The ancient instruments of limnology in the *Crypta Baldi*

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View of the museum interior

URL of the virtual museum: vb.irsa.cnr.it/crypta

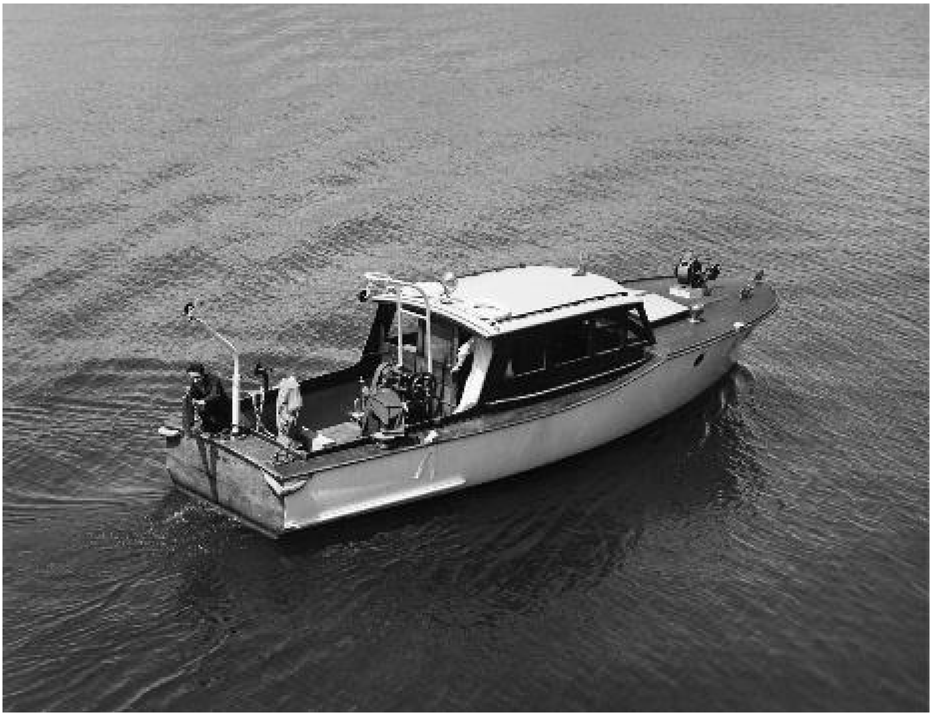
The precise date of production of the instruments listed here is often unknown. The suggested production year or year’s range refers to the date of marketing taken from catalogues, price lists, photographs, scientific papers, etc. The inventory of scientific instruments compiled after the founding of the Italian Institute of Hydrobiology in 1938 does not allow us to know their actual date of production because they were considered as acquired at the institute's start-up date. This date was attributed also to objects belonging to Marco De Marchi, owner of the villa donated to the Italian government as the seat of the Italian Institute of Hydrobiology. As he was an amateur naturalist and limnologist, the villa had long been home to objects relevant to De Marchi's research activities.

Physical limnology

Sounding device with steel cable. Kelvin & Hughes, London. 1947

Early bathymetric measurements or "soundings" were made by lowering a weighted line over the side of a boat and measuring the length of line left in the water body when the weight hit bottom. The sounding device in figure has a metal drum housing 500 m of steel cable with a 10 kg weight at the end. The drum is rotated manually using crank handles and is equipped with brakes and counter to record the length of the cable lowered into the water. The instrument is mounted on a cast iron support, designed to be fixed to a boat.

Kelvin Hughes Ltd was formed in 1947 by the merger between the scientific instrument manufacturing firms of Henry Hughes & Son Ltd, London, England, and Kelvin Bottomley & Baird Ltd, Glasgow, Scotland with Marine Instruments Ltd acting as regional agents in the UK. Kelvin & Hughes Ltd were essentially a part of Smith's Industries Ltd founded in 1944 as the successors of S Smith & Son Ltd.



The sounder on board of the “Gardo”, located in the stern cockpit enclosed in a protective cover (1958)

ELAC Electroacustic echosounder (transducer and recording unit) 1960

The recording echosounder is a device using sonar technology for the measurement of water depth and providing a graph of the bottom. The ELAC echosounder) is suitable for measuring depths of up to 1000 m. It was acquired in 1960 to study the detailed bathymetry of Lake Maggiore. The JRC of Ispra, located near the lake shore, promoted such researches after the official transfer, in 1961, to the European Community of the laboratories of the Italian National Committee for Nuclear Energy. With this instrument the first modern bathymetry of Lake Maggiore was done and published in 1963

The ELAC echograph LAZ 17 in an advertisement of 1959

Surveyor's square with compass. Tecnomasio, Milan. 1920 - 1930

The surveyor's square is a surveying instrument used to define the layout of points, lines and areas. The instrument in the figure, belonged to De Marchi, was probably used, along with a theodolite, to map the topography of many small mountain lakes in the years 30-40 of the last century.

Pagani’s mirror squad. La Filotechnica- Salmoiraghi, Milan. 1941 -1951

It is a goniometer that, using the properties of simple and double reflection, allows you to make the "ship point" from the measurement, carried out on board, of the angles between conspicuous points located on the ground. It consists of a cylindrical body with a handle that allows it to be used by hand or tripod. The cylindrical body is equipped with a horizontal graduated circle with a fixed collimator in the direction of 0-180 degrees and a mirror, normal at the top of the circle that can rotate around a vertical axis. A compass is placed at the top.

Amici - Magnaghi's reflecting circle. 1930 - 1940.

This instrument is devised to measure from a boat the azimuthal angles between three relevant points on the coast. Reporting such angles on a map with a station pointer, it is possible to record the exact position of a boat or of a sampling station. It was used to map the sampling stations in Lake Maggiore The first effective reflecting circle using prisms was built in Italy around 1830 by G.B. Amici (1786-1863). Admiral G.B. Magnaghi (1839-1902) improved the Amici's circle, maintaining the same arrangement of prisms and telescope.

Horizontal limnigraph, Sarasin type. 1900-1910.

The limnigraph is a hydrometrographe recording the water level variations in lakes. The limnigraph in figure, already owned by De Marchi according to a handwritten note inside the instrument (see next page), is a portable horizontal unit built in the first decade of the last century. It is housed in a wooden box to be placed on a pier. A float, now lost, drove a pulley attached to a shaft coming out from the back of the box. The pulley rotation caused by the movement of the float determine the horizontal displacement of a pen. The water level change is recorded on a paper tape, along with the time elapsed, by a clockwork mechanism also used to advance the paper.

Handwritten note attached to the limnigraph box addressing it to Dr. De Marchi in Pallanza:

"Egregio
Dott. De Marchi
Sua Villa
Pallanza"

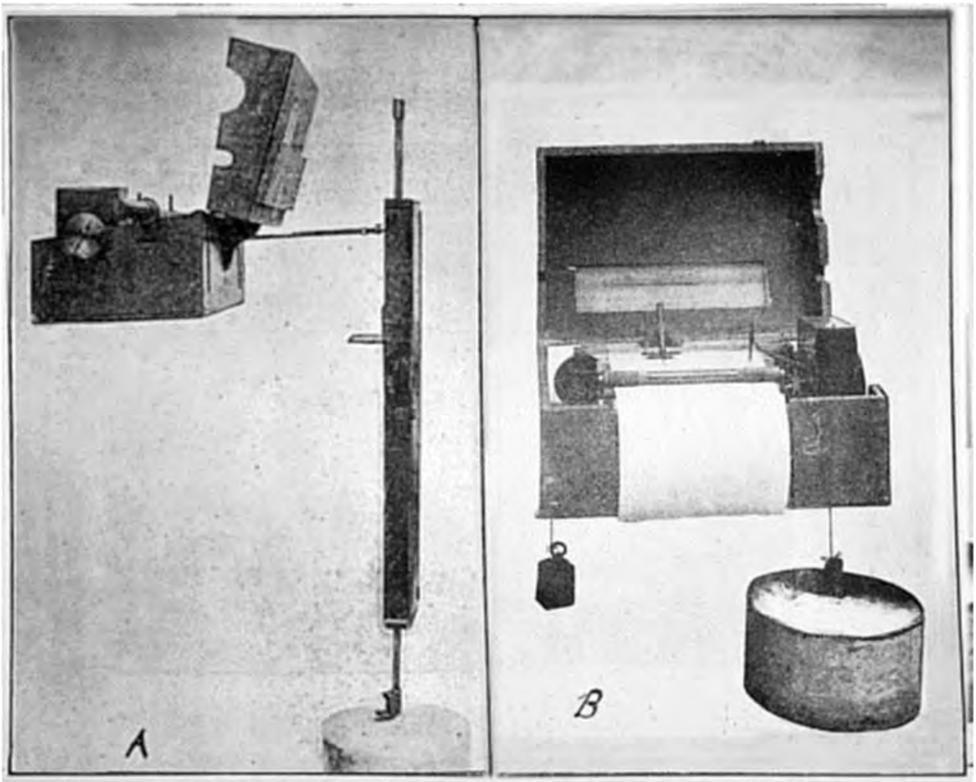


Fig. 15. A. Le limnographe Sarasin. B. le même modifié par le Prof. Chrystal.

