The Silkworm

History, Culture, Traditions and Science

A commented catalogue of the historical Silk Science and Technology collections housed at the former Experiment Sericulture Station of Padua

New edition for the centenary of the laying of the foundation stone of the Station's headquarters
1923–2023

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Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria

Esapolis

aracne
ADVOCATING THE ROLE OF SILK ART AND CULTURAL HERITAGE AT NATIONAL AND EUROPEAN SCALE

REGIONE DEL VENETO

Funded by the European Union
Grant agreement NO 101095188

"Felix qui potuit rerum
cognoscere causas"
Vergilius, Georgica, II, 490

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edited by *Gianni Fila* and *Silvia Cappellozza*

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Experiment Sericulture Station of Padua
as it appeared on September 13th, 1936

From a century of challenges to a future of innovation: the journey of the Experiment Sericulture Station at the Heart of Italian Silk Production

As we celebrate the centenary of the laying of the first stone of the Experimental Sericulture Station, we reflect on a long journey steeped in history. This prestigious institution has emerged as one of the oldest and most continuous expressions of excellence of the Council for Agricultural Research and Economics (CREA). This anniversary is not only a recognition of the past, but also a tribute to the resilience and innovation of the Station's staff. These qualities have guided it through crises and adversity, establishing it as a faithful guardian of the Italian silk tradition. For centuries, this tradition has significantly shaped Italy's productive identity over centuries, with the silk industry being one of our leading export sectors and a source of fundamental inventions in textile mechanics.

Founded at a time of deep crisis when the pebrine was devastating European sericulture, the Station quickly became a key player, bringing together science and practice to rebuild the agro-industrial silk chain on a modern scientific basis. Even in its darkest times, such as the recent environmental contamination by fenoxycarb that severely affected cocoon production in north-eastern Italy, the Station's tenacity and innovation led the way in reviving and enhancing its scientific heritage. The Station has broken new ground and is at the forefront of the revitalization of the silk industry and its by-products.

Today, CREA's Experiment Sericulture Station is a key reference point for sericulture at national and European level, participating in important international projects and bringing the sector back to the attention of many historically silk-producing Italian regions. A major strength of the Station is its living treasure: one of the largest germplasm banks in the world, housing precious collections of mulberry and silkworms selected over centuries, applying genetic knowledge to the cultivation of the plant and the rearing of the insect. These collections are carefully maintained through continuous propagation and reproduction, a unique feature in the Mediterranean Europe, including North Africa. This contributes to CREA's vast agrobiodiversity heritage and provides a significant competitive advantage for our country's agriculture and industry.

This role not only commits us to ensuring the survival of a species (the silkworm) that would not exist in nature without man but also frames our perspective to rethink agriculture as a sustainable and environmentally friendly productive activity.

Through the Experiment Sericulture Station, CREA participates with enthusiasm and professionalism in new scientific projects, rooted in the century-old history of the Station, in the knowledge that Italy can still make an excellent contribution to the to the entire silk supply chain.

Stefano Vaccari
General Director of the Council for Agricultural Research and Economics (CREA)

Sericulture and the Research Centre of Agriculture and Environment of CREA

The Experiment Sericulture Station was integrated into the Centre of Agriculture and Environment as a result of the 2015 restructuring that divided the Council for Agricultural Research and Economics (CREA) into 12 research centres. Unlike its previous affiliation with the Experiment Institute of Agricultural Zoology, this transfer fully embraces an important but less obvious area in which the Station might be valued: agroecology. The Centre of Agriculture and Environment of CREA is pivotal in researching innovative agricultural practices that meet growing demands (food, biomass for energy, biomaterials) of the primary sector and the economic needs of a growing world population, without overlooking the imperative of protecting and conserving Earth's natural resources.

The Experiment Sericulture Station has been at the forefront of this mission since its establishment, becoming a reference in sustainable agriculture.

Antonio Berlese (1863-1927), an entomologist, notably used natural methods for agricultural pest control, marking a turn in crop defense by introducing from China a hymenopteran as a biological controller of a parasite of the mulberry tree, the food source for silkworms. This hymenopteran, named *Prospaltella berlesei* by Berlese, has acclimatized in Italy and naturally controls the mulberry scale (*Pseudaulacaspis pentagona*) population without human intervention.

Mulberry cultivation and sericulture are being revalued not only for their economic value, but also for their important contribution to landscape conservation and the improvement of the soil quality, which protects the environment and supports a rich biodiversity. Moreover, they represent a vision of agricultural work as a cultural heritage, a body of knowledge and skills passed down through generations, creating a deep, respectful bond with the land. Mulberry cultivation practices, which prohibite pesticides and use moderate water resources, contribute to combating erosion and maintaining the ecological balance of hillside slopes. Furthermore, silk, a naturally biodegradable fibre made of protein chains, unlike synthetic materials, poses no disposal issues. The silkworm, which is highly sensitive to even the smallest doses of insecticides and other hormone-like chemicals, acts as an environmental sentinel, indicating an unpolluted environment through its health.

The circular economy is another element that characterises the entire silk agro-industrial chain, thanks to the potential to generate multiple by-products from insect rearing, mulberry cultivation, and the industrial processing of silk thread, as long as it is done with advanced technology that includes recycling and reuse. This approach offers significant added value. In this perspective, for which the Experiment Sericulture Station is working intensively, the ecosystem service provided by sericulture becomes an element of diversification and income integration for small businesses, contributing to the vitality of rural communities and preventing the abandonment of these areas. The multifunctionality of the supply chain is exemplified by the implementation of agroforestry, also known as regenerative agriculture, in which sericulture coexists harmoniously with other commodities while enhancing the agricultural landscape.

In celebrating the centenary of the laying of the first stone of the Experiment Sericulture Station, the management of the Centre of Agriculture and Environment (CREA) does not wish to nostalgically appreciate a cultural tradition and a glorious past but is determined to promote and support this supply chain and propose it as a model of symbiosis between agricultural production and environmental protection. The century-old history of the Station is more relevant today than ever, symbolising a future in which farmers can be guardians of the land from which they derive their livelihood and contribute to the well-being of the country.

Giuseppe Corti
Director of the Research Centre of Agriculture and Environment (CREA-AA)

The Experiment Sericulture Station: how it has changed in the years from the first edition of this catalogue to the present (2010-2023)

This introduction to the new edition of the historical collection catalogue of the Experiment Sericulture Station is a reflection on approximately thirteen years of work. During this period, the author had the responsibility and honour of organizing and supervising the scientific activities of the institution. These years have been marked by strong initiatives that have led to the expansion of activities and the development of numerous national and international relationships, re-establishing the Station as a world reference in the field of sericulture, similar to its position in the first years after its foundation. I would like to dedicate the great responsibility that I have had, including the safeguarding of the existence of the institution in which I work and its placement within the original scientific centre, and my commitment to maintaining the stability of all the staff, to all those who have preceded me in the management of this structure. For better or worse, with the limitations imposed by the different eras and historical crises they experienced, with their varied cultural and scientific backgrounds, and with their diverse capacity for vision and perspective, they have always been aware of being custodians of an immense and priceless heritage and they have done their utmost to pass it on to the generations that would follow them. I feel immense gratitude for all of them; I am also grateful to all those people, a dense mass of workers, technicians, collaborators, researchers, who have been the main driving force behind the activities of the Experiment Sericulture Station over the years, proud to be the guardians of specialized knowledge and the heirs of a noble past. It is to these staff members, who have taken over from one another over the years, often working under severe economic constraints, in the midst of a thousand bureaucratic entanglements, often in a precarious position, that we wish to dedicate these "stumbling stones". Without their sacrifices, none of what we are celebrating today would have been possible. Special thanks to those who have been part of "my team" and who have helped, supported, and trusted me during these beautiful and difficult years of great collective effort to achieve the goals we set for ourselves.

What were these goals and achievements? First and foremost, the maintenance of the mulberry and silkworm genetic collections has required a considerable economic and financial effort. Only through their continued practical application in research projects and collaboration with industrial sectors have we been able to provide the necessary support for their preservation. These efforts have brought us into contact with leading Italian and European fashion companies, and have led us to take part in national and European Community's research grants, thus increasing our experiences and professional development.

However, after the decline of sericulture in Northern Italy, especially in the North-east, due to the fenoxycarb issue, it was necessary to rebuild the silkworm cocoon production chain, which had been devastated by the use of this insecticide for about 20 years. Following the closure of the National Association of Silkworm Rearers in 2011, caused by the disappearance of a large number of silkworm farmers discouraged by the inability to produce cocoons, the Experiment Sericulture Station had to take over several functions previously managed by this organisation. Although not an institutional task, the Station's staff worked diligently to provide technical assistance to the remaining sericulture farmers and to train new ones. This involved the production and distribution of polyhybrid eggs (previously imported), the management of the collective rearing of early-instar silkworms, the drying and storage of cocoons, and support for the marketing of this product. The Station's efforts led to the creation of the 'Fair Silk Network' among Venetian silkworm rearers and collaboration with companies to develop products based on Italian cocoons, especially after the introduction of the new CAP in 2014, which ended the European economic contribution to fresh cocoon production. Finally, the collaboration with the Veneto Region, a key stakeholder in the rebuilding of the supply chain, has been significant. Firstly, through support for the 'Silk Road Revival in Veneto' business network project, a small silk reeling machine of the Experiment Sericulture Station was restored for niche production. This led to the development of a traceability process for Italian cocoons, with CREA drafting a specific protocol. Secondly, a five-year Rural Development Plan (RDP) project, 'Serinnovation', achieved significant results in terms of mechanisation and digital remote control of farms, as well as laying the groundwork for 'Made in Italy' production, with the creation of an Operational Group on Sericulture with implications for other regions. In addition, the Veneto Region funded the 'SilkPlus' Regional Operational Programme (ROP) project for the cosmetic and feed utilisation of cocoon by-products.

The Station's ability to communicate its results, first through joint activities with the Esapolis Museum and the 'Fair Silk' website initially, then through 'Serinnovation', has attracted international attention and fostered significant collaborations. For example, the co-design of the 'Silk Pavilion 2' by world-renowned architect Neri Oxman, which was presented at the Museum of Modern Art in New York in 2020, was woven by silkworms reared in Padua on a metal structure located at a company within our Operational Group. Other recent international contacts include collaborations with foreign biomedical companies, spin-offs from Oxford University, the French start-up 'Serycine', and international organizations such as BACSA 'Black and Caspian Seas and Central Asia Silk Association', which held the 'BISERICA' conference in Padua in 2013.

The Experiment Sericulture Station produces and distributes small quantities of high quality silkworm eggs, thanks to a health certification process in collaboration with the Local Health Department 16 (Euganean), to Italian rearers

and many in Europe (Spain, Portugal, Switzerland, Slovenia, France, Greece) as well as in North Africa (in particular, Egypt and Tunisia). It also contributes to the maintenance of a database on sericulture farmers.

The Station's strong commitment to scientific research has led to the acquisition of a biotechnological platform for the genetic modification of silkworms (the 'BioSilkRoad' project, funded by the Cariparo Foundation in 2013). It also participated as an associate partner in the 2018 European project 'Cinchron' to study the chronobiology of insects. Research on mulberry leaf substitutes in silkworm rearing has resulted in two patents on artificial diets, among many other patents registered by the Station's staff in various fields. The Station's commitment to the environment includes working with ICEA to register the Organic Sericulture Protocol (2015), which was been approved by MIPAAF and became a national standard. All eggs produced by the Station for farmers are currently certified organic.

Finally, in recent years, the Experiment Sericulture Station has developed a collaborative relationship with the Council of Europe to design a cultural silk route in Europe, facilitated by numerous joint conferences. This initiative led to the presentation of the 'ARACNE' project to the European Commission. According to APRE (Agency for the Promotion of European Research), out of 786 Italian project proposals in the 'Research and Innovation on Cultural Heritage and Cultural and Creative Industries' call, only three Italian-led projects were successful in 2022, including 'ARACNE', coordinated by CREA, which aims to revitalise silk art as an industrial sector and a form of intangible cultural heritage. The success of this prestigious objective, coupled with the collaboration with the Veneto Region in the drafting of a law on sericulture, including the creation of a Venetian tourist route, marks the culmination of a long process of developing the skills of its staff.

At this point in its history, the Station is ready to take on the scientific leadership and coordinatation of silk production in Europe, provided that its staff are able to achieve this significant feat.

Silvia Cappellozza
Head of the Sericulture Laboratory (formerly Experiment Sericulture Station) of Padua of the CREA - Research Centre of Agriculture and Environment

Esapolis: a living museum *ante litteram*

At the end of the 15th century, when Leonardo da Vinci was inventing machines for twisting silk threads and designing silk garments for Beatrice d'Este, the wife of Ludovico il Moro, Duke of Milan, and Venice was flourishing in trade, the area between Milan, Venice, and Mantua was what we would now call the golden triangle of silk. Ludovico "il Moro" named after his policy of revitalising agriculture through the cultivation of mulberry (Moro in Italian) to feed silkworms and produce silk, played a key role in this era.

Today, the silkworm is no longer such an important element of our economy, but it remains an important resource for many countries where its cultivation is more competitive, such as China, India, and Thailand. The legendary golden triangle of silk, geographically speaking, continues today, not only with the great silk industry but also with a series of cultural initiatives, museum projects, and new proposals coming from a historically renowned structure like the Experiment Sericulture Station of Padua, now the Sericulture Laboratory of CREA (Council for Agricultural Research and Economics).

On 3 May 2008, Padua enriched its prestigious museum park with a unique addition, positioning itself at the forefront of scientific dissemination and education. The project was born from the Provincial Administration's desire to restore the ancient building of the Sericulture Institute and create a new centre to renew and enhance Padua's centuries-old cultural and scientific heritage. In order to make this centre a dynamic place for dissemination, education, and research, and to involve and captivate the public, the Provincial Administration partnered with Butterfly Arc to embark on this ambitious project.

