date reported in southern Europe, northern Africa and Russia. Trogloxene.

Euscorpius italicus (Herbst)

Natural mouth of the Grotta Grande del Vento.

To date, this species has only been found in Italy, Switzerland, Yugoslavia, and Turkey. Trogloxene.

Arachnida, Pseudoscorpionida
Chthonius (s. str.) *ischnocheles* (Hermann, 1804)
Grotta Bella.
Species known in central-southern and western Europe, Anatolia, Madeira, Canary Islands, St. Helen Island and United States. Trogloxene.
Roncus sp. (Fig. 2)
Grotta di Frasassi.
Probably a new species, without special adaptations to cave life, and thus considered trogloxene.

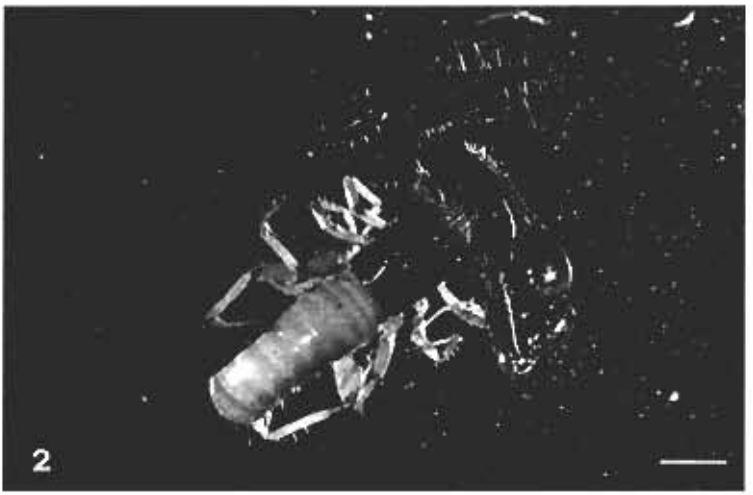

Fig. 2 - *Roncus sp.* (Pseudoscorpionida). This taxon probably represents a new species (bar = 1 mm).

Arachnida, Araneae
Meta menardi (Lotheille, 1804)
Natural entrance of the Grotta Grande del Vento, Grotta dell'Orso Bruno.
This species is distributed throughout Europe. In Italy, it is common in the caves of the central-northern regions, becoming rarer in the south and unknown in the Italian Islands. Eutroglophile.
Meta merianae (Scapoli, 1763)
Grotta del Fiume.
Species with wide paleartic distribution also frequent in caves throughout Italy. It becomes less common in the warmer Eastern and Western Mediterranean areas. Subtroglophile.

Nesticus eremita (Simon, 1879)
Natural entrance of Grotta Grande del Vento, Grotta Bella, Grotta del Fiume, Grotta di Frasassi, tourist cave (room G. da Fabriano), Grotta del Mezzogiorno, Caverna dell'Inferno, Grotta dell'Infinito, Grotta del Paradiso.
Species distribution in the Northern-Mediterranean area; found throughout the Italian territory. Common in natural and also artificial caves. Eutroglophile.
Tegenaria parietina (Fourcroy, 1785)
Natural entrance of the Grotta Grande del Vento.
The species has been identified throughout Europe and northern Africa. Subtroglophile.
Tegenaria sp.
Natural entrance of the Grotta Grande del Vento, Grotta del Fiume.
Tetragnatha obtusa C.L. Koch, 1837
Grotta del Fiume.
Species with paleartic distribution. Trogloxene.
Amaurobius sp.
Natural entrance of the Grotta Grande del Vento, Grotta del Fiume.

Acarina
Grotta di Frasassi.
Undetermined species

Crustacea, Isopoda
Androniscus dentiger Verhoeff
Natural entrance of the Grotta Grande del Vento, Grotta Bella, Grotta del Fiume, Grotta di Frasassi, tourist cave (room G. da Fabriano), Grotta dell'Infinito, Grotta del Paradiso, Grotta del Mezzogiorno, Caverna dell'Inferno.
Reported throughout Europe (except Corsica and Sardinia) and in northern Africa. Eutroglophile.
Chaetophiloscia cellaria (Dollfus, 1884)
Grotta Bella.
Reported in Italy, Istria, southern France, Corsica and Catalogne. Considered eutroglophile.
Porcellio dilatatus Brandt
Grotta di Frasassi.
Species originating in the northern Mediterranean basin. Following accidental importation, also reported in North and South America. Trogloxene.
Porcellio sp.
Grotta del Fiume.

