



ITALY

RESULTS OF THE 1990 EXPLORATION AT THE MOUTH OF THE TIMAVO RIVER

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The underwater exploration began, in June 1990, at the first and third exits of the Timavo spring with the Czechoslovak team, guided by Michel Piskula, in collaboration with the cavediver team of the Società Adriatica di Speleologia and the team of the Commissione Grotte E. Boegan of the Società Alpina delle Giulie. Gabriele Crevatin and Alessio Fabbriatore did all the co-ordinating. The guide lines were checked and re-positioned as required during the dives. New tunnels were found and explored and a complete topographical survey was carried out. Water and plancton samples were taken to be physically and chemically analysed. Samples of fauna and plancton were also taken.

Claude Touloumdjian, the French diver carried out difficult dives during the month of July. He was assisted by the Triest team. He discovered a large submerged chamber with dimensions difficult to measure. Its bottom is located 60 metres below sea level. The second Czechoslovak team with the German cavediver Wolfgang Morloch carried out a number of dives and ascertained that the branches drain into this catchment basin, which is probably the main one for the Timavo river. A complete topographical survey of the new tunnels was carried out and the work was documented externally and underwater, by video cameras. Almost 1000 metres of submerged tunnels and caves

were explored up to a depth of 62 metres. A total of 88 dives were carried out, some very difficult because of the labyrinthic nature of the tunnels. Moreover some passages were very narrow and there were masses of unstable rocks. Visibility was always bad and almost non-existent in the deeper waters, where the vastness of the environment made orientation almost impossible and, consequently, it was difficult to evaluate the submerged chambers. Future programmes for the Timavo project will include further exploration, hydrological and biospeleological research within the area of the spring, also of the bottom of the Grotta di Trebiciano, where the Timavo flows at a depth of 329 metres.

Geological notes

The river Timavo flows out onto rocks whose lithologic characteristics and structures are already well known, as are the geomorphological characteristics of the surrounding region. Much has been written on this subject since the late 1800's regarding the morphology and hydrology of this area. It would appear that the emerging rocks are from the Cretaceous period which are characterised by the carbonaceous deposits in the cliffs and shelf area. They consist of *Bioherme* and *Biostromi*, a vertically and horizontally layered structure of very pure fossiliferous limestone, which extend for about 100 metres. The local structure is *monoclinial* with bland secondary folds and modest transversal or interlayered faults; the reason is because of the ending of an ample western *anticlinale* limestone (known as the Anticlinale del Carso, whose axis runs NWSE and of which this area is part of the southern side) which makes tectonic contact to the south (probably because of *overrunning*, and certainly because of an inverse fault) with more recent sandy marly rocks (Flysch eocenic).

The limestone stratification is usually clean cut, with variations from a few centimetres to one or two metres. The *fracturing* can be quite close (sometimes one hundredth of a decimetre) but there are some wide areas that are sparsely subdivided. Morphologically, the area is quite interesting and varied: immediately to the north and to the east there is a gradual lowering (complicated by some transversal structures such as Monte Ermada) of the wide *karstic* plateau of the Classic Karst; in the north-east sector the groove of the Brestovizza and of the Vallone join in a series of small and complex *polje*; in the western and southern sectors the alluvial deposits of the Isonzo river are slowly deposited further and further out to sea in the Gulf of Panzano and cover with hundreds of metres of quaternary deposits the sea bed which is Karstic limestone joined tectonically with the impermeable Flysch. From the point of view of the recent tectonic evolution, the area has characteristics anomalous to other areas: in fact, although it is higher

than the land and lagoons to the west and south, it is lower than the eastern and therefore lifting with respect to the northern spurs.

The hydrologic characteristics are tied to this particular geological phenomenon and especially to:

- a. The change from east to west from limestone rock to mixed calcareous dolomitic (therefore less karstifiable);
- b. The lithologic delineation from limestone areas, deriving from *flyschoidi* rocks to the south and *dolomie* rock in the north;
- c. An old tectonic and a more recent tectonic, not intense, but such as to give minor energy to the area;
- d. The mixing of waters which have also big hydraulic loads and coming from different catchment basins, with the sea waters;
- e. The well researched variations of the base level (with a rise over one hundred metres in the last 15,000 years).

All these factors have from time to time influenced the hydrologic evolution of the area, giving rise to one of the world's most interesting and famous springs.