Butterfly Arc, the House of Butterflies in Montegrotto Terme, a leader in entomological exhibitions and scientific dissemination since 1988, took up the challenge. Commissioned by the Province of Padua, they have designed the largest living insect museum in the world. It is not only the largest in terms of exhibition space (2,500 sqm), but also in terms of the uniqueness of its collections; the opportunities for interaction with the exhibits, and its synergy with the Butterfly House in Montegrotto Terme, created the most completed naturalistic journey through insects ever seen.

The building, formerly home of the Sericulture Station, has been completely restored to its former glory. Equipped with innovative energy systems, including geothermal wells, heat pumps, and 500 sqm of photovoltaic panels, it has become a symbol of respect for the environment with zero CO_2 emissions, even before the installations were completed. It can be considered a state-of-the-art laboratory for the use of alternative energy resources.

The first exhibitions took place in 2008 with sections on silkworms, bees, expert naturalists, and two extraordinary photo/living exhibitions, unique

in the world. In 2009, the exhibition on insect adaptations, new interactive technological spaces, and even a 4D cinema were inaugurated. In addition, 'Arachnophobia', a room dedicated to the world of spiders, and later 'Insect Evolution', one of Esapolis' most significant halls created for the Darwinian centenary, were opened to the public. Here, visitors can understand the evolution of insects and come into direct contact with living fossils. In the years that followed, Esapolis continued to grow, dedicating space and resources to exhibitions and interactive workshops designed to engage visitors in unique experiences. This included the inauguration of 'Parasitopolis', a space dedicated to the fascinating and curious world of parasites, also made possible thanks to the contribution of the European Regional Development Fund, implemented as part of the Regional Operational Programme (2014-2020).

In addition, the Museum has been modernised, also thanks to the European programme 'Creative Europe' with the development of games and applications to increase interaction among visitors of all ages, as well as the introduction of features within the museum to make it more accessible to the visually impaired. Visitors can look forward to more new and exciting exhibitions and experiences in the coming years, taking them further into the extraordinary world of insects.

Esapolis has been designed to welcome visitors of all ages and backgrounds. The museum offers exciting educational and interactive workshops, particularly for schools, including one that recreates the atmosphere of ancient silk reeling plants, allowing visitors to experience silk reeling as previous generations did. In 2023, Butterfly Arc has continued to manage the museum, now joined by Kheprica, an association focused on enhancing the scientific aspect. This partnership manages the museum, promotes research, scientific dissemination, and collaboration with educational institutes, universities, and other organizations with expertise in the field.

Esapolis is a modern institution with a forward-looking vision, focused on providing space for public engagement and creating educational entertainment. It aims to convey scientific content and innovation through experiences and adventures centred on nature. It is essential to understand the wonders of nature and to appreciate the historical paths that have contributed significantly to humanity. Recognising the millennia-old roots of the silkworm and its role in mediating and sustaining the relationship between nature and man is essential for reassessing our future paths.

Enzo Moretto
Director of ESAPOLIS
and President of Kheprica

Lara Moretto & Gabriella Tamino
Administrators of Butterfly Arc ltd

The ARACNE project

This new edition of the catalogue of the silk collections, antique instruments, library, and historical archives of the Experiment Sericulture Station of Padova comes at a special moment in time, coinciding with the start of the activities of the European Horizon project 'ARACNE' (Advocating the Role of silk Art and Cultural heritage at National and European Scale). This project, supported by the European Community under Grant Agreement No. 101095188, involves the participation of Italy (the lead partner), France, Spain, Slovenia, Greece, Bulgaria, and Georgia in an attempt to recover the European silk cultural heritage in order to give new impetus to the cultural and creative industries of the sector. The definition of possible entrepreneurial developments related to silk is now very broad and not limited to museums as cultural industries or fashion as a creative industry. The new uses of silk, the frontiers opened up by materials science, and the impact of digitalisation on the cultural world, make it possible for silk to become a veritable neural network that can innervate the various sectors of our economy.

The ARACNE project focuses on the cultural heritage of European silk production and its preservation, protection, and valorisation; it aims at revitalising traditional skills through the adaptive re-use of the common cultural and artistic legacy and at shaping European cultural identity linked to silk. Silk, literally and metaphorically, a thread that has woven together European culture, has greatly contributed to the development of the European economy and arts. The production and the past and present development of the silk sector can again be the common basis for a future European Silk Route, conceived as a cultural itinerary across Europe. In order to create an extensive and well-connected network that, starting from the historical path followed by Marco Polo in his travels to the East, and including the routes of silk production and commercialization in Europe in the subsequent centuries, we aim to:

• Bring silk production back in vogue by reconstructing a resilient and innovative silk ecosystem that reflects the concerns of European countries and promotes traditions, architecture, and both tangible and intangible heritage. The consolidation of a European Silk Route will encourage links and joint activities among European cities and regions, in particular among museums, study and research centres, to strengthen the preservation and protection of their culture and promote innovation in production and trade;

• Contribute to improving the skills and competitiveness of European silk-related Cultural and Creative Industries through the renewal, co-development, and implementation of human-centred and place-specific silk-based cultural products, processes, and service innovations, leveraging digital applications and cutting-edge technologies, to foster the transition to more sustain-

able business models, promote economic and social growth, and strengthen the reputation of European countries abroad. The project will also meet the Green Deal and New European Bauhaus macro-objectives.

ARACNE started in March 2023, and in its context, the partnership has already performed some important activities such as the identification of ancient mulberry trees on the national territory of the different countries and the collection of samples for DNA genetic analysis, cuttings for multiplication and phenotypic characterization of collections in Italy, Bulgaria, Slovenia, and Spain, the selection of some ancient silkworm strains, the start of the work with schools to discover and map the cultural heritage linked to silk in the area covered by the project, and informative and communicative events, such as this volume.

After more than one hundred years of history, the former Experiment Sericulture Station of Padova and the Esapolis Museum, that emerged from it, show surprising vitality and initiative in a joint effort that projects them into the future.

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Story of the Station

The Experiment Sericulture Station was established in Padua in 1872 according to a decree of King Vittorio Emanuele II, issued in the previous year, thanks to the proposal of the Minister of Agriculture, Industry, and Commerce. From reading the decree, we clearly understand the purpose of stimulating scientific research on the silkworm and mulberry tree, especially in the field of pathology, to fight the various diseases and disseminate healthy silkworm eggs, to promote sericultural activity through writings and conferences, to conserve germplasm, and to solve practical problems for rearers, including through the establishment of special courses or practical training. The main motivation for the creation of the institution must be found, however, in the determination to end the crisis that had hit Italian sericulture as a result of the pebrine disease epidemic (*Nosema bombycis*) spread throughout Europe since 1845.

It is worth noting that the scientific activity carried out depended not only on the contingent historical moments but also on the personalities and attitudes of the different directors. Thus, under the direction of Enrico Verson (1872-1919) anatomo-physiological studies on *Bombyx mori* flourished, with very comprehensive investigations for that age; under that of Luciano Pigorini (1924-1953) chemical investigations were carried out in particular on the silkworm eggs, along with the embryological studies of Remo Grandori and Amelia Tonon; Porzia Lorenza Lombardi (1958-1965) directed research to the formation and preservation of new pure lines and crossings; Enrico Masera (1931-1967), a prominent figure, although he never held the position of full director, dealt with the pathology of the 'silkworm'; finally Glauco Reali (1969-1987) focused on the technical-economic issues to be solved for a revival of national sericulture, in years when Chinese silk was very competitive.

Luciano Cappellozza (1992-2008) tackled the challenge of transitioning the Sericulture Station from its status within the ISZA (Experiment Institute of Agricultural Zoology), which it had joined in 1967, through the various upheavals that led to the establishment of CRA-API (the Italian reference body for research in apiculture and sericulture). This was formed in 2004 by merging the Station itself and the National Institute

On the opposite page:
Ceremony of laying the foundation stone, March 21, 1923.

Enrico Verson (1845 - 1927).

of Apiculture (INA). His action was to promote a synergy of objectives between the MiPAF (Ministry of Agricultural and Forestry Policies), the Ministry of the Environment, the Province of Padua, and the 'Cassa di Risparmio' Foundation of Padua and Rovigo, which resulted in the creation of a research, conservation, and museum hub on sericulture of great symbolic value for the city of Padua (2006).

In general, if one analyses the amount of research conducted by the Station, in its various aspects, there is a noticeable imbalance between the number of studies performed on the silkworm (*Bombyx mori*) and those dedicated to the mulberry (*Morus sp. pl.*). It should not be forgotten that both Verson and Pigorini were graduates in medicine, which explains their greater interest in studying animal physiology and anatomy rather than plants. Due to the fact that the plant is regarded solely as a food for the silkworms, the limited research that is pertinent to this subject is focused solely on identifying varieties that can optimise silk production and quality by satisfying the insect's nutritional requirements. On this line are the efforts to discover other plant species that can replace the mulberry's nutritional function, or the experiments on leaf conservation to enable to conduct silkworm rearing in the winter as well.

A significantly larger area of research is that concerning *Bombyx mori* and other insects closely related to it, either as predators (*Dermestes lardarius*) or disease vectors (*Nosema bombycis* or pebrine) or as potential re-

Professor Enrico Verson visits the construction of the new site of the Sericulture Station (winter 1923-1924).

placements for silk production.

As for the study of the silkworm's anatomy, Verson thoroughly examined every facet over his years of patient work (1871-1919), leaving behind a notable collection of anatomical-pathological specimens, that are beautifully displayed in the "Padua Collection" showcases.

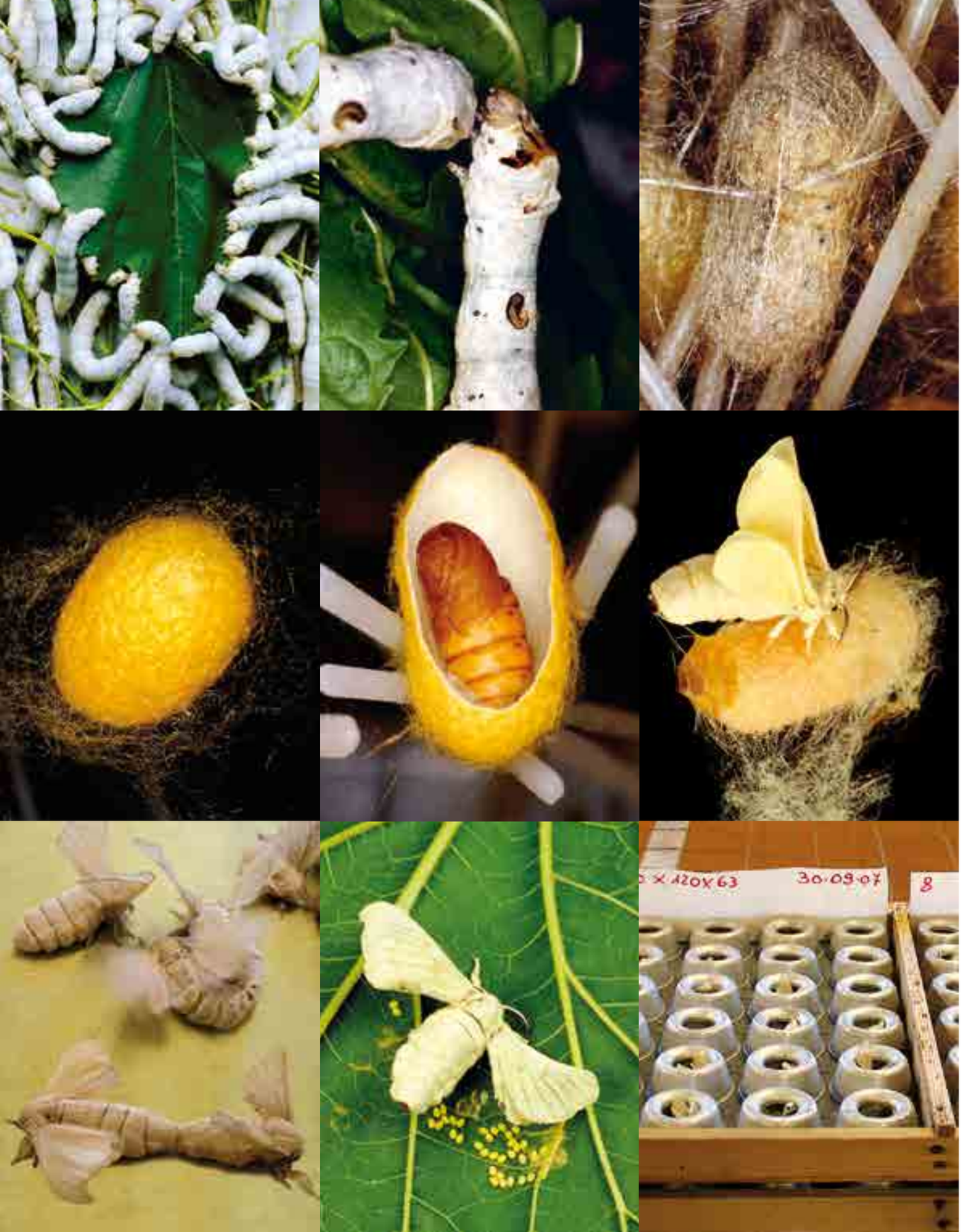
The Station has also dealt with the rearing techniques, particularly in relation to containing the spread of diseases: from the optimal temperature and humidity, from the rationalisation of the facilities and structures used to grow and reproduce the insect, to the correct techniques of mating and silkworm egg selection.