Crustacea, Amphipoda
Niphargus ictus Karaman, 1985 (Fig. 3)
Grotta del Fiume (also in sulfurous water).
Species endemic to the Grotta Grande del Fiume. It is a form of phreatic habitat showing marked adaptation to subterranean life.

Fig. 3 - *Niphargus ictus* (Amphipoda). A species endemic to Frasassi and particularly adapted to hypogean life (bar = 1 mm).

Diplopoda

Polydesmus (Brachydesmus) sp.
Grotta Bella, Grotta Grande del Fiume, Grotta di Frasassi, Grotta dell'Infinito.

Chilopoda

Cryptops umbricus Verhoeff, 1931
Grotta di Frasassi.
Species diffuse in peninsular Italy , extending down to the Campania region. Trogloxene element.
Cryptops sp.
Grotta di Frasassi.
Henia (Chaetechelyne) vesuviana (Newport, 1845)
Grotta Bella.
Widespread throughout southern Europe and in the western Mediterranean region. Also introduced in North America. Trogloxene element.
Lithobius microps Meinert, 1868
Grotta Bella, Grotta del Fiume.
Species distribution including southern Europe. Considered trogloxene.

Insecta, Collembola
Onychiurus sp.
Tourist cave (hall G. da Fabriano).
Isotoma notabilis Schaeffer, 1896
Grotta di Frasassi.
Edaphic species with cosmopolitan distribution. Considered trogloxene.
Isotomiella minor (Schaeffer, 1896)
Grotta di Frasassi.
Like the previous species, it is edaphic, with worldwide distribution. No special adaptation to cave life (trogloxene).
Proisotoma sp.
Grotta di Frasassi.
Mesachorutes sp.
Grotta di Frasassi.
Tomocerus sp.
Grotta Bella.
Megalothorax minimus Willem, 1900
Grotta Bella.
Cosmopolitan distribution. Considered trogloxene.

Insecta, Thysanura
Machilis sp.
Grotta del Fiume, Grotta del Paradiso.

Insecta, Ortrhoptera
Dolichopoda laetitiae Menozzi, 1920
Natural mouth of the Grotta Grande del Vento, Grotta Bella, Grotta del Fiume, Grotta di Frasassi, Grotta del Mezzogiorno, Caverna dell'Inferno, Grotta dell'Infinito, Grotta del Paradiso, Caverna dei Baffoni.
Species with a limited area of distribution along the Apennine Ridge from Emilia to Lazio. Eutroglophile.
Grillomorpha dalmatina (Ocskay, 1932)
Grotta del Mezzogiorno.
Species widespread throughout southern Europe and northern Africa, namely circummediterranean distribution. Subtroglophile.

Insecta, Trychoptera
Micropterna fissa (McLachlan, 1875)
Grotta dell'Infinito.
Species distribution includes the entire Mediterranean area, as far north as the Alps. Considered a subtroglophile.

Insecta, Lepidoptera
Orneodes sp.
Grotta di Frasassi, Grotta dell'Infinito.
Triphosa dubitata (Linneo, 1758)
Grotta del Fiume, Grotta di Frasassi, Grotta dell'Infinito.
Species distribution throughout Eurasia, and all of Italy, even at high altitude

(2200 m). Subtroglophile.
Triphosa sabaudiata (Duponchel, 1840)
Grotta del Fiume, Caverna della Fatticchiana, Grotta dell'Infinito.
Like above, this species has Eurasian distribution. In Italy, it has been reported in the central-northern regions even above 2000 m altitude. Subtroglophile.
Apopestes spectrum (Esper, 1787)
Grotta del Fiume, Grotta di Frasassi, Grotta del Paradiso, Caverna della Fatticchiana.
Species with Mediterranean-Asiatic distribution. Present throughout Italy, but with a localized and less dense distribution in the northern regions. Subtroglophile.
Scoliopteryx libatrix (Linneo, 1758)
Grotta del Fiume, Grotta Bella, Grotta di Frasassi, Grotta dell'Infinito.
Species with Eurasian distribution. Known throughout Italy, even above 2000 m altitude. Subtroglophile.