Image of the Sarasin's limnigraph from a 1908 paper (Collet 1908)

Station pointer in a wooden box. 1945 - 1950.

The station pointer is a tool used in coastal navigation to plot on a chart the position of a boat, or of a sampling station. This instrument, also referred to as a three-arm protractor, is composed of a circular scale connected to three arms. The central arm is fixed, while the outer two can be adjusted to the angles, previously measured with a reflecting circle, subtended by the boat respect to three objects on the coast. After setting the legs of the station pointer to these angles, it can be laid on a map showing the objects. With the legs running over the objects on the map, the center of the instrument will be the boat position. The instrument in figure was built by C.A.I.M. (Cooperative Maritime Enterprises Armament, Genova) founded in 1945

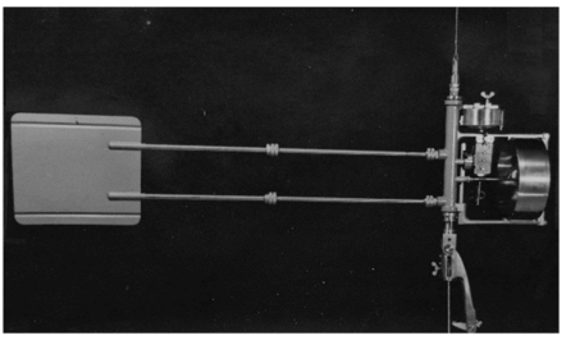
Horizontal Limnigraph. About 1930

This limnigraph is a water level gauge similar to the Sarasin type but with modifications to the transmission of the float displacement. A clockwork mechanism is used for the marking time but the paper advancing is determined by two symmetric weights rotating the roller of recording paper. It was used occasionally in the period 1930- 1940 but the systematic measure of Lake Maggiore level began in 1952, initially with daily readings of a staff gauge and, from 1957, with a hydrometrographe.

Current meter according to Ono, Rigosha production, Japan. 1962

This recording flow meter was invented by Kohei Ono in 1950 and subsequently produced by the Japanese Rigosha. In the figure is shown in its original packaging. The propeller flow meter was fastened to a shaft coming out of the nose cone to which is fixed the protection ring. The flow speed and direction recorder is enclosed in the body of the flow meter, bearing the rings for the mooring of the instrument. This sensitivity of this flow meter resulted too low for measuring weak currents of Lake Maggiore.

Ekman-type current meter. Workshop Dario Pagan. 1962.
Corrent meter built in Trieste by Dario Pagan's "Precision Mechanical Laboratory". It was seldom used in Lake Maggiore because it was not sensitive enough to measure weak lake currents. Designed by the Swedish oceanographer Vagn Walfrid Ekman (1874 -1954), the instrument was subsequently modified and produced by various companies. It consists of a paddlewheel rotor that rotates due to the current with a speed proportional to the current speed. The instrument is lowered to the desired depth suspended from a hydrographic cable and the measurement is activated by sending a messenger. Once the desired time has elapsed, a second messenger is launched and the measurement is interrupted. Below: photo of the current meter mounted in the early 1960s.



Meteorology

Cantoni-type psychrometer. First half of the last century.

Instrument used to measure atmospheric humidity. Belonged to De Marchi. Consists of two mercury thermometers placed side by side, one with the bulb kept dry and one with the bulb kept moist because wrapping it in a cloth soaked in water. This thermometer measures a lower temperature than the previous one because the evaporation of the water subtracts heat, lowering the measured temperature of an amount inversely proportional to the humidity of the air. A ruler placed between the two thermometers allows the humidity to be calculated from the two measured temperatures.

Fortin-type barometer belonged to De Marchi. First half of the last century

The instrument consists of a tube closed at upper end, filled with mercury and with the open end placed in a small container with mercury inside. In the barometric tube the height of the column of mercury varies according the atmospheric pressure balancing the hydrostatic pressure of the mercury. The level of mercury can be adjusted in a fixed position by a screw. The barometric tube is protected by a metal sheath on which is engraved a graduation where the zero corresponds to the ivory tip. The reading of the height of the mercury column, ranging from 500 to 820 mm, is made with a sliding vernier with an accuracy of 0.05 mm.

AEG Microbarograph. 1965

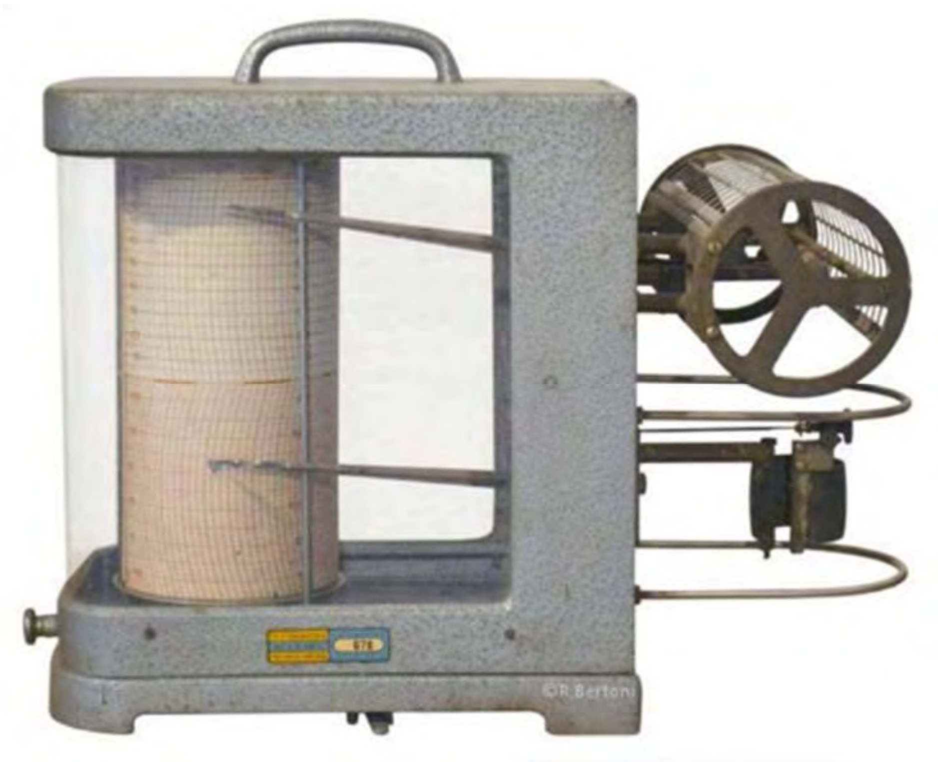
In order to have a less cumbersome and delicate instrument of mercury barometers, the French scientist Lucien Vidi in 1843 invented the aneroid (from the Greek "liquidless”) barometer. This instrument was soon equipped with a pressure recording systems, becoming a "barograph". The one presented in the figure records on a strip of paper the trend over time of the atmospheric pressure values to allow to formulate weather forecasts. The sensitive element that perceives pressure changes is made up by overlapping aneroid capsules, made of copper, in which a partial vacuum is produced. The deformation of the capsules, with their contraction or expansion depending on the changes in pressure, is amplified by a system of levers. The variations are then recorded using an inked nib sliding on a sheet with a weekly pressure-time diagram.

Richard-type thermograph, belonged to De Marchi. 1920 - 1930

The thermograph measures and records the air temperature. His sensor is the Bourdon tube, placed in the cage outside the recording system. This sensor is a C shaped tube filled with a liquid changing volume with changes of temperature, thus increasing or decreasing the curvature of C shaped tube. One end of the Bourdon tube operates a lever, moving a long needle with a writing tip ad the edge. The writing tip writes on a paper strip with temperature-time coordinates printed over. The paper strip is wrapped around a cylinder rotating by a clockwork and running for one week.