Comparative studies on the different strains of *Bombyx mori* were initiated by Quajat in 1890, to compare strains imported from China, Japan, and Persia with the native ones. The impact of environmental conditions was then evaluated in an effort to select local ecotypes that would be best suited for a given location. Advances in genetics (Mendel's laws) have led to the exploitation of hybrid vigour and, consequently, to the testing of crosses for the production of polyhybrid eggs; another area of investigation was the genetic determinism of bivoltinism (two generations of rearing per year).

As evidence of all the work carried out in this regard by the Station, there remain the four display cases in which the 'Padua Collection' is preserved, a collection of 2200 cocoon samples that document, across different periods in which they were collected, the results of the selection operations of pure breeds of different origins and the realization and evaluation of crosses.

The alternating fortunes of Italian sericulture, which fell into crisis again after the Second World War, led to the merger of the Padua Station, later named after Verson, with that of Ascoli Piceno, whose activities concluded in 1958. From Ascoli, one of the two silk collections was inherited, along with many silkworm races and some mulberry cultivars. In 2006, the headquarters of the Station was transformed into the Museum of Living Insects (Esapolis), which still houses the sericulture collections, the archive, and the historical library, while the research institution was transferred to the adjacent restructured silkworm rearing facility (*bigattiera*) for this purpose.

Enrico Quajat (1848 - 1914).



The Prospects of Sericulture at the Beginning of the New Millennium

The Council for Agricultural Research and Economics (CREA)

In 1967, the Sericulture Station of Padua became part of the Experiment Institute of Agricultural Zoology (ISZA) in Florence, under the name of Specialized Section of Sericulture of Padua. The organization, in its various branches, was directly dependent on the Ministry of Agriculture and Forests. Many years later, with Legislative Decree 454/99, the CRA (Agricultural Research Council) was established, bringing together 28 agricultural research and experimentation structures, with 54 peripheral operational seats, under the supervision of the MiPAF (Ministry for Agricultural and Forestry Policies). In this context, the CRA-API (Research Unit for Apiculture and Sericulture) was formed in 2004 from the merger of the National Institute of Apiculture (INA) and the Sericulture Section of the Experiment Institute for Agricultural Zoology (ISZA). However, the reorganization was not yet complete, and in 2015, the CRA was remodeled into 12 Research Centers, 6 sector-specific and 6 transversal, which, with the incorporation of INEA (National Institute of Agricultural Economics), was finally renamed CREA (Council for Agricultural Research and Economics). The former Experiment Sericulture Station suffered greatly from these reorganizations, which threatened its very existence and diminished its role, turning it into a 'laboratory' of the Research Centre of Agriculture and Environment after more than a hundred years as one of the most prestigious international institutions in sericulture.

The Establishment of the CREA/Province of Padua Research and Museum Hub

One of the main issues for the former Experiment Sericulture Station is that the property of the building and the area where the experimental mulberry orchard is located belongs to the Province of Padua, while the research activity is conducted by the CREA staff. Over time, this has led to poor maintenance of the buildings, which by the end of the 1990s and the beginning of the 2000s, had reached a state that limited their use for experimental activities. In order to prevent the situation from

On the opposite page:
Silkworms at the fifth instar; beginning of cocoon spinning; completed cocoon; cocoon in section with chrysalis; newly emerged adult; courtship and mating; egg laying; isolator for the deposition of single egg batches.

becoming worse and ultimately leading to the institution's closure, the then-director Luciano Cappellozza worked on a comprehensive agreement between MiPAF and the Province, which involved the transfer of the Station from the building that had been occupied until then, to create a provincial museum centre (Museum of Living Insects and Sericulture – Esapolis), in exchange for the authorization to use for research and experimentation the former silkworm rearing facility and the experimental mulberry field.

The agreement was ratified in 2006, the year in which the silkworm rearing facility, restored for its current use, was handed over to CREA with this understanding: the lease for the first ten years would be free of charge, in exchange for the possibility to display in the Museum the CREA's silk collections, instruments, archives, and library, while for the following years, CREA would pay an annual fee to the Province to be defined between the parties. The 'Cassa di Risparmio' Foundation of Padova and Rovigo played a fundamental role in the project, and its president, Antonio Finotti, committed to financially support the restoration operations; the Ministry of the Environment financed the geothermal and photovoltaic installation for heating/cooling and energy production. In 2008, the Esapolis Museum opened to the public, entrusted by the Province to the management of the Butterfly Arc, under the scientific supervision of Enzo Moretto who designed and implemented its educational and museum pathways. Starting from the last year (2023), the Museum is entrusted to the non-profit Association Kheprica, still under the same scientific direction.

The CREA Sericulture Laboratory: the prospects

In the 1980s, due to the excess of traditional agricultural productions and the shortage of natural fibres for the textile industry, mulberry sericulture seemed to represent a viable alternative for entrepreneurs in the rural world, and the EC began to grant funding to support cocoon production (subsidy to farmers per silkworm egg box). The environmental value of mulberry cultivation for reforestation of hilly and marginal areas was emphasized. However, in 1988, the insecticide Insegar (active ingredient 'fenoxycarb') was registered in Italy for the fight against phytophagous insects of fruit plants (particularly apple and peach). The active ingredient has a negative effect on the silkworm even in infinitesimal doses. The pesticide treatments carried out on orchards contaminate the mulberry leaf even many kilometers away. It is the so-called 'syndrome of

the failed silk spinning of the silkworm', which acts by altering the hormonal balance of the insect and preventing it from spinning the cocoon and transforming into an adult. Despite a series of legislative measures being taken, the illegal use of the product continued, undermining the foundations of sericulture.

The Ministry of Agricultural and Forestry Policies, in order to safeguard the sector so seriously compromised, entrusted the Specialized Section for Sericulture of Padua of the ISZA with a project aimed at 'Production of new technologies for the relaunch of Italian sericulture' (Ministerial Decree 272/7240/98 of 25/05/98).

Within the scope of the research activity, significant results were achieved, such as the development of a substitute food for mulberry leaves and genetically transformed silkworm lines. In addition, genetic and phenological studies were undertaken to exploit the various mulberry cultivars present in the Padua seat's collection (60 different varieties), also thanks to the ministerial program Vegetable Genetic Resources - FAO. The germplasm collection of *Bombyx mori* currently consists of about 200 strains, having been enriched with materials from the French collection of INRA, following the closure of the National Sericulture Unit of Lyon at the end of 2009.

The problem of Italian sericulture, in addition to the pollution from pesticides, is mainly represented by the Chinese monopoly of the silk

market. For this reason, the research of the Station has been strongly directed towards advancing the automation of mulberry leaf harvesting and silkworm rearing, and towards independence from seasonal cycles (thanks to the introduction of a substitute diet for mulberry leaves in the rearing practices). Moreover, there has been an effort to valorise all by-products of the mulberry and cocoon, with the aim of reducing the production costs of silk for textile uses, also distributing them on the 'by-products'. To this end, the staff of the Station is studying, together with the industry, a series of alternative uses to textile ones, particularly in the bio-medical and cosmetic sectors, which are the most promising; this occurs on two fronts: 1) the silkworm is used as a bio-reactor, to assemble pharmaceutical-use proteins, which are secreted in the silk glands and subsequently extracted and purified; 2) fibroin is used in the form of regenerated or native membrane, as a substrate for cell cultures, to form prostheses (e.g., artificial tendons), for neural bridges, vascular accesses, for bandages with slow release of active ingredients, useful in the treatment of burns. Sericin is also used in cosmetics, and both proteins for the creation of bio-sensors.

In the textile sector, the Italian industry uses silk for high-quality products, especially technical fabrics, where silk fiber is often combined with other natural or artificial fibres to create special effects of comfort or shine. But there is also a growing trend in the production of luxury accessories made of silk and precious metals (for example, silk and gold jewellery).

Industry analysts anticipate that the price of silk on the worldwide market would climb in the medium term, as demand grows due to a rising section of the world population that can afford luxury items. On the other hand, China is undergoing a rapid process of industrialisation and urbanisation, similar to that experienced, but at much slower rates, by post-war Italy, leading to a reduction in lands cultivated with mulberry, and the abandonment of sericulture practices, which are still laborious and traditional in the poorer regions of the Chinese country. In addition, there has been a surge in interest in mulberry cultivation for purposes that were previously regarded as secondary in recent decades, giving rise to the notion of mulberry's multiple applications. The alternative uses consist of the production of:

- protein-rich biomass,
- biomass for thermal energy production,
- fibrous biomass for composite industrial materials,

- fresh mulberries for direct consumption and confectionery semi-finished products,
- pharmacological and cosmetic active ingredients.

In addition to these uses, there is an application not specifically related to production, which concerns the particular suitability of mulberry to be used in environmental contexts, such as in phytoremediation processes.

These new directions of modern mulberry cultivation are based both on experiences developed in the past and on new experiments conducted in different countries. The interest in alternative uses of mulberry is supported by the great adaptability of this species, which makes it capable to colonize lands that are being abandoned and degraded.

Recently, the staff of the Station has been trying to valorize, in addition to the technological aspects, also the cultural and touristic aspects of the Italian and European silk tradition through regional and international projects to recover and exploit the ecosystem of knowledge and skills related to the 'European Silk Road', also to the benefit of cultural and creative industries.

The Silk Road

The silkworm strains in the footsteps of Marco Polo

The origin of the silkworm

The ancestor of the silkworm is the mulberry-feeding wild insect *Bombyx mandarina* Moore, which is still found in various regions of central Asia. The legend attributes the domestication of the silkworm to Princess Si-Ling-Chi (third millennium BC): this popular tradition in fact acknowledges the fundamental role played by women not only in the rearing of larvae, but also throughout the whole production process, from cocoon reeling to fabric weaving.

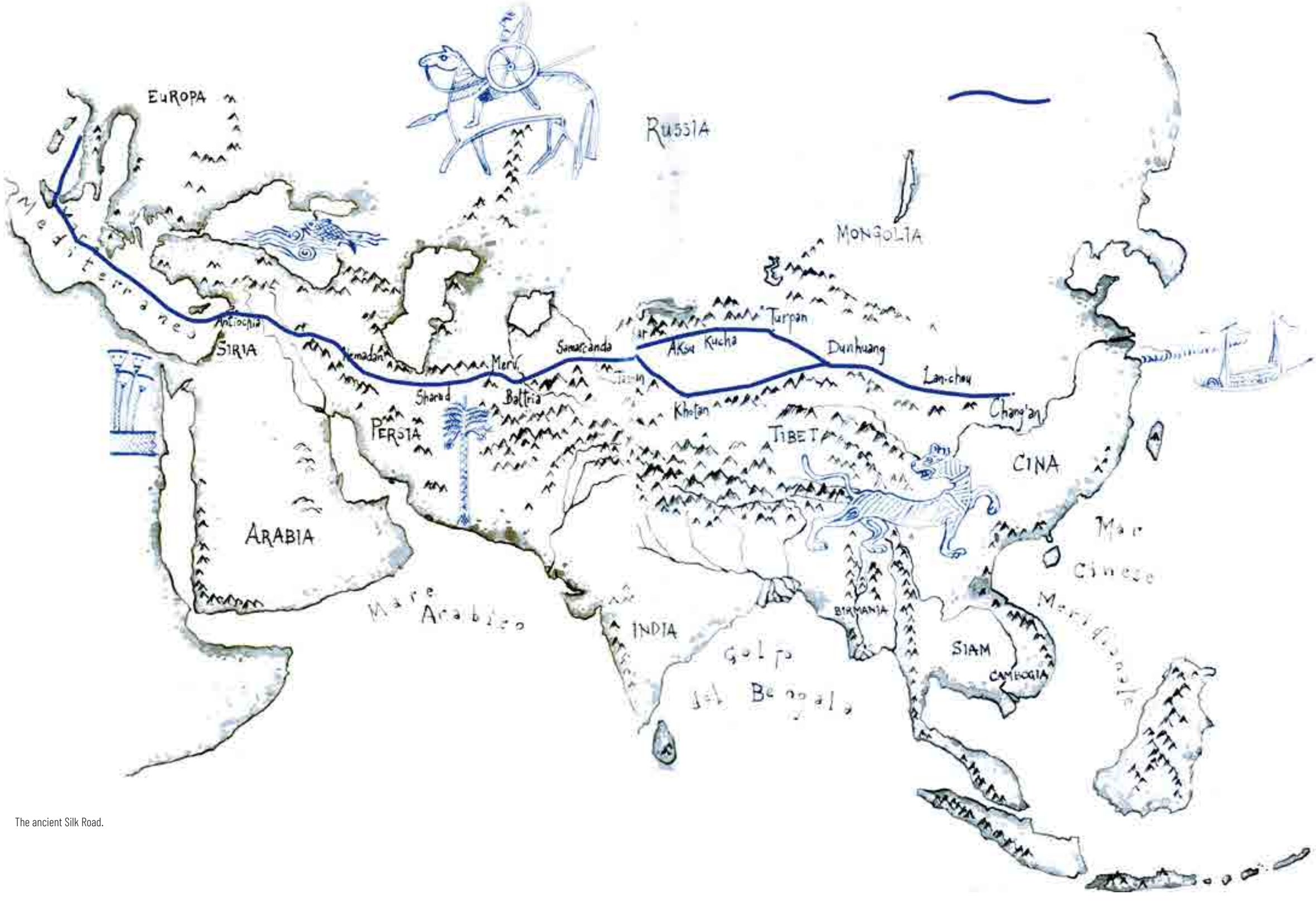
Archaeological evidence in our possession places the start of sericulture in the fourth millennium BC (middle, lower course, and delta of the Blue River and area of the Tai Lake); however, other studies confirmed the presence of silk remains in the tombs of Jiahu dating back approximately 6500 years. In the sixth century BC, the Scythians, a people of the steppes north of the Black Sea, mediated occasional silk exchanges between the Chinese and the Greeks, but starting from the third century BC silk began to be regularly exported from China to the West, and during the Hellenistic period a steady trade route was established between India, Central Asia and the West.