Insecta, Thysanura
Limonia nubeculosa (Meigen, 1804)
Natural entrance of the Grotta Grande del Vento, Grotta Bella, Grotta del Fiume, Grotta di Frasassi, Grotta dell'Orso Bruno, Caverna dell'Inferno, Caverna della Fatticchiana, Grotta del Paradiso, Grotta dell'Infinito.
The species has been reported throughout Europe and Asia Minor. Subtroglophile.
Rhymosia fenestralis Meigen
Natural entrance of the Grotta Grande del Vento, Grotta del Fiume, Grotta Bella, Grotta del Paradiso, Caverna della Fatticchiana, Caverna dell'Inferno.
Area of distribution throughout Europe (especially, the central European regions), including Italy. Subtroglophile.
Exechia sp.
Grotta del Mezzogiorno.
Mycomya sp.
Grotta del Fiume.
Sciara sp.
Tourist cave (room G. da Fabriano).
Zygoneura sciarina Meigen
Grotta di Frasassi.
Common species throughout Europe, considered trogloxene.
Sycorax sp.
Grotta del Fiume.
Phora sp.
Grotta del Fiume, tourist cave, Caverna dell'Inferno, Grotta del Paradiso.
Helomyza serrata L.
Grotta del Fiume, Grotta di Frasassi, Grotta dell'Orso Bruno.
Saprophile and coprophile species found throughout Europe and North America. Eutroglophile.

Insecta, Coleoptera, Carabidae
Laemostenus latialis Leoni, 1907
Grotta di Frasassi, Grotta dell'Infinito.
Species with very limited area of distribution, found only in the central-northern regions of Italy. Eutroglophile.
Duvalius bensai lombardii Straneo, 1939 (Fig. 4)
Grotta di Frasassi, Grotta del Fiume.
The genus *Duvalius* is characterized by species with very limited distribution. The group *"bensai"* is limited to the central Apennine; specifically, the subspecies *Duvalius bensai lombardii* has only been found in the caves of the karst complex of Frasassi. Troglobite, even if this is one of the species of the genus *Duvalius* still having eyes.

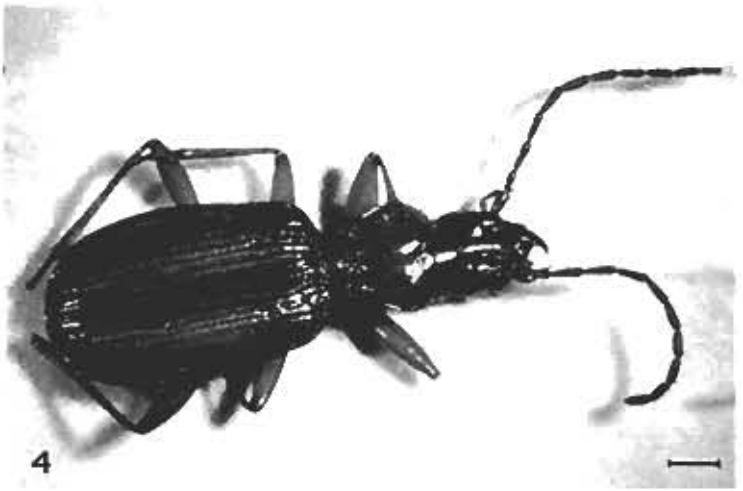

Fig. 4 - *Duvalius bensai lombardii* (Coleoptera, Carabidae), a subspecies endemic to Frasassi. The eyes are still present, as found in only some taxa of the genus *Duvalius* (bar = 1 mm).

Insecta, Coleoptera, Carabidae
Gnathoncus nannetensis (Mars)
Grotta Bella.
Guanobic species widespread throughout Europe and northern Asia (especially Siberia). Trogloxene.
Gnathoncus cerberus Auzat, 1923
Grotta di Frasassi.
Guanobic species to date only reported in a cave in Sardinia (Grotta dell'Inferno, Sassari). Trogloxene.

Insecta, Coleoptera, Staphilinidae
Quedius (Microsaurus) mesomelinus
(Marsham, 1802)
Natural entrance of the Grotta Grande del Vento, Grotta di Frasassi, Grotta dell'Infinito.
This species can be considered cosmopolitan, being reported in the paleartic region, Greenland, North and South America, Australia and New Zealand. Found throughout Italy. Trogloxene.

Insecta, Hymenoptera
Amblyteles quadripunctorius (O.F. Muller, 1776)
Grotta dell'Orso Bruno.
Species diffuse in Europe and western Africa. Trogloxene.

VERTEBRATA

Amphibia, Urodela
Speleomantes italicu (Dunn, 1923) (Fig. 5)
Natural entrance of the Grotta Grande del Vento, Grotta Bella, Grotta del Fiume, Grotta dell'Orso Bruno, Caverna dell'Inferno, Caverna della Fatticchiana, Grotta dell'Infinito.