Richard-type hygrograph mod. 1930 - 1940.

The hygrograph is an instrument for recording variations in atmospheric humidity. The humidity sensor a hair wisp which change in length because of moisture absorption. The variation in length causes the movement of a leverage holding at his end a nib. This writes the humidity changes on a sheet fixed to a rotating drum actuated by a clockwork.

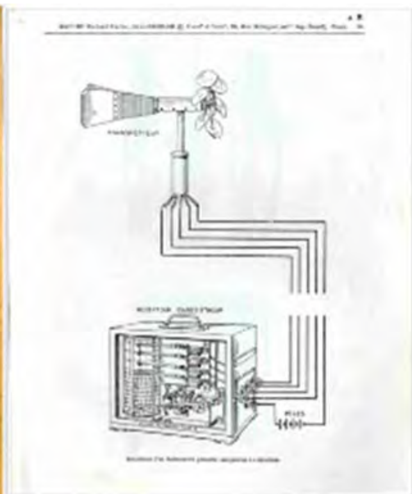


Thermo-Hygrograph MT 11 SIAP. 1956

The Thermo-Hygrograph measures and records both air temperature and humidity. The principle of operation of the two instruments is the same as explained above for the individual instruments. The change of temperature is measured with a Bourdon tube and the variation of moisture is detected through the lengthening or shortening for humidity of a hygroscopic hair bundle. A clockwork produce a weekly revolution of the cylinder housing the paper strip where the temperature and humidity are recorded.

Recorder of the Richard Frères anemograph. Circa 1909.

This electromechanical recorder, belonging to De Marchi, of wind speed and direction was connected to an external sensor, now lost. The drum rotating by a clockwork movement housed a paper chart on which four needles, one for each cardinal point, were marking the wind direction while the longer needle recorded the wind speed. The recorder is in a wooden box and was built by Richard Frères, Paris, in the early decade of the last century as documented in the Richard Frères catalogue of meteorological instruments of 1909 (see below).



Robitzch-type bimetallic Pyranograph, (SIAP). 1951

The Pyranograph, or Pyroheliograph, is an instrument for the continuous recording of solar radiation. Solar energy, expressed in calories per cm^2 of surface, is measured through the differential expansion of three bi-metallic sheets, one blackened and the other two painted in white. Their mutual relative motion is transmitted through levers to a pen and recorded on a paper strip fixed on a rotating drum. A clockwork mechanism allows a weekly recording. The influence of the wind is eliminated by protecting the s bimetallic sensor with a glass cover.

Siphon pluviograph. 1910 – 1920.

The pluviograph, belonged to De Marchi, is a recording rain gauge used to measure the amount of liquid precipitation over a set period of time. An outdoor funnel of know surface collects the rain conveying it to the measuring unit. The rain fills a container with a float inside that would rise with the progressive filling moving a stylus which marked on a strip of paper the volume of rain fallen over time. The diagram is mounted on a rotating cylinder making a full revolution every 24 hours moved by a clockwork mechanism. When the cylindrical container was completely filled, it is immediately emptied by a siphon.

Propeller type Current Meter, Filotecnica Salmoiraghi. 1960.

The Propeller type Current Meter is used to measure the current velocity in rivers. The measure is made in a part of the river where the cross section area is known. The velocity-area data are used to compute the river discharge, i.e. the volume of water transported to a lake in the unit of time. The tributaries discharge allows compute the water balance of a lake and the chemical load inflow. The unit in figure, produced by Filotecnica Salmoiraghi (Milano), dates back to 1960. The current meter is dipped in the river fixed to a rod inserted in cylindrical cavity (at the left). The number of propeller revolutions during a known time interval are counted and from this data it is possible to calculate the current velocity.

Tipping bucket pluviograph Mod. M20. 1930- 1940.

The rain, coming from an outdoor funnel of know surface, is conveyed to a tipping-bucket mechanism, formed by a divided bucket pivoted at its center. Rain collects in the upper half. When this is full, the mechanism tilts and discharges the collected water, allowing the other half of the bucket to begin filling. The alternate filling and discharging continue as long as rain is falling, and each tilt delivers a boost to a pen every 0.2 mm of rainfall. The graph of the rain falling over time is registered on a strip of paper wrapped around a rotating cylinder driven by a clockwork mechanism with week-long charge.

Psychrometers (Wet and Dry Bulb thermometer) of Assmann. 1968.

The instrument consists of two equal thermometers. One of them has the bulb wrapped in gauze soaked in water, while the bulb of the other is dry and indicates the room temperature. A fan operated by a spring device sucks air from the lower end of the instrument promoting the evaporation of water. The heat required for the evaporation causes the wet thermometer to measure a temperature lower than that measured by the dry thermometer. The temperature difference between the two thermometers, i.e. the psychrometric difference, is greater the smaller is the air humidity and is close to zero if the environment is saturated with moisture. From this temperature difference it is possible to calculate the relative humidity.

Kew Barometer. SIAP, 1970

This barometer is similar to the barometer of Fortin, but the level of mercury in the pan interacts, by means of a system of levers, with the position of the graduated scale on which the reading is made. In this way it is not necessary to previously adjust the surface of mercury with a fixed reference.

Maximum and Minimum thermometers (Fuess type). 1940 – 1950.

These thermometers were placed horizontally in the meteorological shed. They measured the temperature of the air in the shade, not directly exposed to the sun's rays.

The "maximum" thermometer (below) is a mercury thermometer with bulb ending in a bottleneck that prevented the mercury from turning back after dilation. The point reached by the mercury in the capillary therefore indicated the maximum temperature reached.

The "minimum" thermometer (above) uses alcohol as a sensitive element, which has a dilation coefficient is about 10 times greater than that of mercury. To increase responsiveness, the bulb is forked to have a larger surface area. Inside the capillary is inserted a metal stick that on one side ends with a curved shape so that the meniscus of the liquid when it recedes drags back the stick to the minimum point reached. When the liquid dilates again, it manages to pass without moving the stick, so that you can read the minimum temperature at the curved edge of the stick. For a new measure, the stick is returned, using a magnet, to adhere to the meniscus of the liquid. (50s)

Bellani spherical pyranometer. 1960

The Bellani spherical pyranometer is a distillation actinometer first designed in 1836 by Angelo Bellani.
The instrument operates on the principle of distillation of a liquid as a result of absorption of the incident irradiation. A major improvement of the Bellani pyranometer was introduced by the Physikalish-Meteorologisches Observatorium, Davos-Plaez, Switzerland, which produced around 700 units in the 1960s, one of which is shown here. This pyranometer (Swiss model) consists of two concentric spheres connected to a vertical burette graduated up to 40 cm. The outer sphere is made of glass and the inner sphere is made of black painted copper. The burette is connected to the copper sphere by means of a capillary tube. The inner sphere is a reservoir for the sensitive element, which is ethyl alcohol. As the solar radiation (direct, diffuse and reflected) affects the copper sphere, its temperature increases, part of the alcohol evaporates and condenses again along the burette which is at a lower temperature. The amount of alcohol accumulated in a given time is directly related to the total radiation intercepted in by the copper sphere.

Arago - Davy actinometer (radiation intensity meter), 1940-1950

The Arago-Davy actinometer is an instrument for measuring the intensity of solar radiation. It consists of two thermometers, one with a white bulb (now lost) and the other with a blackened bulb. To reduce the external disturbances, the thermometer bulb is located in a vacuum chamber. When exposed to the sun the black bulb attains a higher temperature than the bright bulb. The temperature difference is converted to solar irradiance using an equation proposed by Marié-Davy in 1875.

Heliograph. 1970

This apparatus, dating from around 1970, measures the absolute heliophany, i.e. the actual duration of direct insolation, with the sun's disk not covered by clouds. The heliograph was invented in 1853 by John Francis Campbell (1821-1885). The sun's rays, passing through the solid crystal sphere, are concentrated on a strip of dark-coloured paper placed on a guide below, which can be oriented in relation to latitude. The strip is burnt for the duration of the insolation, describing a continuous line if the sun shines without interruption.