The Silk Road

The term was coined by the renowned German geographer and geologist Ferdinand von Richthofen in the introduction to the work '*Tagebücher aus China*' in the late nineteenth century to denote the complex network of trade routes that connected China to the West through Central Asia.

Not only silk travelled along these routes, but the most diverse commodities, including perfumes, spices, gold, metals, medicines and, most importantly, cultural influences in the form of religious concepts, spiritual values, and artistic techniques. Oases, or safer locations than the steppe and deserts were established along the roads for rest and trading; along the most trafficked routes, caravanserais, fortified settlements, cities, monasteries were built. From Ch'ang-an, the Han imperial city (now Xi'an), the products were transported to

On the opposite page:
the Ming imperial chariot with flags, silk painting. Taipei, National Palace.



The ancient Silk Road.

From the top: Sericulture in the ancient Asia; Saint Basil, Bishop of Caesarea; Map of Constantinople.

Ostia, Alessandria and other ports of the Roman Empire via the eastern coast of present-day Turkey.

Romans and silk

According to legend, the Romans were defeated in the war against the Parties (Battle of Carre, 53 BC) because they were terrified by the brilliance of the silk bands of the enemy army, which were deployed in the sun. The historical truth is that the Parties introduced silk to the Romans, and it became a highly-sought-after commodity among the affluent classes. The emperors intervened to regulate its use, considering it to be less virile. The Romans used to reweave Chinese fabrics and to dye them with purple in Syria, but until the first century AD they believe the fibre be of vegetable origin, partly due to the secrecy maintained by the Chinese regarding its true nature. However, sericulture began to expand outside China in the third century AD (towards Bukhara and Samarkand, now in Uzbekistan).

The Silk in the Eastern Roman Empire

According to Procopius, two monks sent by the emperor Justinian succeeded in taking possession of the eggs of the silkworm and bringing them to Constantinople, hidden in the hollow of their stick. Justinian started the rearing of silkworms under a true monopoly system, re-proposing the Chinese model. Sericulture reached its pinnacle, including its technical aspects, between the eight and twelfth centuries.

Silk in the Arab world

Following the Arab conquest of the Bukhara and Samarkand region, silkworm rearing spread like wildfire throughout the Islamic world, both in the East and in the countries bordering the Mediterranean. The Arabs also became silk lovers, although Muhammad had insistently deprecated luxury and well-being. Muslim textiles reached Byzantium and Western European countries.

Silk in Italy

Sericulture probably arrived in Italy between the tenth and eleventh centuries as a result of the simultaneous introduction of diverse peoples (Arabs, Byzantines and possibly Jews), in multiple zones of influence. The earliest evidence of the production of raw silk dates back to 1037 and pertains to the area of Avellino, but shortly there-

after the silkworm quickly spread throughout the South. In the Centre-North weaving presumably appeared first, followed by sericulture only later (Bologna, Genoa, Lucca, S. Severino Marche in the XII century), Fossombrone, Sulmona (XIV century), Florence (XIV or XV century).

The silkworm strains

The domestic silkworm has been differentiating over the centuries and in relation to the environmental conditions to which it was subjected into distinct geographical strains, which are referred to as Asiatic, if they have developed in the original area, or European if they are descended from the first stocks imported from the Byzantine Empire around the sixth century AD. The distinction between these strains resides primarily in their morphological characteristics, which involve the cocoon, larva and egg; or their physiological traits, mostly associated with behaviour, moulting, the number of generations completed in one year, and silk production.

Keystone insisting on the ceiling of Capodilista Villa on the hill of Montecchia, a work by Dario Varotari the Elder (1539-1596), painter and architect, the father of Padovanino. The image of the insect, until a few years ago considered mysterious, probably represents a rare 16th-century image of a silkworm moth, a time when, in this territory, sericulture was one of the elements of renewal and a driving force in agriculture.

From the top: Lodovico il Moro; Beatrice of Este; Eleonora of Toledo.

Traditional rearing

The methods and equipment for rearing silkworm in Italy have been presented in a harmonious and almost identical manner in both technical-scientific and descriptive-popular literature from the seventeenth century to the early twentieth. In fact, it was only through the breakthroughs in the microbiological field initiated by Pasteur and his fellow researchers that it was possible to understand the transmission dynamics of the most prevalent pathologies and thus to distinguish between rationally necessary rearing techniques and superfluous or even harmful methods or interventions, based on traditional superstitions or practices with no demonstrable basis.

The rearing rooms

Rearing facilities had to be spacious, with large windows for the exchange of air and a heat source to obviate sudden temperature changes or better manage the excessive humidity that could be. Prior to the start of rearing, this environment and all the instruments were meticulously cleaned and sanitised, as there was no cure for the majority of the worm's potential diseases, necessitating careful prevention. In reality, only the largest companies had a 'bigattiera', a building specially devoted to the rearing of the silkworms (called 'bigàtti'). In the houses, the larvae were placed in the family's living rooms, the kitchen and adjoining chambers, the barn and even the bedrooms.

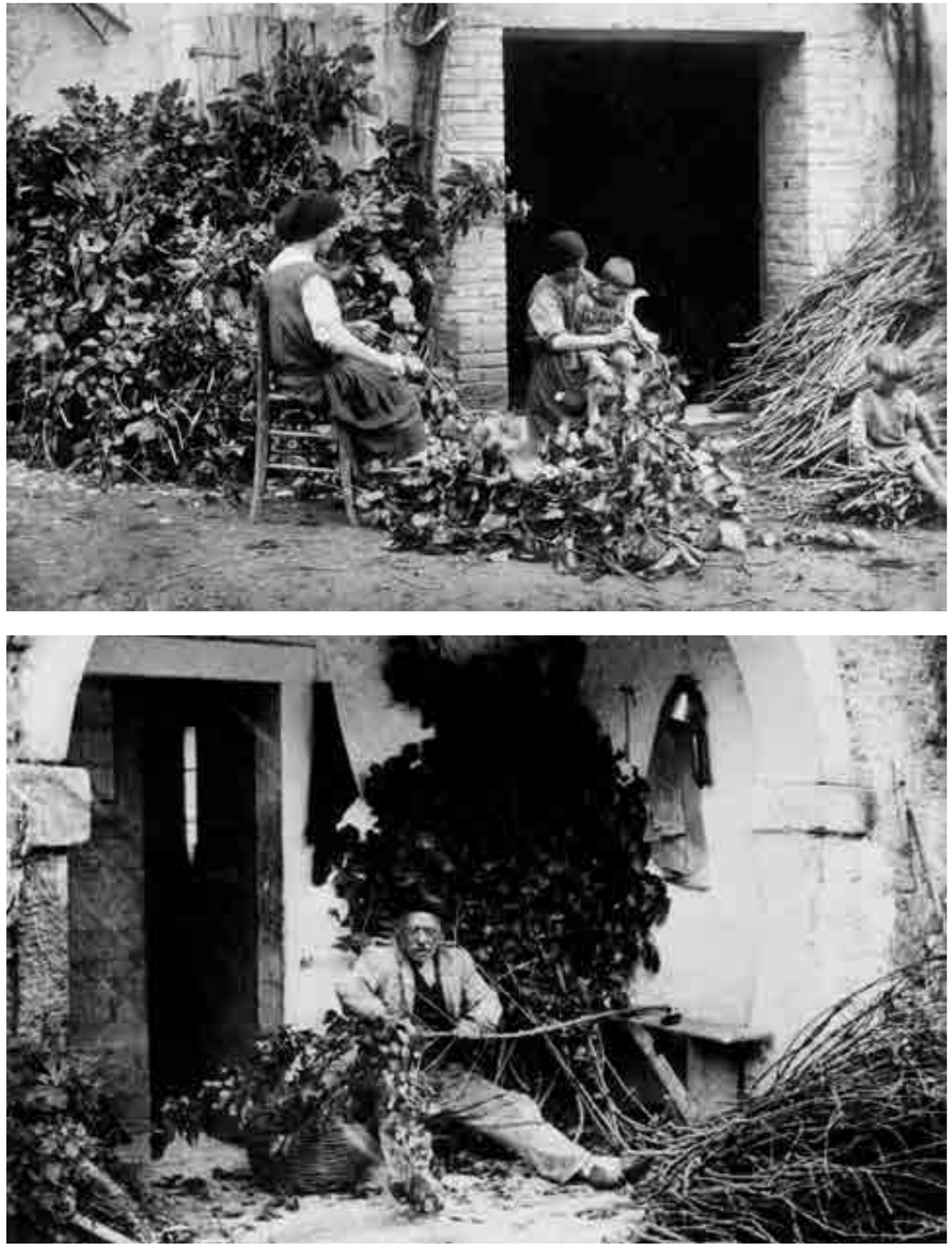
Egg incubation (silkworm eggs)

To ensure the contemporaneity of larval eclosion and synchronisation with food availability, the eggs were incubated, in the case of large farms, in special rooms under controlled temperature (incubators), or, at home, heated by the kitchen, placed among mattresses or even brought into the women's breast. If the eggs and the early instars of the worm's life were incubated at home, they were put in a kind of box suspended from the ceiling to prevent dangerous intrusions by ants or other invaders.

REARING FRAME FOR YOUNG LARVAE

Description: wooden box with the bottom made of marsh reeds. Handle and hook in wire to hang it.
Function: The box was hung at home to contain and protect the young larvae of the first instars
Author: Handicraft manufacture
Cultural area: Veneto
Dating: Late 19th - early 20th century
Category: Agro-silvo-pastoral activities
Type: Bed for silkworms
Materials: Wood, canes, iron wire
Size (cm): 87 x 55 x 8 h
State of preservation: Fair
Location: Esapolis Museum - ground floor
Bibliography: Bolle, G. (1908)

Silkworm rearing in a rural environment. At the top: removal of cocoons from the plant mountage frameworks used to let silkworms spin their cocoons.
At the bottom: rearing in the Friulian branch method. Feeding with whole branches.



Silkworm rearing in a rural environment. Manual defoliation of the branches to obtain leaves for feeding the larvae.

SILKWORM EGG INCUBATOR

Description: The object consists of a wooden body, supported by long legs, with a door with a glass insert on the front. Inside, a removable frame carries nine removable trays, with gauze bottom, and a system of tubes allows the circulation of air or heated water. Under the central body, a wooden base acts as a support, adjustable in height with a rack, for housing the heating device.
Function: to provide the silkworm eggs with a progressively increasing temperature, until it becomes constant and controlled, in order to synchronize larval hatching among eggs and with the availability of mulberry leaf.
Author: La Cosentina Casella – Cosenza
Cultural area: Italy
Dating: Late 19th - early 20th century
Category: Manufacturing activities
Type: Incubator for silkworm eggs
Materials: Wood, sheet metal, iron, glass
Size (cm): 50 x 34 x 107 h
State of preservation: Fair - to be restored as trays are missing
Location: Esapolis Museum - first floor
Inventory number: III, 352 bis
Bibliography: Bolle, G. (1908)

The rearing

The silkworm larvae, which had begun to develop, were then transferred to the rearing room and placed on various types of structures that supported fixed or mobile shelves, often made up of canes: the so-called 'beds'. Every few hours the voracious and perpetually hungry animals were given meals based on mulberry leaves, which in the early instars had to be sliced with knives or special machinery (leaf-cutters), to encourage feeding by young larvae. During the four moults, which each lasted a couple of days, the larvae remained motionless and ceased foraging; therefore, they should not be disturbed. Immediately thereafter, it was possible to change the beds, luring fasting animals with fresh leaves, to let them pass through a perforated paper or a net, so that they completely abandoned the previous bed comprised of already exploited branches, dried leaves, and frasses. This would also allow for enlarging the space dedicated to larvae, necessary for the continuous increase in the size of the worms.

The 'cavallone friulano' method

Towards the end of the 1800s another rearing method, known as 'cavallone friulano' became widespread. Unlike the previous methods, which involved individual leaf separation from the shoots, the entire fresh mulberry shoots were harvested and leaned them inclined to a trestle, to form a thick interweaving, on which the larvae were placed to live since the fourth age. As the silkworms consumed the leaf, new sproutings were provided. Therefore, much labour was saved: in the field, as pruning branches is faster than picking the leaf, and in the rearing, because it was no longer necessary to change the beds. Furthermore, the leaves remained fresh for longer; there was better air circulation, and the worms were healthier.

When the silkworm was ready to spin the cocoon

As the time came for the larvae to spin, indicated by the worm ceasing to leaf feeding and attempting to climb upwards, it was necessary to prepare the mountages, which were bundles of twigs or straw that were properly aired and dry, with no leaves or other residues that may spoil the cocoons. The spinning framework had to be carefully prepared, as it needed to be sufficiently open to allow air circulation and facilitate the silkworm's cocoon weaving, without being overly large to prevent wastage of silk when the silkworms anchored themselves to distant supports. Broom, heather and rape dry branches were excellent to build the mountages; even straw could perform the same function with good results.

Cocoon harvest and first processing steps

The final phase of rearing was the collection of cocoons, their sorting, for the elimination of the doupions or the stained ones, and the deflossing, or removal of the outer and fluffy filament used to anchor the cocoon to the mountage. For this purpose, special deflossing machines were used; subsequently it was possible to calibrate the cocoons, that is, to divide them according to the size.

Normally, the vital activity of the silkworms reared for the production of cocoons to be reeled was terminated at the chrysalis stage, since the emergence of the moth, which causes the weave of the cocoons to weaken, would severely harm their quality. For this reason, after about 10 days from the mounting phase, the collected cocoons were sent to the storage centres, where they were dried with hot air currents and then stored, awaiting further processing.