Fig. 5 - *Speleomantes italicus* (Urodela, Plethodontidae). An element often present at the entrance to the caves at Frasassi (bar = 1 cm).

This species is distributed along the Apennine Ridge, extending north up to the border between the provinces of Parma and Reggio Emilia and south to the Abruzzese Apennines. Eutroglophile.

Amphibia, Anura
Rana dalmatina Bonaparte
Grotta del Fiume.
Species found throughout Europe (except the northernmost regions and in Asia Minor. Trogloxene.

Reptilia, Sauri
Podarcis sp.
Grotta del Fiume.
This lizard is only occasionally found in caves and thus represents a trogloxene element.

b) Karyological results on *Speleomantes*

Karyological analysis performed on *Speleomantes* from Frasassi revealed 28 chromosomes, grouped into 14 pairs, in both males and females. Except for pair XIV, all chromosomes pairs were metacentric or submetacentric. Pair XIV is the smallest; in the female, the two chromosomes are of the same size and subtelocentric. On the contrary, in the male one is subtelocentric and the other submetacentric.

Fig. 6 - *Speleomantes italicus*. Mitotic metaphase stained with the C-banding technique. Note the strongly stained heterochromatic bands. The arrows indicate sex chromosomes (bar = 10 μm).

The C-bands are located at the level of the centromere and in the pericentric region. However, the pericentric C-bands stain more weakly than the centromeric ones in the majority of chromosomes. Moreover, the individual chromosomes of pair XIV have a peculiar C-banding pattern (Fig. 6). The X chromosome has a large C-band at the level of the centromere that can be split into two components: one is a heavier C-band on the long arm, close to the centromere, and the other is a much smaller band, corresponding to the centromere. Instead, the Y chromosome presents two distinct C-bands: one on the short arm and a smaller one at the centromere.

DISCUSSION

Examination of the cave dwelling population in Frasassi lead to the identification of a large number of taxa. The most significant species found in this survey are the amphipod crustacean *N. ictus*, the carabid beetle, *D. bensai lombardii*, the Histeridae beetle, *G. cerberus* and the pseudoscorpion of the genus *Roncus*. The first two species, *N. ictus* and *D. bensai lombardii*, provide further evidence for two significant endemisms; the third species, *G. cerberus* has only been reported in a single occasion and indeed, to date is only known in Sardinia (Grotta dell'Inferno, Sassari) (Auzat, 1923). These specimens were collected from guano deposits.

According to Prof. Gardini, the pseudoscorpion is definitely a new species, which can only be described following a thorough revision of the entire *Roncus* genus.

Repeated observations in various periods of the year, aimed at quantitatively evaluating the more abundant species, *A. dentiger*, *D. laetitiae* and *S. italicus*, led to the conclusion that the first two species do not show variations, whereas the plethodontid salamander presents remarkable differences in the specimens number, that, however, do not seem related to seasonal cycles in our case.

We can state that the animal communities found in the studied caves during the second year sampling campaigns are not qualitatively or quantitatively different from those collected in the caves of the first year field trips. This further supports the high stability of the endogenous animal population throughout the karst complex of Frasassi. The situation can be explained by the close proximity and common origin of the studied caves, and also by their predominantly horizontal extension and similar altitudes. On the other hand, the available literature data on cave fauna from central Italy extends this homogeneity to the entire zone. If we consider the list of species found by Bani (1984) in the "Grotta dei Cinque Laghi" (Pesaro), 16 out of the 26 described taxa were also found by us in the karst complex of Frasassi.

The small number of animals in the tourist cave is probably related to the large distance from any natural entrance and to the modest amount of organic material it receives from the outside world. A survey of the biospeleologic features of this cave performed by one of the authors the year

the show cave was discovered (1971) had already pointed out the almost complete lack of fauna. Thus, the paucity of animals does not stem from the impact of cave tourism.

Adaptation to cave life in our study can be defined as troglophile in 50% of the collected species and troglobite (including the species inhabiting the phreatic zone) in only two animal species. The large number of troglophiles and the small number of troglobites may be related to the geological age of the studied caves (Taddeucci et al., 1987, and this issue) and can in any case be attributed to a relatively recent faunistic colonization, so as to halt the long process of adaptation that lie at the bases of troglobitic selection.