Sampling of water and organisms, *in situ* measurements

The "Pavesia". 1900-1905

It is a portable, foldable boat built by the “Pietro Baglietto” shipyard in Varazze (Savona) in the early years of the last century. The name "Pavesia" was given to honor Pietro Pavesi, Rina Monti's teacher at the University of Pavia and a scholar of the fauna of Italian lakes. Belonging to Marco De Marchi who used it during his research on high altitude alpine lakes, it was also used by Rina Monti for her research in these environments, as evidenced by the abundant photographic documentation available. He rested for over seventy years in an attic of Villa De Marchi, the Monti base camp for many research campaigns on Alpine lakes. On the occasion of the 75th anniversary of the Institute, the "Pavesia" was exhumed and restored.

Meter wheel with dial indicators. Thalassia. Circa 1950.

The meter wheel allows to know the sampling depth and so it is an essential complement of any winch. In portable winches the counter is often integrated into the unit. With fixed winches a sheave meter wheel is often used, similar to that shown in figure, with the hydrographic cable passing over a sheave fitted with a device that records the number of revolutions. The dials give directly in meters the length of wire gone through.

Portable hand operated winches. 1940 - 1955.

Portable hand operated winches are often used to sample lakes from small boats. Manual winches, like those in the picture, can be installed on almost any boat using a suitable docking systems. The one on the left (1950) has a meter wheel and that at the right one is equipped with electrical cable and rotating contacts to acquire data from underwater sensors. The latter dates back to 1952 and was used with a plankton sampler named *Limulus.*

Fixed hand operated winch. 1940-1950

The second research boat of the Institute was named "Gardo" (from Edgardo Baldi) and had a winch operated by the boat's engine. At the bow it was carrying also the manual winch in figure.

Ewing type underwater camera system for high depth. 1960 - 1965.

The camera and the flash are located in individual waterproof case, in higher and lower position, respectively. The camera takes a picture when a trigger weight touches the bottom, operating the shutter and the film advancing. A paper illustrating the prototype of this system was published in 1946.

The system was equipped with a Robot Star II camera (now lost, the picture below is from internet) able to take up 50 square (24x24 mm) exposures per standard 35mm roll of Leica film using a spring motor.

Nansen bottle (left, about 1930) and with support for two reversing thermometers (right, about 1950).

Water sampler designed to collect samples at selected depths by the oceanographer Nansen around 1910. It is made up by a cylinder with a valve at each end, which is immersed in water attached to a cable with valves in an open position. Once the desired depth is reached, a messenger is launched that triggers the release of the upper end of the sampler. The cylinder falls downward closing the valves and trapping the water sample inside.

Richard type sampling bottle. About 1950

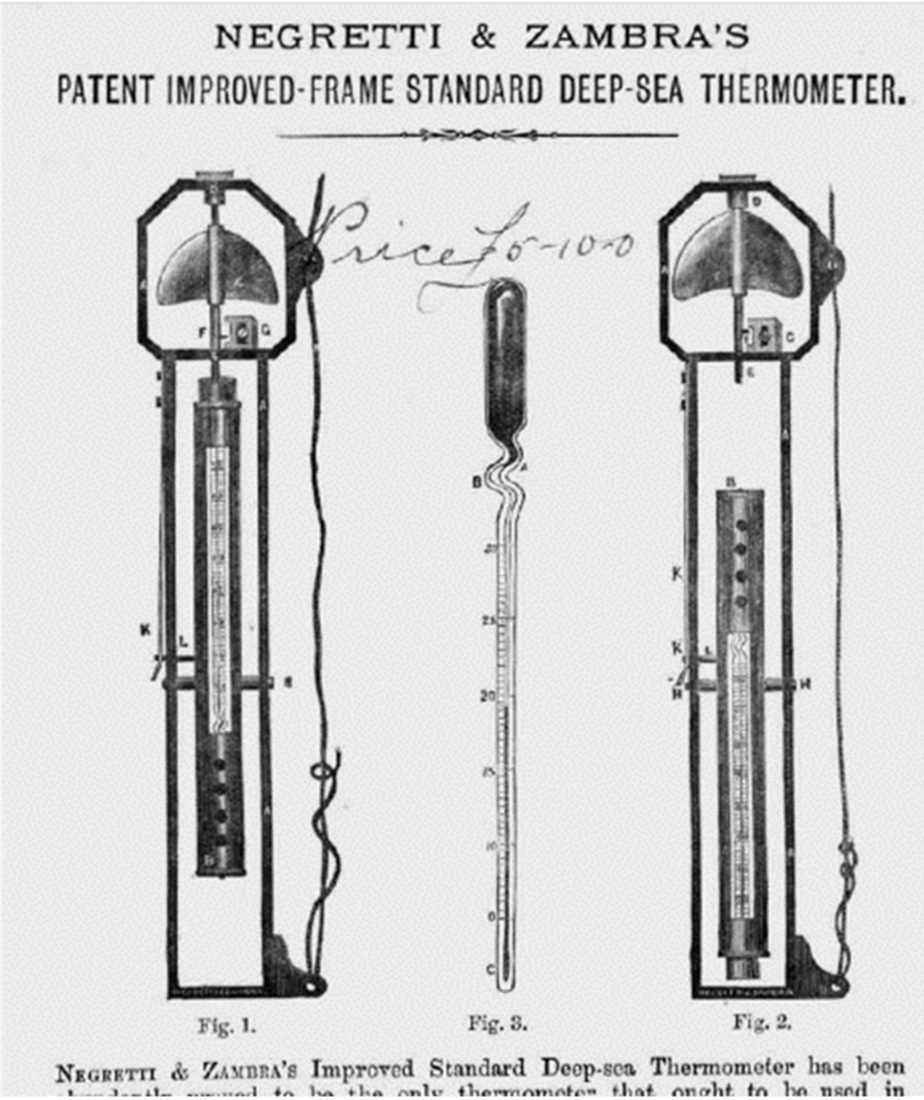
In this sampler, designed by Jules Richard in 1902, the release was triggered raising the bottle a few meters so that the rotation of a propeller could release the bottle, eliminating the need to use a messenger.

Wooden mounting for reversing thermometer. 1920 - 1930.

This lightweight mounting of non-industrial production, probably based on a design by De Marchi or Baldi, was used for sampling the high-altitude lakes. The messenger hit the top ring after sliding down the rope to which the mounting is suspended. The thermometer holder is thus freed and can rotate around the central pivot causing the reversing of the thermometer and the interruption of the column of mercury.

Magnaghi-type mounting for reversing thermometer. About 1900

The release of the reversing thermometer was triggered raising a few meters the device. In this way the propeller located at the top of the mounting rotates loosening a screw hanging the thermometer in a vertical position and allowing it to turn upside down. In the figure: the apparatus before (left) and after (right) reversing.



It is difficult to know the year of production of this instrument. But it is worth mentioning that the Reversing thermometer in Magnaghi's frame, by Negretti and Zambra, is mentioned in the catalogue of the company of 1878.

Messenger operated mounting for reversing thermometer (Negretti & Zambra, Londra, UK). 1910-1920.

Also for this instrument the date of production is difficult to establish. However, as you can be see in the picture below it was already advertised in 1920.

Bacterial bottom sampler, Emery type, Rigosha. 1962.

It has inside a glass tube filled with sterile water, placed with the mouth facing downwards and held closed by a metal blade. When touching the bottom sediment the lower disk drove a mechanism opening the mouth of the tube, which penetrate the sediment for about 5 mm and then closed. The surface sediment is than collected aseptically. This sampler was published in 1958.

Ekman type dredge. Open (left) and closed (right). 1930s.

This dredge was designed by the Swedish oceanographer Sven Ekman (1876-1964) to sample soft bottoms. Many variants of this device have been created. Before sampling the mouth is kept open by two ropes blocking the dredge jaws to a release mechanism. By exerting pressure on the arm to which the dredge is attached, or by sending a messenger, the jaws are released and can close drawn by a spring, trapping the surface of the bottom sediment.

Motoda type plankton sampler. 1963.

Sampler developed at the beginning of 1960s by Sigeru Motoda and marketed by the Japanese Rigosha & Co. Ltd. for quantitative fast sampling of plankton. A conical net is contained in the metal cylinder and at the base of the nose cone, partially separated from the body in the figure, is located a flow meter that allows to evaluate the volume of water filtered.

Baldi’s dredge. 1930s.