LOMBARD REARING FRAME

Description: Structure composed of four poles that extend from the floor to the ceiling, supporting shelves with surfaces made by 'arelle' or 'graticci' built with marsh reeds.
Function: This traditional rearing system was traditionally utilised in Lombardy and Veneto. The shelves might be made with wooden boards or racks built with intertwined canes or branches and, in some cases, could be directly attached to the wall.
Author: Local handicraft
Cultural area: Lombardy-Veneto
Dating: Around 1900
Category: Agro-silvo-pastoral activities
Type: Lombard rearing frame
Materials: Wood, marsh reeds
Size (cm): 318 x 174 x 178 h
State of preservation: Good
Location: Esapolis Padua Museum, ground floor
Inventory number: III 352 bis
Bibliography: Bolle, G. (1908); Casella, L. (1919)

SILKWORM EGG INCUBATOR

Description: It consists of a wooden piece of furniture with long legs and a front glass door. It has ten trays with strips inserted in a removable structure, and a tube system enables air or warm water to circulate. Under the central body, a wooden base serves as a support, adjustable in height with a rack, for housing the heating device.
Function: To gradually raise the temperature of the silkworm eggs until it becomes stable and controlled, in order to synchronise the larval hatching among eggs and with the availability of mulberry leaf.
Cultural area: Italy
Dating: Late 19th - early 20th century
Category: Manufacturing activities
Type: Incubator for silkworm eggs
Materials: Wood, sheet metal, iron, glass
Size (cm): 50x34x107 h
State of preservation: Fair - to be restored
Location: Esapolis Museum - first floor
Inventory number: III 353
Bibliography: Bolle, G. (1908)

HAND-CRANKED LEAF CUTTER

Description: Handcrafted instrument with a wooden box holding the leaves and a steel blade operated by a hand crank. Manually-operated lever feed piston.
Function: The machine was used to cut the mulberry leaves that were fed to the silkworms during the initial larval instars of their life cycle.
Author: Officina meccanica G. Pradello & figli, Vittorio Veneto
Cultural area: Veneto
Dating: Around 1900
Category: Manufacturing activities
Type: Leaf cutter
Materials: Wood, steel
Size (cm): 112 x 52 x 116 h
State of preservation: Good
Location: Esapolis Padua Museum, ground floor
Inventory number: III, 71
Bibliography: Bolle, G. (1908)

LEAF CUTTER

Description: Hand-crafted tool, with a wooden box for the leaves and a steel blade with manual movement. Piston for manually operated lever feed.
Function: The machine was used to cut the mulberry leaves used to feed the silkworms in the early period of their life cycle, i.e. the first larval instars.
Author: Officina meccanica G. Pradello & figli, Vittorio Veneto
Cultural area: Veneto
Dating: Around 1900
Category: Manufacturing activities
Type: Leaf cutter
Materials: Wood, steel
Size (cm): 115 x 50 x 94 h
State of preservation: Good
Location: Esapolis Padua Museum, ground floor
Inventory number: III 494

NET FOR BED CLEANING

Description: Hemp twine net with wide mesh of 2 x 2 cm
Function: Net for bed cleaning consisting of varied thickness threads with varying mesh sizes based on the silkworm instar. When the insects are still fasting in the early morning, perforated papers or nets are put on top of them, and the leaf is distributed above: the insects do not take long to pass through the holes of the paper or the meshes of the net, attracted by the fresh leaf that is placed above. After a few hours, the operator moves the paper or net with larvae to another shelf, widening the branches in order to widen the space dedicated to the rearing.
Author: Local handicraft
Cultural area: Veneto
Dating: 1900-1950
Category: Agro-silvo-pastoral activities
Type: Net
Materials: Hemp twine
Size (cm): 300 × 145
State of preservation: Good
Location: Esapolis Museum, ground floor
Bibliography: Bolle, G. (1908); Casella, L. (1919)

TRADITIONAL MOUNTAGE

Description: Bundle of intertwined branches tied to the bottom end
Function: A support structure that facilitates the cocoons formation process by fully developed silkworms. It was usually placed above the structures used for insect rearing.
Author: Local handicraft
Cultural area: Veneto
Dating: 1900-1950
Category: Agro-silviculture-pastoral activities
Type: Traditional mountage
Materials: Branches of broom, twine
Size (cm): 145 h
State of preservation: Good.
Notes: Cocoons of *Bombyx mori* are present.
Location: Esapolis Museum, first floor
Bibliography: Gallese, G. (1950); Bolle, G. (1908)

COCOON DEFLOSSING MACHINE

Description: A machine consisting of an inclined plane on which rough metal cylinders revolved in the opposite direction of advancement of the cocoons. Driven by a manual handle.
Function: The machine was used to free the cocoons from that silky complex of weak and tangled burrs (floss silk), with which the silkworm secures itself to the mountages
Author: Officina meccanica G. Pradello & figli, Vittorio Veneto
Cultural area: Veneto
Dating: 1900-1950
Category: Manufacturing activities
Type: Deflossing machine
Materials: Wood, steel
Size (cm): 160 × 60 × 120 h
State of preservation: Good
Location: Esapolis Padua Museum, first floor
Inventory number: III, 549
Bibliography: Bolle, G. (1908); Carboni, P. (1947); Gallese, G. (1950)

Egg production

The activity of the sericultural institutes and plants aimed at the creation of disease-resistant strains capable of providing good quantitative and qualitative production, at the education of the rearers, to ensure correct worm rearing conditions and above all at the production and distribution of healthy eggs.

Operations at the facilities

The operations involved in the egg production facilities comprised the following stages: cocoon collection and stocking, sorting, cocoon sexing, moth emergence, egg laying, stocking of mother moths for the subsequent analysis, moth grinding, microscopic inspection, washing and disinfection to obtain loose eggs, egg hibernation. All these operations were carried by a workforce composed almost exclusively by female employees, frequently younger than 14 years old. The workers were organised into teams overseen by a supervisor or by a worker with more seniority of service. The cocoons used for reproduction belonged to pure lines, obtained avoiding crossbreeding between different genetic accessions. Cocoon sorting involved the separation of the waste cocoons from the first quality ones. The process was carried out manually, eliminating malformed or stained individuals, visibly sick or not meeting the standards of the strain.

The management of the hatching until the laying of eggs

If the cocoons were separated with a rotatory scale to separate male from female cocoons (see figure on page 46), the sexing of the chrysalis occurred before eclosion (the moment when the adult insect emerges from the cocoon). Alternatively, at the time of eclosion, males were immediately separated from females to avoid random mating within the same lineage. Females (recognizable by their more static behavior and larger abdomen), after mating with selected males, laid their eggs separately, in paper or gauze bags. In this way, each batch of eggs could be identified and possibly eliminated, if the moths that produced it was

On the opposite page: cocoon sorting in a picture of the early '900.

MOTH GRINDING MACHINE

Description: Machine consisting of ten pistons that operate separately on as many containers, in which the sample to be ground is placed. The movement is given by a pedal and transmitted to the pistons through a series of gears.
Function: Machine utilised for grinding moths in silkworm egg production facilities, to assess the health status of the moths that have laid the eggs and eliminate the pebrine-contaminated ones on the basis of the microscopic examination.
Author: Banzani and Uboldi, Milan
Cultural area: Italy
Dating: 1900-1950
Category: Manufacturing activities
Type: Mechanical grinding machine
Materials: Wood, metal
Size (cm): 64x69x110 h
State of preservation: Good
Location: Esapolis Museum, first floor
Inventory number: III, 495

found to be diseased. After egg-laying, in fact, the just dead moths could be crushed through a special grinding machine, and the juice obtained was subjected to microscopic examination to assess the possible presence of microorganisms, among which the most feared was undoubtedly *Nosema bombycis*, the causative agent of the incurable pebrine. Healthy egg batches were instead preserved through estivation and hibernation. This practice was necessary to synchronize the larval hatching with the availability of mulberry leaves. To prevent the premature embryonic development due to early spring warmth, the silkworm eggs were stored in special places (ice houses) where the temperature did not exceed 2 °C.

COCOON SEXING SCALE

Description: Eight-arm balance, with each arm consisting of a rigid rod to which a housing for the cocoon is pivoted, connected to a counterweight below. On the arms, there are weights for calibrating the instrument according to the standards of the considered breed.
Function: Comparing the weight of the cocoons from the same batch and strain could allow a summary distinction between cocoons containing female chrysalides (heavier) and those that would have given rise to males. This is done to prevent random coupling at the time of emergence.
Author: Unknown. Chinese manufacture
Cultural area: China
Dating: Uncertain
Category: Manufacturing activities
Type: Cocoon sexing scale
Materials: Wood, brass, iron
Size (cm): 60x60x19h (wooden base 29.5x29.5x4h)
State of preservation: Good
Location: Esapolis Museum, first floor

Silkworm egg packaging.

On the opposite page: microscopic examination to verify if the pathogenic pebrine agent is in the moth's tissues, after egg laying, in a laboratory at the beginning of '900

The silkworm diseases

The very long period of domestication of the silkworm and the human selection for productivity have reduced its resistance to both natural predators and diseases. As these diseases in a very short life cycle organism cannot be cured, the only solution is to prevent their occurrence through proper rearing methods. The muscardine is the oldest known disease in history, dating back to the beginning of the eighteenth century; the others all appeared in more recent times, in the second half of the nineteenth century. In scientific literature, the silk moth diseases most frequently mentioned are: muscardine, pebrine, flacherie and two viruses mentioned with their common and widespread denominations.

Giant models of healthy and diseased silkworm larvae (early '900): the students attending courses at the Experiment Sericulture Station used these tools to study and learn to identify the different pathologies in the insect. From the left: pebrine, muscardine, healthy larva, bacterial flacherie, viral flacherie and nuclear polyhedrosis.

On the opposite page:
Microscopy laboratory. Ascoli Piceno, early '900.

PEBRINE AFFECTED LARVAE

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Whole specimens in glass containers, preserved in a mixture of distilled water, glycerine and 90% alcohol
Description: Pebrine affected larvae that is a disease caused by the fungus *Nosema bombycis*, with the body covered by blackish spots
Size (cm): Ø 6 x16 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor
Bibliography: Cornalia, E. (1871); Masera, E. (1960); Pasteur, L. (1870)

MUSCARDINE AFFECTED LARVAE

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Whole specimens stored in glass containers, maintained in a mixture consisting of distilled water, glycerine and 90% alcohol.
Description: Larvae infected by muscardine, i.e., by a disease caused by the *Beauveria bassiana* fungus, with the characteristic chalky appearance, due to crystals of calcium oxalate produced due to the infection.
Size (cm): Ø 6 x 12 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum – ground floor
Bibliography: Quaiat, E. (1878)

The most dangerous diseases for the silkworm

Muscardine: It is caused by the parasitic fungus *Beauveria bassiana*, which can infect the insect at every stage of its life cycle, making the larva, chrysalis or moth itself to resemble pebbles.

The pathogen infects the cuticle of the silkworm via microscopic spores of the fungus; when these spores come into contact with the animal, they germinate into hyphae, which later develop into mycelia that perforate the epidermal layers and proliferate in the viscera. After three or four days, the mycelium kills the animal, germinates outward and produces spores. The body of the dead larva shrinks considerably, becomes brittle and is covered with a whitish chalky powder, formed by the fungus' spores.

The etiological agent was discovered by Agostino Bassi in 1807 and named after him; the experimental conclusions obtained from the study of this disease gave rise to what is arguably the most influential concept in the history of medicine, the microbiological theory of infectious diseases, later taken up by Pasteur's subsequent studies.

Pebrine: it is caused by the fungus *Nosema bombycis* and is hereditary (it is transmitted from the mother to the offspring); the diseased larva becomes inappetent and shrivels, at the same time its body is covered with blackish spots called petechiae. The name 'pebrine' comes from the Provençal 'pebre', meaning pepper, due to the appearance of the spots on the larval body. When pebrine appeared in the mid-nineteenth century it dramatically reduced cocoon production. The concern generated by its rapid spread was the major motivation for the foundation of research institutions such as the Sericulture Station of Padua.

Flachery: determined by cytoplasmic polyhedra, infectious flacherie, or intestinal bacterial diseases. Its symptoms are typically most noticeable when the insect is about to spin the cocoon; it reduces the larva to a rotting, foul-smelling shell filled with blackish liquid ('negrone').

Gattine: This term was formerly used to describe a collection of symptoms (loss of appetite, vomiting and diarrhoea) that are associated with a noticeable reduction in larval length and turgor, which eventually results in the larva's death within a brief period of time. This behaviour may be caused by various etiological agents such as bacteria, or the

aforementioned viruses of flachery. If an animal is struck in the last instar, it may even spin a little cocoon in which it dies without developing into a chrysalis.

'Giallume' (Nuclear Polyhedrosis): it is a chronic disease so visible symptoms appear in the silkworm generally in the last days of its development; it is caused by the virus that causes nuclear polyhedrosis. The distinctive traits of the disease are: swollen body segments, laceration of the cuticle with loss of white or yellow haemolymph (liquid), which is dense (because it is rich in viral capsules or virions), loss of appetite, wandering. The word 'giallume' (roughly equivalent to 'yellowish appearance') derives from this discharge of yellow fluid in strains that produce coloured cocoons and have the haemolymph pigmented with carotenoids.

Agostino Bassi (1773 - 1856).