The study of plethodontid salamanders revealed that the karyotype of *S. italicus* found at Frasassi is not substantially different from that of other continental populations. A quite congruous karyological picture has been found in the species from eastern Sardinia. The karyotypes of the European and American species are also remarkably similar (Nardi et. al, 1986). The only difference occurs at chromosome pair XIV. Indeed, the karyotypes of the American species do not have heterochromosomes. Additional data are provided by the study of repetitive DNA sequences within the genome, initially described by Nardi et al. (1986). A joint research project with the University of Pisa lead to several studies which have been published or are currently in press (Batistoni *et al.*, 1989; Nardi, in press; Batistoni *et al.*, in preparation).

The genome of *Speleomantes supramontis* (Lanza *et al.*, 1986) from Sardinia evaluated in the study was found to consist of two families of highly repetitive DNA, labeled Hy500 and Hy5, differing from each other in terms of genomic organization and distribution of the single chromosomes. The Hy500 family is a typical highly repetitive satellite DNA, located at the level of centromeric heterochromatin of all chromosomes, including the sex chromosomes. Satellite DNA was also found in the Frasassi population and in all the examined European species, both from Sardinia and the continent. This situation implies that Hy500 probably already existed in a common ancestor and was amplified before the single species differentiated from each other, suggesting a relatively recent speciation. Instead, the Hy5 family consists of very long units. Unlike in the Hy500 family, it is dispersed throughout the genome, and *in situ* hybridization experiments have shown that the sequences are distributed throughout the chromosome set without a precise localization in a given chromosome. An important aspect is that this DNA group is found in much smaller amounts in *S. italicus* of Frasassi and also in *Speleomantes genei* (Temminck and Schlegel, 1838), than in the species from eastern Sardinia, where it is highly conserved.

Our data point out the high uniformity of the continental populations, in accordance with the karyological, morphological, biogeograhic, ethological and biochemical data of other authors (Nardi et. al, 1986; Lanza et al., 1986) and confirm that the continental populations are closer to the species from eastern then from western Sardinia.

In conclusion, this faunistic study has provided an embracing picture of the cave-dwelling animal populations of the Frasassi area and has added

valuable knowledge to aid the correct management of this natural resource.

REFERENCES

Auzat V., 1923 - *Description d'un nouveau Gnathoncus de Sardaigne (Coleopt. Hist.).* Boll. Soc. entomol. ital., 55: 145-147.

Baccetti B., Capra F., 1959 - *Notulae Orthopterologicae. XII. Revisione delle specie italiane del genere Dolichopoda. Bol. (Orthopt. Rhaphidophoridae).* Redia, 44: 165-217.

Bani M., 1984 - *La grotta dei cinque Laghi.* Sez. Speleol. Città di Castello, Urbania: 1- 214.

Bassi S., Fabbri I., 1986/87 - *Note preliminari sui Chirotteri della grotta della B.V. di Frasassi.* In: *Ipogea.* Gruppo Speleol. Faentino, Faenza: 16-19.

Batistoni R., Nardone M., Demartis A., Rebecchi L., Nardi I., 1989 - *Repetitive DNA sequence in the plethodontid salamander Hydromantes (Amphibia Urodela).* Atti Ass. Genet. Ital., 35: 35-36.

Batistoni R., Nardi I., Rebecchi L., Nardone M., Demartis A. - *Centromeric satellite DNA in the European plethodontid salamander Speleomantes (Amphibia, Urodela).* In preparation.

Bertolani M., Cigna A.A., 1990 - *Activity of the scientific commission of "Grotta Grande del Vento" (Genga, Ancona, Central Italy).* This issue.

Bordoni A., 1974 - *Studi sulla sistematica e la geonemia del genere Quedius Steph. - III. Le specie italiane appartenenti al sottogenere Microsaurus (Steph.) sensu Gridelli, 1924 (Coleoptera, Staphilinidae).* Redia, 55: 1-82.

Brignoli P.M., 1972 - *Catalogo dei Ragni Cavernicoli Italiani.* Quad. Speleol. Circ. Speleol. Rom., 1: 5-212.

Brignoli P.M., 1977 - *Ragni d'Italia XXVII. Nuovi dati su Agelenidae, Argyronidae, Hahanidae, Oxyopidae e Pisauridae cavernicoli ed epigei.* Quad. Mus. Speleol. "V. Rivera", 4, :3-117.

Brignoli P.M., 1985 - *Aggiunte e correzioni al Catologo dei Ragni Cavernicoli Italiani.* Mem. Mus. Civ. St. Nat. Verona, Ser. II, Sez. biologica, 4: 51-64.