This small dredge, belonged to Baldi, entered the soft sediment by gravity. It was partially filled of bottom material through a valve closing at the recovery of the instrument. Once on board the bottom closure could be removed to extrude the collected material.

Sampling bottle. First half of the last century.

This sampler consists of a copper tube with an outer and an inner stopper at the top and at the bottom, respectively. Inside there is a central axis to which are attached the top and bottom stoppers, which close the sampler when the central axis falls down. The bottle is lowered into the water suspended to a rope tied to the bottle handle. To the same rope is fixed a releasing device holding up the axis and keeping the bottle open. Once the sampling depth is reached, a messenger is launched who actuate the release allowing the stoppers to go down and close the bottle.

Friedinger type sampling bottle. About 1950.

This sampler, now devoid of the release mechanism, in some respects resembles a Friedinger's bottle. The builder is unknown as the date of purchase. It's curious the position of the mounting of the reversing thermometers, placed in a plane perpendicular to the bottle.

Release mechanism in brass. 1920 - 1940.

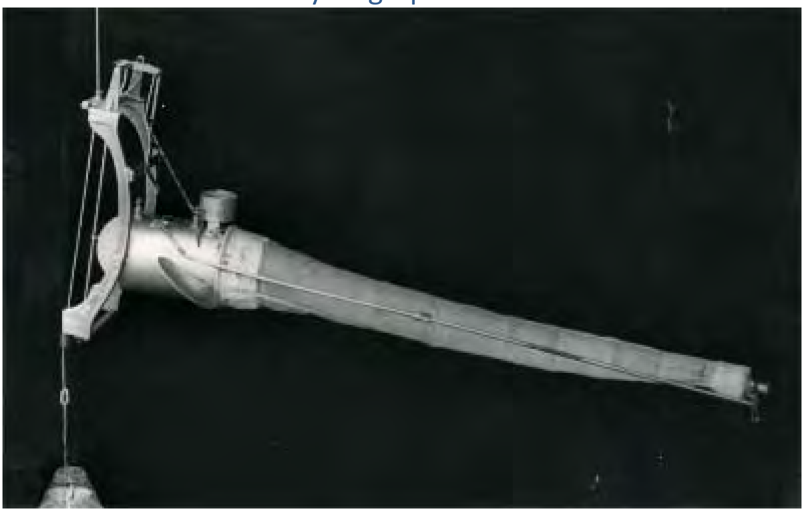
The messenger causes the lowering of a shaft of less diameter in its central part (compare left and right figures). Thus the C shaped washer (at right) previously hooked to the shaft can slide away releasing the instrument fastened to it.

Apstein-type plankton net. 1920 - 1940.

Plankton net with a device for closing the net mouth at depth at the end of sampling. The device was operated by a release system like the one shown in the previous figure. Attached to the smaller end of the conical net is a metal cup with mesh walls designed to concentrate the plankton caught. This type of net allowed quantitative sampling by calculating the volume of water filtered, which is equal to the volume of a cylinder with a base area equal to the surface of the mouth of the net and a height equal to the distance between the opening and closing depths of the net. This approach can only be applied when fishing vertically, i.e. by immersing the net to the desired depth and then dragging it to the surface.

Clarke and Bumpus plankton sampler. 1940 - 1950.

This plankton net (by Clarke and Bumpus, 1940), allows the quantitative plankton sampling. It has a mechanism to open and close the net mouth by sending two messengers in sequence. In addition, it is equipped with a gauze measuring the volume of water filtered while dragging the net shown in the picture above.
This device allows take plankton samples more representative than those taken by vertical hauling since it can sample a very large portion of the lake performing sinusoidal hauling. Below a photo (of about 1950) of the net mounted on the hydrographic wire.



Reversing thermometer with its wooden case. 1960.

This thermometer has the measuring capillary folded up just above the bulb. This feature causes the interruption of the mercury column when the thermometer is reversed. In this way the temperature reached at the instant of the overthrow is permanently recorded.

Wheatstone bridge and Thermistor probe. 1953.

This instrument has been built to measure the temperature of the water up to about 20 m deep. It is a Wheatstone bridge used to measure the resistance of a thermistor probe. The probe was deepened in the lake connected to the measuring bridge through an electrical cable. The thermistor (from *thermal* and *resistor*, patented in 1930) is a semiconductor of resistance significantly variable with temperature.

Wheatstone bridge ICE Mod.6600. 1960.

This professional Wheatstone bridge was purchased in 1960 and was used in the laboratory for the calibration of the thermistor probes to be used for *in situ* temperature measurements.

Batitermograph Thermarine (Wallace & Tieman, New Jersey, USA).1950. Right box: coated glass slides and graph reader.

This torpedo-shaped device holds a temperature sensor and a transducer to detect changes in water temperature versus depth down to a depth of approximately 285 m. Lowered by a winch on the ship into the water, the unit records pressure and temperature changes on a black-coated glass slide as it is submerged through the water. A lever system causes the displacement, proportional to temperature and pressure, of a point scratching the coated glass slide. Because the pressure is a function of depth, temperature measurements can be correlated with the depth at which they are recorded. In the right pane are visible, enlarged, two coated glass slides with their box and the slides reader with the graduated scale used to extract data.

Underwater photometer, Polli type. In the box: two photocells EvansElectroselenium LTD (UK).1952.

The photocells, closed in their waterproof case, are lowered to increasing depth, suspended to an electrical cable connected to a millivolmeter, until the instrument reads 0 mV. The electric current produced by the photocells is registered and then converted to radiation unit by comparison with a conventional light meter.

Millivolmeter Allocchio Bacchini mod. 2660. 1941.

Used to measure the voltage output from the photocells of the underwater photometer or of the turbidity meter shown in the next figure. Belonged to Baldi.

Turbidity meter. About 1955.

It is devised to measure the turbidity at a defined depth. The change in turbidity with depth can occurs, for instance, if the riverine water carrying suspended solids enters in the lake sinking in deep layers. The algal population can also affect the vertical distribution of turbidity, being more abundant where light and temperature conditions are closer to its optimum growth condition. Below: picture (1955) of the turbidity meter connected to a millivolmeter:

Instrument to measure depth and temperature (above) through sensors placed in a careened plankton net (below). About 1953.

This sampler, named Limulus, was designed and built by V. Tonolli. The underwater part (plankton net and sensors) is lost.

Chemical analysis

Analytical balance belonged to De Marchi. First half of the past century.

For weighing up to 100 g, with reference weights lodged inside the drawers below.

Analytical balance Galileo-Sartorius. 1954

Made by Officine Galileo (Florence, Italy) in collaboration with the German Sartorius, is equipped with a shock absorbing system. It is the last of this type before the introduction of the single-pan versions, with automatic loading of the masses. It is provided with a box of weights and has a maximum capacity of 200 g.

pHmeter Beckman Instruments Mod G. 1957.

This electronic pH meter, manufactured by Beckman Instruments founded by the inventor Arnold Orville Beckman (1900-2004), is similar to the first pH meter marketed in 1934. The electronics was contained in a wooden box with a lockable compartment, shielded to avoid interferences, containing the reference and the measurement electrodes.

Water conductivity meter, Kohlrausch bridge (WTW, Wissenschaftlich-Technische Werkstatten GmbH). 1962.

Device to measure the lake water conductivity. It could be used in the laboratory or in the field, with a battery power supply, visible at the bottom of the figure. Apparatus and power supply are housed in a wooden case with a compartment for storing the electrode (right). The Kohlrausch bridge is the AC version of the Wheatstone bridge.

Potentiometer by Hellige & Co, Freiburg. 1939.

It was powered by batteries and was equipped with a reference electrode (calomel or hydrogen) and one measuring quinhydrone electrode, stored in the case at the right of the measuring panel.

Manual centrifuge. 1930s.

The manual centrifuge was often used for the treatment of samples in field laboratory, as in research on high-altitude alpine lakes in the first half of the last century. This unit could accommodate four tubes of 20 ml and rotate at speeds close to 4000 RPM thanks to a system of gear.

Galileo-Hellige colorimeter. Officine Galileo, Florence. About 1940

Used to compare the light absorption by two coloured solutions, one with a known concentration (reference solution) and the other with an unknown concentration (sample solution). The length of the light path through the solutions can be varied for a visual match. The concentration is taken to be equal when the colors match, so the concentration of the unknown can be determined by simple proportions.