NUCLEAR POLYHEDROSIS VIRUS AFFECTED LARVAE

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Whole specimens in glass containers, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Yellowish larvae by *Nuclear Polyhedrosis Virus*, a parasitic disease that often causes the yellowing of the larval body.
Size (cm): Ø 6 x16 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor
Bibliography: Quaiat, E. (1878)

MICROSCOPE KORISTKA

Description: Multi-magnification microscope with revolver lenses. The optical tube is positioned vertically and is kept in place by a stand that is grafted onto a support base in the lower section. Immediately underneath the objective is the holder for the sample to be studied, with a graduated device for measuring it and the possibility of moving along the Cartesian axes. A hole in the middle allowed the passage of the light necessary for the observation of the transparency of the sample; the light was collected thanks to a freely adjustable mirror positioned immediately below and concentrated by a condenser, essential in cases of high magnification.
Function: The microscope has the purpose of magnifying small samples of material (typically biological) in order to analyse their morphology and structure.
Author: Flli Koristka, Milan
Dating: 1900-1950
Category: Optics
Type: Optical microscope
Materials: Metal, glass
Size (cm): 14x18x35 h
State of preservation: Good
Note: Supplied with eyepiece holder (inv. III, 41 and 42)
Location: Esapolis Museum - first floor
Inventory number: III, 5
Bibliography: Cornalia, E. (1871); Perroncito, E. (1876)

MICROSCOPE ZEISS

Description: Microscope of relatively simple construction; the optical tube, in fact, is positioned vertically and is held in place thanks to stand which, in the lowest part, is grafted onto a support base. Immediately below the objective is the plate on which the sample to be analysed was placed. At its centre a hole allowed the passage of the light necessary for the observation in transparency of the sample; the light was collected thanks to a freely adjustable mirror positioned immediately below.
Function: The microscope has the purpose of magnifying small samples of material (usually biological) in order to enable the study of their morphology and structure.
Author: Carl Zeiss, Jena
Dating: Around 1870
Category: Optics
Type: Optical microscope
Materials: Metal, glass
Size (cm): **6**x12x24 h
State of preservation: Good
Notes: Supplied with box-container and lens holder cm. 24X17x9 h (inv. III, 32)
Location: Esapolis Museum - first floor
Inventory number: III 8
Bibliography: Cornalia, E. (1871); Perroncito, E. (1876 and 1879)

OILY LARVAE

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Whole specimens in glass container, preserved in a mixture of distilled water, glycerine and alchol at 90°.
Description: Oily larvae, presumably suffering from disease caused by the virus of *Citoplasmatic polyhedrosis*
Size (cm): 4.5 x 2 x 12 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum, ground floor
Bibliography: Quaiat, E. (1878)

On the opposite page:
the ancient collection of old microscopes of the Museum

The ‘Padova’ sericultural collection (1871-1960)

Ground floor

The Royal Experiment Sericulture Station of Padua mantained a silk collection, created by the first Director, Prof. Enrico Verson and his assistant, Dr. Enrico Quajat, and later curated by Dr. Amelia Tonon; the specimens were collected and ordered between 1871 and 1960 and include 2,200 samples of silkworm cocoons, as well as fabrics and yarns.

Annual and bivoltine crosses (end of 1800 - beginning of 1900): the bivoltine are strains featured by two generations per year: they are divided into populations that produce white cocoons, which were introduced from China and Japan in 1881, and yellow cocoons (Asian and Italian as well as their respective two-three-four-way hybrids). The bivoltine strains were taken into consideration particularly for carrying out two rearing cycles in the same year: one in spring/summer and one in summer. Due to their low productivity, rearing bivoltine strain lost relevance in Europe with the discovery of the method to induce the artificial hatching of eggs through treatments with acids. Despite their occasional inclusion in the crosses owing to their resistance to diseases, bivoltine strains eventually became only of scientific interest.

Japanese strains: particularly those with green cocoons, were used during the pebrine outbreak (1884-1908). The disease, caused by a microsporidium fungus (*Nosema bombycis*) is transmitted from the mother moth to the offspring, in the infected e ovipositions. When this disease spread throughout Europe, the silkworm production industry was no longer able to provide healthy eggs to farmers, who, therefore, were forced to import them from Japan. Unlike the indigenous strains, which were generally yellow in color, the Japanese ones were white with greenish tones (the so-called green strains). The use of these strains was completely abandoned when the disease was eradicated; the inclusion of microscopic examination of moths in the regular practice of silkworm egg production was employed as an effective disease prevention method.

COCOONS AND GREEN JAPANESE YARN

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons and yarn, in glass containers
Origin: Japan
Rearing: Padua
Description: Cocoons of the Japanese green strain, reared in Italy to introduce pebrine resistance genes into the local germplasm via cross-breeding. Yarn obtained from the same strain’s single cocoons and with 5 hands, to evaluate its productivity.
Size (cm): Ø 8 x 20 h
Dating: 1900
State of preservation: Excellent
Location: Esapolis Museum - ground floor

GOLDEN CHINESE COCOONS SPUN BY LARVAE REARED IN CHINA

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: China
Rearing: China
Description: Chinese strain cocoons from larvae reared in China; they belong to a group of samples collected with the intention of comparing the characteristics of rearing cycles conducted in different locations or comparing cocoons from the countries of origin of the strains with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1933
State of preservation: Excellent
Location: Esapolis Museum - ground floor

The Japanese cocoons were, in fact, of poor quality when compared to those of the European strains and had a tendency to produce dupions (two cocoons spun together by the larvae that weave the threads) and to rust (defect of the cocoon consisting in a staining of the same).

Crossing of old strains: crosses were performed primarily to enrich the strain of origin with those robustness characteristics that were lost during productivity-oriented selection ('re-blooding'). Since the second decade of the 1900s, the concept of heterosis, or hybrid vigour of crosses, was fully understood, and the phenomenon was systematically exploited for the production of polyhybrid silkworm eggs.

Dyed silk: silk may be dyed using either chemical or natural colorants. As a matter of fact, silk has a strong affinity for dyes due to the quality of the proteins that compose it.

Pure lines and crosses (1918-1960): the cocoons of the pure lines are presented as both distinctive examples of the strain, and as crossbreeds. The goal of crossing, as explained above, was to improve the quality and product characteristics of silk. In this regard, samples of single-cocoon reeling are present in the collection, which are important for assessing the overall length achieved by the silk thread.

Pure lines and Japanese crosses in use since 1953: after the introduction of Mendelian genetics to the production of the silkworm eggs from the second twenty years of the twenthieth century, the Japanese sericulture leaped ahead; pure lines and Japanese crosses began to be imported into Italy. Since then, pure Japanese lines have been utilised, together with the Chinese ones, for preparation of excellent crosses.

Artificial silk: synthetic fibres are obtained from petroleum and are made up of more or less long filaments. They vary depending on the starting raw materials, organic or inorganic, as well as the manufacturing processes. Synthetic fibres first appeared on the market after 1940 and quickly became popular: the most widely used being polyester, nylon, acrylic, and polyamide. In general, for the making of clothes, these fibres are blended with natural ones to create soft, wrinkle-free and highly resistant textiles. The comparison with silk of natural origin was crucial, especially at a time when artificial silks were gaining market share.

AFRICAN COCOONS

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: Africa
Rearing: Cape of Good Hope (South Africa)
Description: Cocoons of an unidentified African strain, reared at the Cape of Good Hope; they belong to a collection of specimens gathered with the intention of comparing the characteristics of rearing cycles conducted in different locations, or comparing cocoons from the countries of the strain origin with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1918-1960
State of preservation: Excellent
Location: Esapolis Museum - ground floor

YELLOW COCOON STRAIN REARED IN AMERICA

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: China
Rearing: America
Description: Cocoons of the Chinese Yellow strain, reared in America; they belong to a group of specimens collected with the intention of comparing the characteristics of rearing cycles held in different places, or compare cocoons from the countries of origin of the strain, with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1918-1960
State of preservation: Excellent
Location: Esapolis Museum - ground floor

GOLDEN CHINESE COCOONS SPUN BY LARVAE REARED IN RHODES

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: China
Rearing: Rhodes (Greece)
Description: Cocoons of a Chinese strain reared in Rhodes; they belong to a group of specimens collected with the intention of comparing the characteristics of rearing cycles conducted in different locations or comparing cocoons from the country of origin of the strain with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1934
State of preservation: Excellent
Location: Esapolis Museum – ground floor

Various yarns and fabrics (1872-1914): the yarns are made from single cocoons, two or four cocoons. Samples of twisted silk and hand-spun silk or reeled with more rational methods (reeling machines) are also exhibited. Furthermore, samples of silks degummed with the use of water of various types and in different ways can be observed as well as fabrics made with *Bombyx mori* silk and silk of wild silkworms.

Anatomical preparations and diseases of *Bombyx mori*: you can admire anatomical preparations obtained with extreme skill: the silk glands and the entire secretory apparatus of the fibre (silk glands, silk ducts, and spinnerets), female genital apparatus, Malpighian tubules, nervous system, muscle bundles, cuticle.

The preparations regarding sick silkworms mainly describe fungal diseases (muscardine) at all stages of the silkworm's life cycle.

Plant fibres and fabrics: In 1886 the 'Mulberry linen' plant was founded in Vittorio Veneto by Giuseppe Pasqualis, former director of the city's sericulture observatory. He wanted to use the shoots of the mulberry tree, which were generally used as firewood after being stripped of their leaves, to obtain a textile fibre, called 'gelsolino' (mulberry linen), which is found under the thin bark. It was employed to obtain a variety of cheap fabrics with strong resistance. Mulberry is similar to hemp for this characteristic of strength of its fibre. The industry did not last for long since the mulberry fibre became even more expensive than the silk waste, leading to the closure of the plant towards the end of the century. Currently mulberry is studied, along with a few other dozens of species, because it may provide fibres suitable for the production of composite materials, that is to say supports made of a fibro-cellulosic matrix combined with small percentages of synthetic binders. In the showcases, in addition to the jasmine fibers, the fibers obtained from the stem of *Cannabis sativa* (hemp), belonging to the Cannabaceae family, and the ramie, the fibre obtained from the stem of *Bohemeria nivea*, a member of the Urticaceae family, very valuable for the brightness and sturdiness, are exposed. Furthermore, one of the most important mineral fibres is shown: asbestos, a set of minerals from the silicate group, used because

From the top:
Mulberry linen, shoots and fibre, 1887;
ramie, fibre, 1886.

On the opposite page:
histological laboratory of the
Experiment Sericulture Section of
Padua in the early 1900s.

FEMALE REPRODUCTIVE APPARATUS

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Zootomic preparation in a glass container, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Female genital apparatus
Size (cm): Ø 6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor

DORSALLY OPENED LARVA

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Zootomic preparation in a glass container, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Dorsally opened larva.
Size (cm): Ø 6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor

SKIN WITH STIGMAS

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Zootomic preparation in a glass container, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Larva skin (fifth instar).
Size (cm): Ø 6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor

VENTRALLY OPENED LARVA

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Zootomy preparation in a glass container, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Ventrally opened larva.
Size (cm): Ø 6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor

NERVOUS AND MUSCULAR SYSTEM

Collection: Padua
Definition: Anatomical specimen
Object: Silk moth (*Bombyx mori*). Zoological preparation in a glass container, preserved in a mixture of distilled water, glycerin, and 90% alcohol.
Description: Nervous and muscle system
Size (cm): Ø 0.6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum, ground floor

SILK GLANDS

Collection: Padua
Definition: Anatomical specimen
Subject: Silkworm (*Bombyx mori*). Zootomy preparation in a glass container, preserved in a mixture of distilled water, glycerine and 90% alcohol.
Description: Silk glands: silk production apparatus.
Size (cm): Ø 6 x 16.5 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum - ground floor

ROTARY MICROTOME

Description: Precision cutting tool, with vertical specimen movement controlled by a crank. A micrometric mechanism (1 tooth = 0.001 mm) controls the advancement of the sample to be sectioned.
Function: Used to obtain particularly thin sections of biological tissue (up to 2 microns), ideal for transparent observation under an optical microscope (the very thin section of the sample allows light to pass through).
Author: E: Zimmermann, Leipzig
Cultural area: Europe
Dating: Early 20th century
Type: Microtome
Materials: Metal
Size (cm): 23x23x20h
State of preservation: Good
Location: Esapolis Museum, ground floor
Inventory number: III, 101

SLIDING MICROTOME

Description: Precision cutting tool, defined as a "slide" because the piece to be cut slides on an inclined plane, being processed by the blade, which glides on a horizontal plane, enabling cutting. The advancement of the sample to be sectioned is regulated by a micrometric mechanism.
Function: Used to obtain particularly thin sections of organic tissue (up to 2 microns), ideal for transparent observation under an optical microscope (the very thin section allows light to pass through the sample).
Author: R. Jung, Heidelberg
Dating: 1900-1950
Type: Sliding microtome
Materials: Metal
Size (cm): 35x10x16
State of preservation: Fair
Location: Esapolis Museum, ground floor
Inventory number: III, 141

BINOCULAR MICROSCOPE

Description: Binocular compound microscope, equipped with two optical tubes that enable three-dimensional vision by permitting the observer to examine the sample with both eyes. It features a micrometric focus adjustment. The optical tubes are positioned in an oblique manner by means of a vertical support, with the lowest part being affixed onto a horseshoe-shaped base. Placed directly beneath the objective is the plate containing the sample to be analysed. A hole in the plate centre allowed the passage of the light necessary for observing the sample in transparency; the light was collected by a freely adjustable mirror positioned immediately below. The instrument has also two wooden hand rests that are grafted into special screws placed on the sides of the stage table, where the forearms are positioned during the dissection operations.
Function: The microscope aims at magnifying small samples of material (usually biological) in order to analyse its form and structure. It was used by Enrico Quajat to make anatomical preparations.
Author: Carl Zeiss, Jena
Dating: Around 1900
Category: Optics
Type: Optical microscope
Materials: Metal, glass, wood
Size (cm): 54x20x32 h
State of preservation: Good
Notes: Supplied with eyepieces and replacement lenses
Location: Esapolis Museum - first floor
Inventory number: III, 12
Bibliography: Cornalia, E. (1871); Perroncito, E. (1876); Quajat, E. (1878)

it is incombustible, impervious to acids or alkalis, and a bad conductor of heat and electricity. Its heat resistance and its fibrous structure make it suitable as a fireproof material for garments and furnishing fabrics, but its toxicity has led to its prohibition in Italy by Law 257/1992. Asbestos powders, if inhaled, cause asbestosis, which may lead to pleural cancer, or pleural mesothelioma, both of which are fatal. An asbestos fibre is 1300 times thinner than human hair. There is no risk threshold below which the concentration of asbestos fibres in the air is safe: inhaling a single fibre can cause mesothelioma and other deadly diseases.