Cola L., Freude H., 1974 - *Prima nota sulla fauna delle grotte nella zona di Genga (Ancona).* Boll. Soc. Entomol. Ital., 106: 37-39.

Cristiani R., Gambelli G., Moscardi F., 1976 - *Grotta Grande del Vento. Costruzione seconda galleria.* Relaz. Geol. per il Com. di Genga (Ancona).

Dragoni W., Verdacchi A., 1993 - *First results of the monitoring System of the karstic complex of "Grotte di Frasassi-Grotta Grande del Vento" (Central Apennines, Italy).* Proc. Int. Symp. on Hydrog. Proc. in Karst Terr., Antalya (Turkey) Oct. 1990, IAHS Publ. N° 207: 107-117.

Dresco E., 1963 - *Araignées cavernicoles d'Italie (1re note).* Ann. Spéléol., 18: 13-30.

Dubois A., 1984 - *Miscellanea nomenclatorica batracologica (IV).* Alytes, 3 (3): 103-110.

Gall J.C., Pardue M.L., 1971 - *Nucleic acid hybridization in cytological preparations.* Methods Enzymol., XXID: 470-480.

Karaman G.S., 1985 - *New Data of the Genus Niphargus Schiodte (Fam. Niphargidae) in Italy and Adjacent Regions (Contributions to the Knowledge of Amphipoda 138).* Boll. Mus. civ. St. nat. Verona, 12: 209-228.

Kezer J., Sessions K., 1979 - *Chromosome variation in the plethodontid salamander, Aneides ferreus.* Chromosoma. 71: 65-80.

Lanza B., 1954 - *Notizie sulla distribuzione in Italia del Geotritone (Hydromantes italicus Dunn) e descrizione di una nuova razza (Amphibia, Plethodontidae).* Arch. Zool. it., 39: 145-160.

Lanza B. - Personal communication.

Lanza B., Nascetti G., Bullini L., 1986 - *A new species of Hydromantes from eastern Sardinia and its genetic relationships with the other Sardinian plethodontids (Amphibia: Urodela).* Boll. Mus. reg. Sc. nat. Torino, 4: 261-289.

Magistretti M., 1956 - *Coleoptera. 2. Cicindelidae, Carabidae dei Monti Sibillini.* Mem. Mus. civ. Stor. nat. Verona, 5: 229-256.

Magistretti M., 1965 - *Coleoptera, Cicindelidae, Carabidae.* Catalogo topografico. Fauna d'italia, 8. Calderini, Bologna, 512 pp.

Nardi I., Andronico F., De Lucchini S., e Batistoni R., 1986 - *Cytogenetics of the European plethodontid salamanders of the genus Hydromantes (Amphibia, Urodela).* Chromosoma, 3: 377-388.

Nardi I., (in press) - *Cytogenetics of the plethodontic salamander Hydromantes (Amphibia, Urodela).* In: D. Green, S.K. Sessions (eds.) *Amphibian cytogenetics and evolution.* Academic Press.

Roewer C.F. 1962 - *Ueber einige Mediterrane Arachniden.* Fragm. Entom., 4: 11-18.

Ruffo S., Vigna Taglianti A., 1968 - *Alcuni Niphargus delle acque sotterranee dell'Italia centro-meridionale e considerazioni sulla sistematica del gruppo orcinus (Amphipoda, Gammaridae).* Mem. Mus. Civ. St. Nat. Verona, 16: 1-29.

Straneo S.L., 1939 - *Sulla distribuzione geografica del Duvalius bensai Gestro (Coleopt. Carab.).* Boll. Soc. entomol. ital., 71: 105-107.

Taddeucci A., Conte A., Voltaggio M., 1987 - *Datazione col ^{230}Th di alcuni speleotemi del complesso carsico "Grotta del Fiume-Grotta Grande del Vento" a Frasassi (Ancona).* Boll. Soc. Geol. Ital., 106: 807-812.

Taddeucci A., Tuccimei P., Voltaggio M. 1990 - *Th-230 dating and related implications of the speleothems from "Grotta del Fiume-Grotta grande del vento" karst cave at Frasassi (AN).* This issue.

Teobaldelli A., 1982 - *Lepidotteri rinvenuti all'interno di alcune caverne nelle Marche (Lepidoptera).* Lavori Soc. ital. Biogeogr., 7: 809-816.

Vigna Taglianti A., 1970 - *Osservazioni su alcuni Duvalius appenninici (Coleoptera, Carabidae).* Fragm. Entom., 7: 45-54.