Turbidity meter Hellinge. 1951.

Marketed since 1948, this equipment manufactured in the United States was given to the Institute in 1951 on the Marshall plan, officially called ERP (European Recovery Program). It was used for the analysis of suspended solids in water and for nephelometric determination of silicates.

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Spectrometer model MG1. Officine Galileo, Florence. About 1950

The spectrometer model MG1, by the Officine Galileo, is the refinement of a spectrometer already produced in 1933. It has a Pellin-Broca prism fixed to a rotating platform enclosed in a box with a lid, open in figure to show the prism. This can be rotated by means of a cylindrical drum moving a precision screw to explore the 380 - 800 nm spectrum interval. The wavelength value of the line framed at the spectrometer inlet is readable on the graduated drum. The two perpendicular cylindrical arms bear a collimator with a variable slide adjustable up to 0.01 mm and an optical system allowing to isolate a single color line.

Photoelectric colorimeter Lumetron Mod. 401. 1950.

Device for the measurement of the optical density of colored solutions, evaluated by a photocell. The test tube containing the sample is placed between a light source (filament lamp) and a selenium photocell. Between the lamp and the sample tube holder colored filters can be inserted to select the measuring wavelength. The photocell output varies depending on the amount of light received and is measured by a galvanometer, calibrated in percentage of transmitted light (T%) and in amount of light absorbed (Abs)

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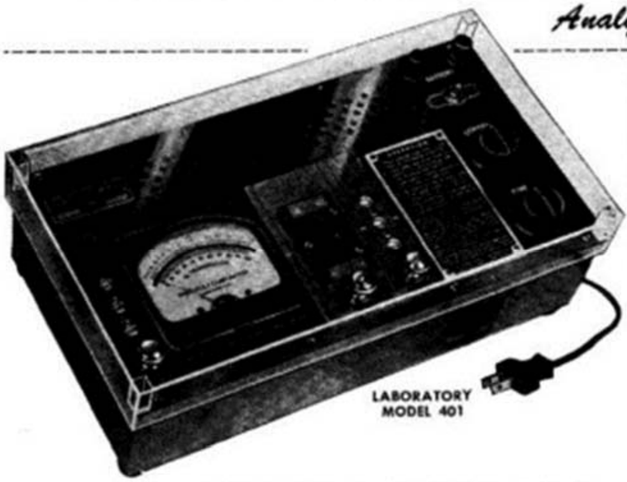
Analysis



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Complete Laboratory Equipment

Mohr-Westphal balance (early 1900s).

Instrument to measure density according to Archimedes' principle, which states that a body immersed in a fluid receives a downward thrust equal to the weight of the volume of fluid displaced.
It consists of a metal pedestal with three fixed feet at the base, one of adjustable height to set in central position the indicator located at one end of the scale arm. On the opposite edge of the arm, there are ten pegs where small weights, called knights, with known density values will hang. The float at the end of the long arm of the balance is immersed in the liquid and the arms of the balance are balanced with the weights, whose value corresponds to the density of the liquid. To measure the density of a solid (obviously not soluble in water), a perforated metal saucer is used instead of the glass float.
Gift of Andrea Lami, 3-10-2016

Microscopy and accessories

Nuremburg Culpeper-type compound microscope. Germany, Early 19th Century

This microscope is made of a cardboard tube with parts inserted one inside the other and free sliding to adjust focus changing the length of the optical path. The tube is held in a vertical position by three wooden columns anchored to a circular support base. At its centre is a support that holds an adjustable mirror to reflect sunlight towards the microscope objective and illuminate the specimen. The lower part of the microscope base (see below) is branded with the initials of the maker, “iM” in dotted oval. This brand is known from several other examples in museum collections.

Near the brand there is the inventory label of the institute and another label “A.o Franzini Pallanza” with a hand written number. The label suggests that this object belonged to Arnoldo Franzini (1854-1916), an important member of Pallanza society of the time

Microscope Officine Galileo. 1940-1950.

The production of microscopes by Officine Galileo in Florence increased with the acquisition of the firm F. Koristka in Milan in 1929. These microscopes have been widely used in routine research for their good quality and robustness. The eyepieces and the objectives of this microscope allows enlargements from 15X to 500X.

Advertising of Galileo microscope in 1940.

Dissecting stereo microscope, Officine Galileo. 1930 - 1935

This microscope, in use in 1938, features three twin objectives holders and three pair of twin eyepieces. It allows magnifications up to 100X and was used particularly for the study of the zooplanktonic organisms.

Dissecting microscope (stereomicroscope) Koristka. Circa 1930.

For the study of planktonic organisms, dissecting microscopes such as the one shown in the picture were often used, with a maximum magnification of around 100X or slightly more but offering a three-dimensional view. This instrument is equipped with two pairs of objectives (4 X and 14 X) and two pairs of eyepieces (5 X and 10 X) and has a glass slide holder to ensure maximum illumination of the object under observation.

Carl Zeiss inverted microscope. 1961.

The inverted microscope allows the specimen to be placed over the objective, making it possible to observe organisms suspended in liquid and placed to sediment in cells with transparent bottoms. It is used to count vegetal and animal plankton, fixed and placed in a sedimentation chamber (Utermohl cell).

Projector microscope W&H Seibert Wetzlar (1930?)

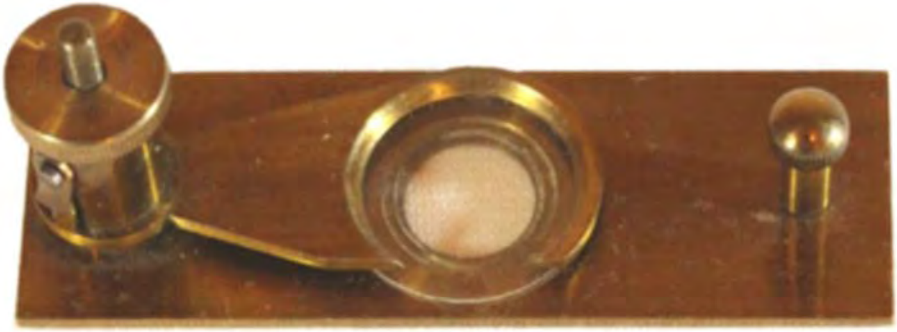
This is a microscope fixed to a suitable stand to hold it in a horizontal position, together with a device for illumination. The eyepiece faces a mirror that reflects the image and projects it onto a sheet of paper. The researcher can thus draw the projected image by following its contours. Below: early 20th century print showing its use

Busch photographic microscope "Metaphot". 1930.

It is an inverted microscope, i.e. the specimen to be observed is placed above the objective. It is equipped with an internal reflex camera and has optics that allow magnifications from 3X to 2500X. It is assembled in a rigid monoblock with ground glass for focusing in a fixed position in front of the observer.
Used by Baldi for the photographs illustrating his popular text 'Microcosm' published by Heopli in 1939.

Labgear-Harding type microdissection instrument

Invented by J.P. Harding in 1950 and marketed by Labgear, it can be used with magnifications up to 100 X. It consists of two very fine-tipped needles moving in the three planes of space following, on a very small scale, the movements of the hands thanks to a system of levers as in a pantograph. Tiny zooplanktonic crustaceans can thus be dissected to prepare microscopic preparations.



Rousselet type compressorium. Circa 1900.

Special object slide for observing mobile organisms. These can be immobilised by means of the coverslip, which can be lowered by turning a screw until the organism to be observed is blocked.

Small lathe for luting slides. 1950s.