Furthermore, collodion can be seen, which is a solution (in the proportion of 3/2) of cellulose nitric esters in an ethyl ether/ethyl alcohol mixture. Exposed to the air, this solution forms a transparent and elastic film that is used to preserve medicaments, make lacquers and in photography.

Dyed cocoons: obtained by adding pigments to the mulberry leaf, on which silkworms fed: the result is represented by small cocoons of odd colours (blue, violet...) that have reduced dimensions, since the larvae have been adversely affected by the addition of chemical dyes.

Strains imported from China-Japan-Persia and bred in Italy from 1871 to 1918: they were imported from various Asian countries with the hope of acclimating them and exploiting them for commercial rearing. Most of this important group were abandoned because some of them were difficult to acclimatise and did not give the expected results, either as strains as they were or as crossbreeds; others did not acclimatise at all. The cocoons of these strains are exposed, comparing the characteristics of rearing cycles conducted in different times or locations, or comparing cocoons from countries of strains' origin with those obtained in Italy, after selection.

***IN VIVO* DYED COCOONS**

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons and yarn, in glass containers
Rearing: Padua
Description: Violet cocoons, obtained from larvae fed with mulberry leaf treated with Kreyselplan
Size (cm): Ø 8 x 20 h
Dating: 1907
State of preservation: Excellent
Location: Esapolis Museum - ground floor

COCOONS OF THE BUKHARA STRAIN REARED IN KASHMIR

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: India
Rearing: India
Description: Bukhara cocoons, from larvae reared in India; they belong to a group of samples collected with the intention of comparing the characteristics of rearing cycles held in different places, or compare cocoons from the countries of origin of the strains with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1871-1918
State of preservation: Excellent
Location: Esapolis Museum - first floor

YELLOW COCOONS OF THE VOLGA STRAIN

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: Russia
Rearing: Russia, Astrakhan region
Description: Yellow cocoons of the Volga strain reared in Russia; they belong to a group of samples collected with the intention of comparing the characteristics of the rearing cycles held in different places or compare cocoons from the country of origin of the strain, with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1871-1918
State of preservation: Excellent
Location: Esapolis Museum - first floor

CHINESE WHITE CONSTRICTED COCOONS

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Origin: China
Rearing: China
Description: White constricted cocoon of a strain reared in China; they belong to a group of specimens collected with the intention of comparing the characteristics of rearing cycles held in different places, or compare cocoons from the countries of origin of the strain, with those obtained in Italy, after selection.
Size (cm): Ø 8 x 20 h
Dating: 1900
State of preservation: Excellent
Location: Esapolis Museum - first floor

First floor

Cocoons and yarns of old European and Italian strains, studied since 1871: Strains imported from China-Japan-France-Eastern Europe and reared in Italy from 1871 to 1918: they were imported from various Asian and European countries in the hope of acclimating them and using them for commercial rearing. Of this important group, most were abandoned because some of them acclimated with difficulty and did not yield the expected results, neither as pure lines nor as crosses; others did not acclimate at all. Of these strains, the cocoons are displayed, comparing the characteristics of rearing conducted in different epochs or places, or comparing cocoons from the countries of origin of the strain, with those obtained in Italy, after selection.

Bivoltine strains and crosses (1881-1914): also shown here, as in the showcases in the ground floor, are bivoltine strains and their crosses. The bivoltinism character has been the subject of extensive research, which led to the conclusion that it is determined by maternal inheritance, that is, the mother moth is fundamental for the characteristics of egg hatching, while the male, at least in the first generation, is irrelevant. Today it is known that the bivoltinism character is largely regulated by environmental phenomena such as the incubation temperature of the eggs, temperature during larval rearing and the duration of the photoperiod (day-night alternation).

Crossings of old strains (1881-1914): crossing was practiced essentially to enrich the strain of origin with characteristics of robustness that were lost during the selection process for productivity ("re-blooding"). From the second decade of the '900 the phenomenon of heterosis, or hybrid vigour of crosses was fully understood, and this knowledge was systematically exploited for the production of polyhybrid silkworm eggs.

Romagna - Calabria - Sicily - Abruzzo - Lombardy - Piedmont (silk regions - strains used from 1918 to 1935): these are the strains utilised by industry for the production of silkworm eggs from 1915 to 1922 and from 1923 to 1936 (grouped by regions). The cocoons on display testify the presence of sericulture activity in many regions of Italy, with local strains, adapted to the various environments. The

COCOONS FROM A CROSS: WHITE COCOON BIVOLTINE X GOLDEN COCOON X KNOBBED LARVA STRAIN

Collection: Padua
Definition: Biological specimens
Subject: *Bombyx mori* cocoons, in a glass container
Rearing: Padua
Description: Cocoons from a poly-crossing with a bivoltine strain
Size (cm): Ø 8 x 20 h
Dating: 1907
State of preservation: Excellent
Location: Esapolis Museum - first floor

dominant strains were the yellow ones, with a fine filament.

Parental lines: parental silkworm populations, used in the establishments for 'Parental lines' and selected by the Ascoli Piceno and Padua Stations (starting from 1937, the year in which the plants were opened). The cocoon samples illustrate the first results of genetic research on silkworms in Italy and the advances obtained with simple mass selection based on phenotypic characteristics.

Samples of various cocoons from the 'Parental lines': collected between the plants' opening and 1960. It is possible to follow the progress in the quantitative and qualitative yield, as well as the variation of the silk industry's request, which abandoned the yellow strains, whose silk was considered more valuable, in favour of the introduction of the white, less delicate strains.

GOLD CHINESE AND WHITE CHINESE COCOONS FROM TWO STRAINS REARED IN TRENTINO

Collection: Padua
Definition: Biological findings
Subject: *Bombyx mori* cocoons, in a glass container
Origin: China
Rearing: Trentino
Description: Cocoons of Chinese strains reared in Italy in different regions to detect quantitative and qualitative differences in the product
Size (cm): Ø 8 x 20 h
Dating: 1918-1935
State of preservation: Excellent
Location: Esapolis Museum - first floor

On the right:
Overview of the anatomical preparations belonging to the 'Padova' collection (1870-1920).

The ‘Ascoli Piceno’ collection (1916-1958)

The Ascoli Piceno collection, smaller in size compared to that of Padua, documents most of the studies carried out from 1916 to 1920 at the Sericulture Institute of Portici and those carried out in Ascoli from 1920 (the year the Sericulture Station was founded in this city) to 1958 (the year the Station ceased activities). All the museum material was moved to the city of the Saint, precisely in 1958, by order of the director of the Ascoli Station, Porzia Lorenza Lombardi, when she took over as head of the Station of Padua. Originally, the Ascoli collection was housed on the first floor of the historic building, which has now been restored, and it completes and integrates the Padua collection, which is currently located in the various rooms that make up the Living Museum of Insects.

How the collection is organized

The collection comprises the following:

1) detailed studies on the selection of old Italian and exotic strains

2) developed at that time strains (obtained through crossing and selection, based on newly appeared traits)

3) crossbreedings implemented to improve the commercial quality of silk.

There are 503 samples in total. Jars containing silkworm eggs, egg shells, larvae of various strains, larvae affected by muscardine and pebrine, silk yarns and fabrics, flowers prepared with artificially dyed cocoons are on display.

As in the case of the Padua collection, silk is compared with other fibres, both of natural plant origin (linen, hemp, cotton) and artificial or synthetic origin (rayon, nylon, lyliane).

The arrangement of the sample collection is designed to appeal to the visitor’s sense of aesthetics rather than scientific sensibilities, with less emphasis placed on expository clarity, or concern for the perishability of the materials. These exhibits include a variety of shaped wooden frameworks upon which the cocoons are artistically arranged to form

Moths and cocoons of *Samia cynthia* on ailanthus.

Silk flowers made of cut and dyed cocoons

Comparison between threads obtained from natural or synthetic fibres

particular weaves, colourful garlands, pyramids, spheres and cubes with cocoons of various strains. Silk-made flowers and leaves are interspersed with silk fabrics. The optimal preservation of the cocoons has been compromised due to the loss of their original colours caused by years of exposure to dust and light. Even the labels placed on the frames as captions are often almost illegible. An inventory of the numerous samples, which have not been categorised or numbered in any way, has just lately been created.

A curious detail

The silk clothes derived from the parachutes used during the Second World War are worth noting: once the soldiers had got rid of them and left them on the ground, they were collected by women who used them to make their own shirts. The display of cocoons of the wild silkworm *Samia cynthia* Dr. that was raised on the ailanthus is also interesting, as documented also by the "Padova" collection.

Relevance of the collection

This collection of Ascoli Piceno, like that of Padua, is very useful for reconstructing the history of sericulture, a once-flourishing economic activity in Italy, and for describing the scientific advances made in the field of silkworm genetics. Both also testify the assiduous activity of the researchers employed at the ancient Sericulture Stations who committed themselves to the study of the silkworm with real passion.

The material presented here is not only a source of historical information, but also the genetic basis of a living collection of *Bombyx mori* strains that are annually reproduced, selected, and improved by the technical staff of the Sericulture Laboratory of Padua of the Research Centre of Agriculture and Environment, CREA. The Institution's staff is responsible for the conservation of this treasure of animal biodiversity, as well as the equally important collection of germplasm of mulberry varieties, which have always been inextricably linked to the fate of the precious silk-producing insect.

A glass and carved wood case for exhibition purposes. In the central part, at the top, the polyhybrid formation process from pure Chinese and Japanese parental lines is schematised. The following are then exhibited: cocoons with their floss, skeins of silk, dupions (formed by two larvae spinning together), cocoons with shape defects and cocoons of some strains.

Other silk-producing animals

The ancient collection of Quajat

The showcases display samples collected and catalogued by Dr. Enrico Quajat, assistant to the director, Dr. Enrico Verson, between the late 1800s and the early 1900s. There are 347 glass vases covering 50 silkworm species (Bombycidae, Lasiocampidae, Saturnidae). There are various anatomical preparations, moths, cocoons, chrysalides, larvae and spun or woven silks. Many samples are gifts brought by travelers from distant countries, adding to the diversity of silkworms origin: Asia, Africa, South America, Mexico…

The exhibition aims to draw the visitor's attention to the fact that not only *Bombyx mori* is able to produce silk of a certain value, as evidenced by yarns and fabrics, often still used at the level of local crafts, especially in the regions of India. Among these, only for about eighty species, attempts have been made for commercial exploitation in Asia and Africa.

There are now programs underway in north-eastern India, a region traditionally devoted to the production of silks of various origins, to extend these activities in order to achieve eco-compatible exploitation of forest resources. The conservation of traditional use species, in fact, ensures the preservation of the territory from deforestation, encouraging farmers to maintain it in its biodiversity while earning a living.

The most important 'wild silks'

'**Tasar silk**': it is produced in the tropical and temperate zone by four species of the genus Antheraea: *Antheraea mylitta* (India tropical zone); *Antheraea proylei* (India temperate zone); *Antheraea pernyi* (China and former USSR temperate zone); *Antheraea yamamai* (Japan temperate zone).

SILK GUTS

Collection: Quajat
Definition: Biological specimen
Object: Silk guts; specimen in a glass container
Description: Specimen consisting of filaments obtained by stretching the silk contained in the silk glands extracted from the mature silkworm just before the emission of the silk. Used as fishing line or surgical suture thread before the advent of nylon.
Size (cm): Ø 10 x 24 h
Dating: 1870-1920
State of preservation: Fair
Location: Esapolis Museum, first floor
Inventory number: I, 413
Bibliography: Colombo, G. (1945); Belli, A. (1936)"

Spider silk from species like *Nephila*, *Araneus*, and *Epeira* was used in the past, especially in 18th century in France, for making clothing items: it took more than 1,300,000 oothecae, the cocoons that enclose the eggs, to obtain one kilogram of silk. More recently, silk derived from spiders has found applications in textile engineering and microsurgery.

'Muga Silk': the yellow-gold muga silk is secreted by *Antheraea assamensis*, a moth widely distributed in the Indian state of Assam; this silk is difficult to find out of this area as it is almost entirely used in the same place of production for traditional clothes.

'Eri Silk': it is secreted by *Samia cynthia* var. *ricini*, a domestic *polyvoltine* silkworm.

'Anaphe Silk': native of central-southern Africa, it is typically produced from caterpillars of the *Anaphe* genus. The larvae spin a community cocoon (nest), all enclosed by a thin layer of silk.

'Fagara Silk': it is obtained from the giant moth *Attacus atlas* and from a few other related species or races that inhabit the Indo-Australian bio-geographical region, China and Sudan.

'Coan Silk': the producing larvae are those of *Lasiocampa* (*Pachypasa*) *otus*, which live in the bio-geographical region of the Mediterranean (Southern Italy, Greece, Romania, Turkey, ...) and feed mainly on tree leaves such as pine, ash, cypress, juniper and oak.

Silk from insects other than moths and from other animals

Other insects that produce silk are the social Hymenoptera (the cocoons are formed both by the bees in the operculated cell, and by the ants), the Trichoptera (whose aquatic larvae build a case of silk and various material: sand, plant debris, shells of empty molluscs ...), the Rincota (the Cochineals form a shield composed of lacquers, waxes and silk). Silk is also produced by animals other than insects such as spiders, with their cobwebs, and molluscs, that produce threads of byssus.