Although much has been learned

about the general area, there is much yet to learn about particular features. One only has to look at the hypogene network that carries thousands of cubic metres per hour to three sources but about which very little is known of the chemical and biological make up: We only have a superficial knowledge of the interaction between river and sea water. We know nothing of the relationship between running and stagnant water. We recognise that a lot must still be done.

It is with this view that the TIMAVO PROJECT began. During the underwater operations, purely geological research was carried out. Also many samples of sediment in suspension were extracted, not without considerable difficulty. Morphological considerations were reported on the area explored, and supporting evolutionary interpretation of the Underwater Network.

Italy, Trieste.
At the Timavo mouth, Dive planning
(Jurko Lapanja)



Hydrochemical research

In the course of the explorations carried out at the Timavo karst spring in 1990 some water samples were collected from the galleries and some pits explored by French and Czechoslovak cave divers.

The analysis and testing laboratory of the A.C.E.G.A. (the body that runs the waterworks) carried out the following analyses on these samples:

1. specific electric conductivity at 20°C by the conductometric method;
2. total hardness by the complexometric method (EDTA);
3. chlorides, nitrates, sulphates by ionic chromatography.

The aim of the hydrochemical test was to point out even minimal differences in the composition of the waters in order to discriminate between the water more directly linked to the upper Timavo from that of *local* origin. The results reported in the chart included in this article clearly show that in the period in which the dives were carried out there was no significant difference in the composition of the water

collected in the galleries and pits. All this seems to be proof of a single supply for the karst springs at any rate during a period of low water which is when the samples were collected.

Conversely research carried out in May of the same year at the three branches of the Timavo and at the Sardo springs located at a short distance one from the other and at the two pits upstream from the karst springs had shown slight differences in the composition of the waters. Almost certainly the hydrological conditions at the time of sampling and also the previous one, affect the composition and therefore the type of supply of the karst springs, but this will have to be confirmed by subsequent research. We must also point out that it was precisely in June 1990 that the factory of organic acids at Ilirska Bistrica (Slovenia Jugoslavia) stopped working (forever, we hope). This factory is responsible for much of the organic pollution of the upper Timavo. In one way this fact will make exploration easier since the water at Trebiciano cave and at San

Giovanni di Duino will appear more limpid and less polluted, but it will make it more difficult to differentiate between the waters coming from the upper Timavo from the other karst waters.

We hope to carry out further and more sophisticated analyses on the samples of water, still perfectly preserved.

If the Isotopic Geochemistry Laboratory of the Mineralogy Institute of Triest University participates in this research, it will be possible to carry out the analysis of oxygen 18, stable isotope, contained naturally in the waters whose concentration is function of the altitude at which the rain-waters collect on the ground or penetrate underground. This is a particularly useful analytical method for differentiating between waters that are chemically similar but come from different zones and from different altitude.

Yugoslavia, Mount Snežnik. Timavo spring
(Alessio Fabbriatore)



HYDROCHEMICAL RESEARCH

1) Analysis of the pits and of the Timavo exits 10th May 1990

		Pozzo 226 V.G.	Pozzo Colombi	Sardos	Timavo 1°	Timavo 2°	Timavo 3°
conductivity	μS/cm	369	385	360	379	383	383
total hardness	°F	21.4	20.9	20.2	20.7	21.2	21.5
chlorides	mg/l	7.5	7.7	7.2	7.1	6.7	6.8
nitrates	mg/l	7.7	7.6	8.0	7.1	7.3	7.4
sulphates	mg/l	12.9	12.6	12.4	12.6	12.2	12.4

2) Third Timavo exit 24th June 1990

place of sampling		I	II	III	IV
depth	m	surface	9	18	surface
conductivity	μS/cm	403	406	400	393
chlorides	mg/l	6.1	5.5	5.9	5.7
nitrates	mg/l	8.6	8.3	8.7	8.4
sulphates	mg/l	12.6	11.9	12.5	12.8

3) First Timavo exit 25th - 27th June 1990

place of sampling		I/I	II/I	N/1	M/1	M/2	M/3
depth	m	12	5	6	4	7	11
distance from entry	m	220	100	20			
conductivity	μS/cm	384	385	381	382	381	382
chlorides	mg/l	6.0	3.0	2.8		2.9	2.8
nitrates	mg/l	8.2	7.6	7.3		7.4	7.3
sulphates	mg/l	12.0	9.7	8.7		9.0	9.0