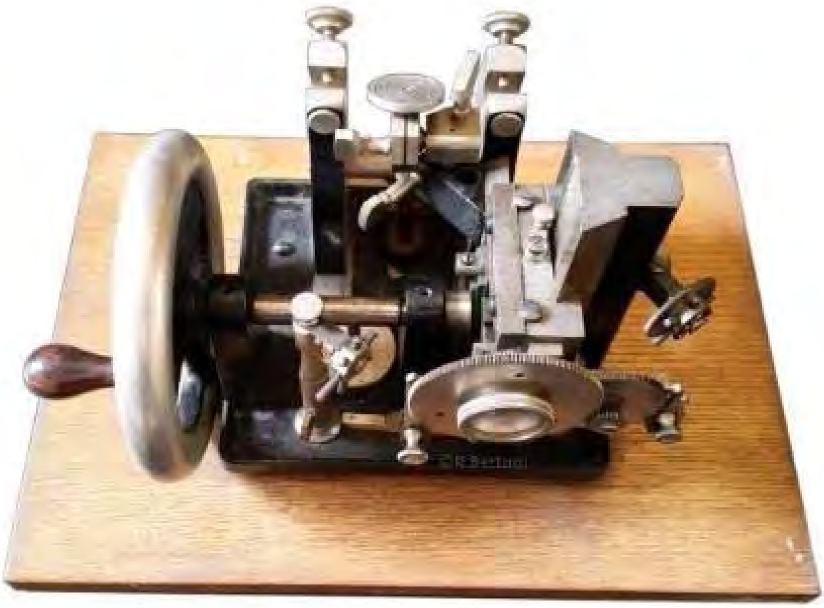
It was used to prepare permanent preparations with a round coverslip. The slide in preparation was rotated while a special mastic was applied to seal, i.e., lute, the round coverslip to the microscope slide.
Below: two permanent preparations made with this apparatus using a black putty.

Microscope illuminator. 1920 - 1930.

This illuminator for microscope has a peculiar front lens, made by a spherical glass bottle filled with water, to focus the light on the specimen.

Lenses holder, Veinzierl type. Officine Galileo. 1930 - 1940

Optical system built by Officine Galileo and used to examine biological specimens and separate benthic organisms hosted in large containers, of a size inadequate for using a stereomicroscope. Selecting the appropriate lenses it is possible to change the magnification.



Zimmerman rotating microtome. 1940 - 1950

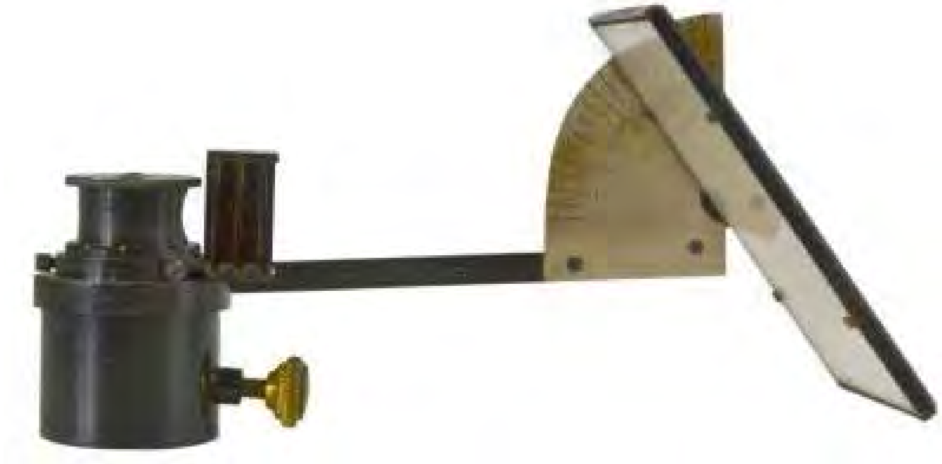
This rotating microtome, designed at the beginning of the last century by E. Zimmermann in Leipzig, derives from the Minot microtome, made in 1886. Here is without the blade, to be fixed between the two screws visible at the topo of the figure top, in front of the disc holding the material to cut. Every flywheel rotation (left in the picture) produced rising of the material to cut of a defined thickness and its slide against the blade. The cut section can then be collected and mounted onto a microscope slide.

Sliding microtome. Officine Galileo. About 1950.

This sliding microtome, produced by Officine Galileo around 1950, is a development of the microtome designed by Ulbrecht-Reichert. The blade at the top slides on a horizontal plane above the specimen holder, advancing along an inclined plane so to raise at each pass of the blade of the desired section thickness. This tool allows cutting of slices with thickness from 2 to 10 microns.

Water-jacket electric stove for inclusions. Carlo Erba. 1939.

This water-jacket electric stove was used to include in paraffin the organisms to be studied under a microscope. After cooling, the paraffin become solid and the included organisms can be cut with a microtome. To keep the temperature a Vertex thermometer was used, which controls the temperature with a contact between the mercury and a movable conductor inside the capillary of the thermometer.



"Camera lucida" by Abbe. Belonged to De Marchi, 1930s.

The "camera lucida", invented by Abbe at the end of the 19th century, was used for drawing images from microscope contouring an image projected on a paper sheet. A special eyepiece containing a prism is used to deflect the image in an optical path perpendicular to the usual one, from objective to eyepiece. The image is caught by a mirror which, properly angled, projects the image on a sheet of paper.

Camera for microscope, Officine Galileo. 1940.

This camera for microscope, employing 6X9 plates, can be installed instead of the normal eyepiece of the microscope. The system allowed the vision of the microscopic field through a mirror placed under the shutter and was equipped with a 6X eyepiece.

Wooden support to draw with"camera lucida", Zeiss. 1940

The complement of the "camera lucida" is a special wooden support (below in a picture of 1940) where to accommodate the paper sheet and which allows its optimal positioning and adjusting as to reduce the distortion of the projected image.

Photography and cinematography

Wall timer Agfa. Beginning of 1930s.

This timer belonged to Baldi. It was used in a darkroom to check the exposure time in printing photo. It was designed for long exposure times, measuring up to 30 minutes. The figures are painted with phosphorescent paint to make them visible in the dark and there is a buzzer to give an audible indication of the expired time.

Photographic enlarger Leitz Focomat 1C. 1950.

Leitz Focomat 1C auto focus enlarger, equipped with Focotar lens Leitz Elmar 50 mm f 4.5 or 50 mm f 3.5 and paper holder. Built starting in 1950, this enlarger was widespread. It allowed to enlarge from 2 to 10 times the original film 24 x 36 mm. The paper holder, attached to a wooden base, can be unlocked and moved to frame the picture to print.

Movie camera 16 mm Siemens mod. B. 1933.

This camera, manufactured by Siemens, Germany, starting from 1933, is equipped with a 20 mm 1:2.8/Bush Glaukar Anastigmatic lens. The 16 mm film used was stored in special cartridges containing 15 m of film. The equipment belonged to Baldi and was used to make a documentary on the Tovel Lake at the end of the 1930s.

Advertising of Siemens movie camera in 1933

Stand to couple a movie camera and a microscope. 1930 - 1940

Stand designed to couple a movie camera and a microscope, watching the microscopic field when filming. The camera was fixed to the upper bracket and the monocular microscope was housed on the floor of the stand, placing the optical connector shown in figure between the microscope eyepiece and the camera objective.

Baldi's microcinematography system. End of the 1930s

Kodak titler. 1930 - 1940

It was used by Baldi for the editing of the fillm "Il Lago di Tovel" in 1939. It is a documentary without soundtrack illustrating the limnological research carried out in that lake to explain the phenomenon of the occasional reddening of its waters. The film, which lasts 22 minutes, contains drawings, graphics and captions filmed with this titler.

Bromograph Agfa. About 1940

The bromograph was used in the photo lab to produce contact print from 13x18 plates and photographic film. The device is a wooden box with a light bulb inside, closed at the top by a metal cover. An external switch allows switching on and off the bulb. The metal cover has a fixed bottom with window closed by a ground glass, and a mobile part. To make a contact print, a plate or a film is placed above the ground glass covered by a sheet of photosensitive paper. The lid is then closed and the light is switched on for the desired exposure time. With the bromograph, it was possible to make many paper reproductions of a photograph quickly.

Communication

Epidiascope Aldi Epivisor. 1952.

Used until the early 80's, it has long been the tool for presentations in the conference room of the Institute. This equipment was used to project slides and images or designs from opaque materials such as books, photographs on paper or drawings.

Advertising of the Aldis epidiascope in 1952

Microfilm readers Fotorex G.G.S. 1950s.

The Fotorex comes from the G.G.S. Company, founded in Milan at the end of World War II to produce 24x36mm cameras. The production of projectors and microfilm readers of 36 mm films began in the 1950s, when the microfilm was used a support for the dissemination of scientific documentation.

Siemens & Halske AG mod. Standard 16mm film projector. 1935 1940.

This projector, belonged to Baldi, consists of a base housing the motor and the commands and of a top housing the light source, the optics and the film dragging system. In this part are also fastened the brackets holding the bobbins for the 16 mm film. The projector is equipped with a Meyer Kinon f. 5 lens.

Slides projector Zeiss Ikon Orikar. 1930- 1940.

This projector, probably built in the early 1930s was used during World War II and in the postwar period to project, during seminars and lectures, the 35 mm slides used to illustrate search results. Equipped with 150 mm lens F:3.2 Ikon Orikar, it can use both slides and continuous film, using an adapter.

Dictaphone, recoding unit. 1920 - 1930.

Professor Baldi used this audio recorder for dictating his scientific memoirs, later typed by a secretary. The name "Dictaphone", registered by the Columbia Graphophone Company in 1907, soon become the common term to refer to this device, especially in his version using wax-coated cylinders as recording support. The voice recording was obtained exploiting the vibrations of a membrane caused by the sounds. The membrane was fixed a metal pin affecting the surface of a wax-coated rotating cylinder. To reproduce the sound, the metal pin was slid along the groove engraved before, causing the membrane vibration and the sound reproduction.

Wax coated cylinders for dictaphone. 1920 – 1930.

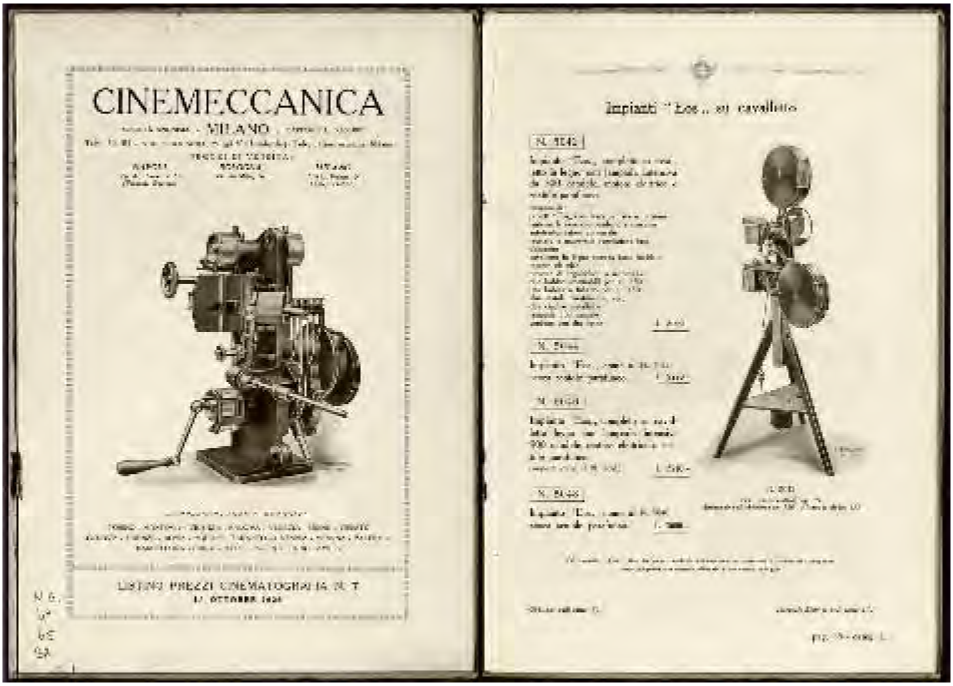
These wax-coated Dictaphone cylinders are housed in a special metal case. Each one allowed about 4 minutes of recording time.
They are hollow inside so that they can be mounted on the rotating cylinder of the Dictaphone.

Erasing unit of the Dictaphone,. 1920 - 1930.

Recording unit of Dictaphone was normally coupled with an erasing unit, used to level the surface of the engraved cylinders making them usable for another recording.

Movie projector, Cinemeccanica S.p.a.. 1926 – 1930.

The unit belonged to De Marchi. It is an assembly over a wooden tripod of a hand-cranked projector, named EOS 5046, equipped with an electric motor and a power supply system with transformer and rheostat for tension control. The lens is a Bush A.G. Rathenow mod. Ki, focal length 10 cm.



Pages from the catalogue of Cinemeccanica of 1926 advertising the Movie projector before illustrated.

New additions

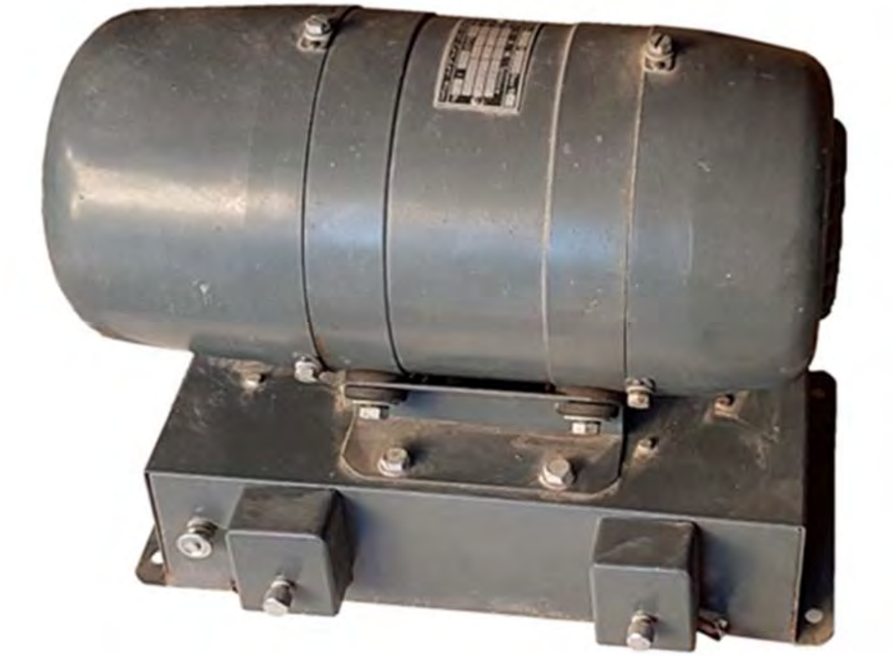
There are still many objects, owned by the institute or by private individuals, which have not yet been assigned to the museum but which are certainly worthy of being exhibited when the *Crypta Baldi* will be enlarged and reorganised. Some of these objects are briefly illustrated in the following pages.

Thin-window Geiger counter. Circa 1960.

In the 1960s, the Italian Institute of Hydrobiology began measuring primary production using the ^{14}C method. The measurements were carried out with a SELO multichannel thin-window Geiger counter, which has been lost.
This small instrument was used to monitor possible contamination.

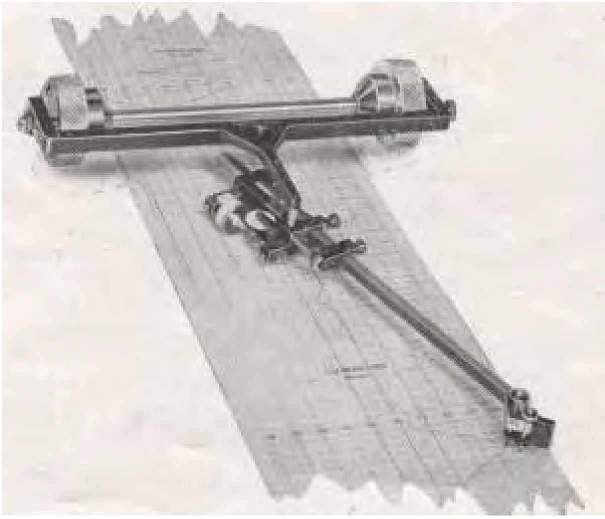
Stereovisor for photogrammetry. Officine Galileo. Circa1960.

It was used to define, , using aerial photographs, the boundaries of the catchment area of some lakes in the Lazio region whose bathymetry had been measured and charted.



Condor rotary converter, 12-110 V (1962)

This device was used in the 1960s and 1970s on board the ship "Gardo" to supply the electrical energy needed for certain electronic instruments.



Salmoiraghi planimeter with trolley. 1965.

It was used to digitise the analogue diagrams produced, for example, by instruments measuring solar radiation.

Marco De Marchi's telescope, first half of the 20th century

The 1958 photo on the left shows the telescope in the meteorological tower of the Institute.

Microscope illuminator Hellige. 1930 – 1940

Microscope illuminator Busch. 1930 - 1940

equipped with aspherical condenser with iris diaphragm, filter holder and lamp centring system.

Articulating arm for binocular microscope.

Microfilm reader, Microfilmfotorex s.r.l., Circa 1950