4) Other exploration 27th - 29th June 1990

place of sampling		N/1A	N/2A	M/4A	B ₁
date		27	27	28	29
conductivity	μS/cm	376	375	372	275
chlorides	mg/l	4.8	5.1	4.7	4.8
nitrates	mg/l	7.1	7.2	7.0	7.1
sulphates	mg/l	10.0	9.8	9.8	9.9
depth	m	11		45	

Samples of water collected at San Giovanni di Duino and Villaggio del Pescatore

Date of sampling: 22nd March 1991

parameter	measurement unit	sample	sample	sample	sample
		1st	2nd	3rd	4th
pH	μ.pH	7.1	6.95	7.18	7.17
temperature	°C				
conductivity at 20°C	S/cm	815	493	381	388
total hardness	°F	32	23	21.5	21.6
partial hardness	°F	23.9	18.8	17.2	17.5
calcium	mg/l	124	81	74	78
magnesium	mg/l	16	9.1	8.1	7.3
sodium	mg/l	77	21	5.2	4.5
potassium	mg/l	4.7	2.1	1.0	1.1
chlorides	mg/l	103	37	7.4	6.5
nitrates	mg/l	3.7	7.3	7.6	7.7
sulphates	mg/l	35	17.2	12.4	12.5
silica	mg/l	2.4	2.6	2.0	2.0
U.V. ray assimilation		0.14	0.07	0.05	0.04
turbidity	U.F.	0.4	0.9	1.1	0.6
oxygen	mg/l	7.4	6.8	8.3	7.8

1st sample: pit between Villaggio del Pescatore and Timavo spring

2nd sample: cave located in Villaggio del Pescatore

3rd sample: cave near the church of San Giovanni in Tuba

4th sample: pit San Giovanni di Duino no. 226 V.G.

Biological research

1990 saw the start of the interdisciplinary programme named Timavo Project that comprehends exploration, physical-chemical measurements and biological studies in aquatic underground environments of the Timavo region in Italy.

The research on *stigobia* fauna consisted in collecting some plankton and benthos, carried out by means of special, very finely meshed, nets ($\approx 130 \mu\phi$). The samples were collected in the following places.

1990:

1. cave registered in the catastre no. 3948 V.G. near Peschiera del Timavo;

2. unregistered cave known as Grotta del Villaggio del pescatore;

3. pit near San Giovanni di Duino, registered in the catastre no. 226 V.G.

1991

1. cave registered in the catastre no.

3948 V.G. near the Peschiera del Timavo;

2. unregistered cave known as Grotta del Villaggio del Pescatore;

3. pozzo del lago; registered in the catastre no. 4583 V.G.;

4. pit near San Giovanni di Duino, registered in the catastre no. 226 V.G.

From a preliminary examination of the samples collected it was clear that there is a certain similarity in the composition of the plancton present in the Grotta del Villaggio del Pescatore, in cave 226 V.G. and in cave 4583 V.G. Great differences are to be seen however in 3948 V.G. probably due to particular chemical conditions (the presence of chlorides), that are also confirmed by physico-chemical tests on the water.

Among the most interesting faunistic elements are to be noted: *Hadzia fragilis stochi* (Anphipoda Crustacea) characteristic of alkaline waters (slightly salty) found in cave 3948 V.G., in the unregistered cave of

Villaggio del Pescatore and in the first exit of the Timavo; *Sphaeromides virei* (Isopoda Crustacean) so far found in 3948 V.G.; *Troglocaris*, *Anophthalmus* group, (Decapoda Crustacean) common to all places. Various species of anphipoda Crustacean of the genus *Niphargus* were collected in all the places examined; some of them would show a possible mixture with the karst water of the zone of the Isonzo karst. In the Grotta del Lago, in the unregistered Grotta del Villaggio del Pescatore and in the submerged galleries of the branches of the Timavo, *Marifugia cavatica* was also common, the only Anellid Polichaete to adapt to a cave environment and already reported in the province of Triest, in the Grotta di Trebiciano and some pits at San Giovanni di Duino.

Italy. Pit San Giovanni di Duino no. 226 V.G.
Biological research (Jurko Lapanja)



Together with the Timavo Project research the Natural History Museum of Trieste is taking a series of samples of the same type in the underground waters of the Monfalcone karst. The future correlation of all these data will throw light on the possibility of the mixing of the karst waters on the basis of the faunistic composition found in the different collecting places.

We wish to point out that this article has a quite preliminary nature since some samples are still to be studied while the collecting season is still continuing in some places.

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