The other silks in antiquity

Already in antiquity, different types of silk were distinguished. Pliny the Elder describes not only the silk of the Chinese ('Seres'), but also the 'bombycin' silk from the island of Cos (also mentioned by Aristotle) and that of Assyria. Of these latter two, the former was produced by silkworms feeding on mulberry; the latter was produced by Bomby-

***ANTHERAEA MYLITTA* COCOONS**

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Antheraea mylitta*, in a glass container
Origin: India
Rearing: Padua
Description: Cocoons ranging in colour from off-white to coffee, provided with a strong silk peduncle, through which they are attached to the plant. They produce silk with a very high titer.
Size (cm): Ø 8 x 20 h
Dating: 1899
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Butler, E. (1888); Carboni, P. (1947); Quajat, E. (1904)

***ANTHERAEA MYLITTA* SILK YARN**

Collection: Quajat
Definition: Specimen from artisan activity
Subject: Yarn from *Antheraea mylitta*, in a glass container
Origin: India
Description: Silk yarn (weft) tussur
Size (cm): Ø 7 x 20 h
Dating: 1899
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Butler, E. (1888); Carboni, P. (1947); Quajat, E. (1904)

***ANTHERAEA YAMAMAJI* COCOONS**

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Antheraea yamamaji* in a glass container
Origin: Japan
Description: Greenish-yellow, oblong, regular cocoons. They are enclosed between oak leaves and tied to the branch with a flat silk ribbon.
Size (cm): Ø 10 x 20 h
Dating: 1892
State of preservation: Excellent
Location: Esapolis Museum - first floor
Inventory number: 276 I
Bibliography: Butler, E. (1888); Colombo, G. (1917); Quajat, E. (1904)

***ANTHERAEA PERNYI* COCOONS**

Collection: Quajat
Definition: Biological specimens
Subject: Cocoons of *Antheraea pernyi*, in a glass container
Origin: China
Description: Ovoid cocoons varying in colour from dark blond to walnut, fine grain
Size (cm): Ø 10 x 22 h
Dating: 1886
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Butler, E. (1888); Carboni, P. (1947); Quajat, E. (1904)

***ANTHERAEA PERNYI* SILK YARN**

Collection: Quajat
Definition: Specimen from artisan activity
Subject: Yarn from *Antheraea pernyi*, in a glass container
Origin: China
Description: Silk yarn in skeins, white and coffee color
Size (cm): Ø 6 x 16 h
Dating: 1891-1892
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Butler, E. (1888); Colombo, G. (1917); Quajat, E. (1904)

***THEOPHILA* (*BOMBYX*) *MANDARINA* COCOONS**

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Theophila* (*Bombyx*) *mandarina*, in a glass container
Description: Small, oblong, whitish or light coffee cocoons. They have a flat and very fine burr.
Size (cm): Ø 7 x 16 h
Dating: 1890-1910
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

On the opposite page:
Antheraea pernyi

***ANAPHE INFRACTA* COLLECTIVE NEST**

Collection: Quajat
Definition: Biological find
Subject: *Anaphe infracta* nest
Origin: Africa
Description: A collective nest made of silk, used by the larvae living in society. The nest is almost spherical, composed of several layers of papery consistency and bronze colour.
Size (cm): 12x12x12 h
Dating: around 1900
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

COLLECTIVE NEST

Collection: Quajat
Definition: Biological specimen
Subject: Collective nest of wild silkworms
Origin: India
Description: Collective nest in silk, used by the larvae that live in society. The nest is composed of several layers of varying consistency. Species is not indicated.
Size (cm): 24x14x8 h
Dating: 1874
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

***EUCHERIA SOCIALIS* COLLECTIVE NEST**

Collection: Quajat
Definition: Biological specimen
Object: Nest of *Eucheria socialis* in a glass container
Origin: Mexic
Description: Collective silk nest in the shape of a bag, with two openings, one for the entrance and exit of larvae, and the other for the elimination of excrement and corpses. The cocoon is occupied for 11 months by the larvae, then by chrysalides, and then abandoned. Not suitable for carding.
Size (cm): Ø 14 x 23 h
Dating: 1905
State of preservation: Excellent
Location: Esapolis Museum, first floor
Bibliography: Quajat, E. (1904)

cidae (probably *Lasiocampa* or *Pachypasa otus*) that lived wild on plants other than the mulberry, such as oak, chestnut and beech. This silk, produced by Lepidopterans other than silkworms, was not reeled in hot water as a unique continuous filament, according to the Chinese technique, but was carded from the opened cocoon and spun using a spindle. The thread obtained with the two procedures had different characteristics: the Chinese thread was thin, while the filament of the wild Lepidopterans was thicker and less bright. When the Byzantine Empire began producing raw silk in the middle of the 6th century, they followed the Chinese technique, which spread into Europe and Mediterranean Africa, while the old procedure continued in Western Asia (as in the most part of the Islamic world until the tenth century AD).

Antheraea mylitta

***PACHIPASA OTUS* COCOONS**

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Pachipasa* (*Lasiocampa*) *otus*, in a glass container
Origin: Asia minor
Rearing: Izmir
Description: Known since antiquity as the silk of the island of Cos (Aristotle, Pliny). White oval cocoon with very loose texture, open at one end. Polyphagous species, the larvae live in groups and move at night to feed on leaves; it overwinters as a worm caterpillar, with a larval life lasting about 10 months.
Size (cm): Ø 6 x 15 h
Dating: 1890-1910
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

ANTHERAEA ASSAMA LARVA

Collection: Quajat
Definition: Biological specimen
Subject: Larva of *Antheraea assama*, in a glass container; stored in a mixture of distilled water, glycerine and 90% alcohol
Origin: India
Description: Whole larva
Size (cm): 2.5X2.5X6 h
Dating: 1890-1900
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Colombo, G. (1917), Quajat, E. (1904)

ANTHERAEA ASSAMA COCOONS

Collection: Quajat
Definition: Biological specimens
Subject: Cocoons of *Antheraea assama* in glass container
Origin: India
Description: Large, ovoid cocoons endowed with a peduncle. They produce abundant, bright, yellowish silk.
Size (cm): Ø 6 x 15 h
Dating: 1890-1900
State of preservation: Excellent
Location: Esapolis Museum - first floor
Inventory number: 389 I
Bibliography: Colombo, G. (1917), Quajat, E. (1904)

ANTHERAEA ASSAMA SILK THREAD

Collection: Quajat
Definition: Specimen from artisan activity
Subject: Yarn from *Antheraea assama*, in a glass container
Origin: India
Description: Weft yarn, warp and carded yarn of Eri of Assam.
Size (cm): Ø 10 x 24h
Dating: 1890-1900
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Colombo, G. (1917), Quajat, E. (1904)

On the opposite page:
Attacus atlas

***SAMIA (PHILOSAMIA) CYNTHIA* VAR. *RICINI* COCOONS**

Collection: Quajat
Definition: Biological specimen
Subject: *Philosamia* (*Samia*) *cynthia* var. *ricini* cocoons, in a glass container
Origin: Assam-India
Rearing: Italy
Description: The worm, called Eri, preferably lives on the castor plant; the cocoons are small and are processed by carding, producing a light coffee-coloured yarn (the classic "colonial" colour)
Size (cm): Ø 8 x 18 h
Dating: 1890-1910
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

***SAMIA (PHILOSAMIA) CYNTHIA* VAR. *RICINI* YARN**

Collection: Quajat
Definition: Specimen from artisan activity
Subject: *Philosamia* (*Samia*) *cynthia* var. *ricini* yarn, in a glass container
Origin: Assam-India
Description: Light coffee-coloured silk yarn made from Eri (*Philosamia ricini*) cocoons carded and spun in England. At the time used for traditional indigenous fabrics and colonial clothes for Europeans.
Size (cm): Ø 8 x 20 h
Dating: 1890-1910
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

COCOONS OF *CRICULA TRIFENESTRATA*

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Cricula trifenestrata*, in a glass container
Origin: Burma
Description: Yellow-coloured ovoid cocoon often cross-linked or with numerous small holes, that are scarcer towards its extremity. Bivoltine or polyvoltine species, which lives in society in the wild.
Size (cm): Ø 4 x 8 h
Dating: 1890-1910
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

On the opposite page from the top:
Cricula trifenestrata, *Antheraea assama*, *Samia cynthia* var. *ricini*: one of the various larval ecotypes

PHILOSAMIA (SAMIA) CYNTHIA LARVA VENTRALLY OPENED

Collection: Quajat
Definition: Anatomical specimen
Subject: *Philosamia (Samia) cynthia*. Zootomic preparation in a glass container, stored in a mixture of distilled water, glycerine and 90% alcohol.
Description: Larva ventrally opened.
Size (cm): Ø 4 x 12 h
Dating: 1890-1910
State of preservation: Good
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

SAMIA (PHILOSAMIA) CYNTHIA COCOONS

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Philosamia (Samia) cynthia*, in a glass container
Origin: China, but also widespread in Japan and India
Description: Ovoid cocoon, enclosed between one or two leaves, so that the surface shows visible imprints of their veins; grey, blond or walnut in colour, open at one end. Soft silk, fine, but not shiny, prone to numerous breaks.
Size (cm): Ø 9 x 20 h
Dating: 1914
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Quajat, E. (1904)

ATTACUS ATLAS COCOONS

Collection: Quajat
Definition: Biological specimen
Subject: Cocoons of *Attacus atlas*, in a glass container
Origin: Assam - India
Description: Silk cocoon, either bag-shaped or spindle-shaped, enclosed in one or more leaves, leaving a distinct impression of their venation on the surface; it ends at the top with a thin cord, which wraps around the leaf stalk or branch. Light umber (brown) in color, with an opening for the moth's exit, made of looser threads. Degumming is difficult due to the high percentage of sericin that impregnates the silk filament.
Size (cm): Ø 8 x 16 h
Dating: 1898
State of preservation: Excellent
Location: Esapolis Museum - first floor
Bibliography: Butler, E. (1888); Quajat, E. (1904)

On the opposite page:
Samia cynthia.

The ‘Sea Fashion’

Rare and Precious Specimens

The word byssus derives from the Greek word *byssos*, which means ‘fine fibre’. Fabrics made from the filaments of *Pinna nobilis* were formerly referred to as ‘byssus’, while in the textile world, thin fibres with a uniform weave of silk, cotton and linen are now referred to in the same manner. Because of this confused terminology, the specimens that we can confidently identify as marine byssus are limited (around fifty to date). Others may exist, be housed in museums or private collections, and be wrongly ascribed to other textile fibres. The identification of the byssus fibre in principle is not difficult, because it differs from other silky fibres by its elliptical section, visible under the scanning electron microscope.

The processing of fine linen (byssus) has been documented since ancient times, dating back to the time of Phoenician colonies in Sardinia. This practice was carried out together with the collection of murex for dyeing purposes. The earliest known piece of cloth identified as sea byssus dates back to the 4th century AD, and was discovered near today’s Budapest, which was a frontier city of the Roman Empire. The handicraft of byssus certainly reached its apogee in Taranto in the era of Emperor Justinian and the main cause of its decline can be attributed to the introduction of mulberry silkworm silk in Europe.

Byssus evolved into a valuable commodity reserved for royal or ecclesiastical patrons. The yarn derived from the silky tuft, with which the shell anchors to the seabed, has indeed a special shine with golden reflections, as well as outstanding thermal qualities. For this reason, it was traditionally used to produce luxury socks and gloves. Fur silk processing has also been attempted with the silk of the byssus, obtaining magnificent results. Furthermore, prior to the first half of the twentieth century, there was a local manufacturing of artefacts traditionally woven

On the left:
Pinna nobilis.

with byssus in Sardinia.

Pinna nobilis

In the past, this bivalve shellfish was widely spread and catched for both food and textile purposes. Today, it is protected under the European regulation on natural habitats conservation. The species is now threatened mostly by trawling, but pollution also plays a role, badly impacting the *Posidonia oceanica* and *Cymodocea nodosa* grasslands, the natural habitat of *Pinna nobilis*.

Byssus is a tuft of long silk-like filaments, generated by a special gland located in the shellfish foot. The threads emerge from a crack (the throat of the byssus), which retains its aperture even after the shell is closed. The chemical composition is essentially protein and this material, once hardened, does not dissolve in water, enzymes, or organic solvents.

Byssus processing

In traditional processing, the fibres were carded and spun with small spindles after being carefully cleaned in fresh water and treated with citric acid (lemon juice), in order to enhance their sheen.

Cuffs and collar made of byssus, brooch with byssus

The cuffs and the fine collar shown on the next page, belonging to the silk collections of the Royal Experiment Sericulture Station of Padua, were probably part of a sophisticated nineteenth century dress, and were woven to achieve a distinctive appearance comparable to real fur.

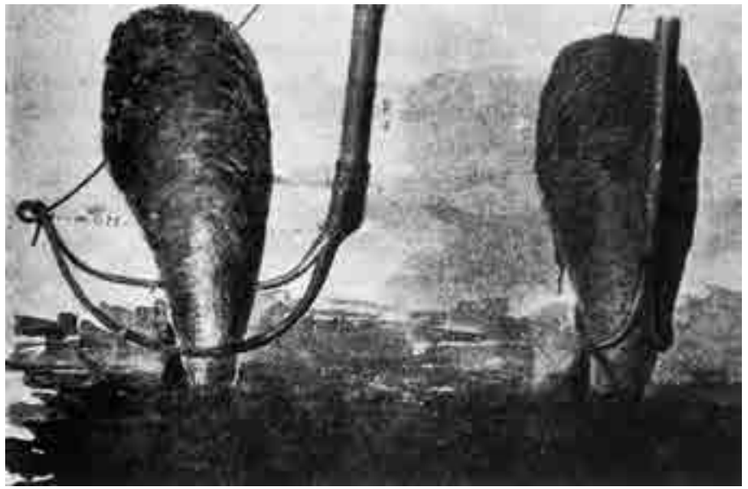
The fabrics' vertical lines, which indicate the specimens' weak points, provide clues about how they were handled and preserved. The silk support weave, on which the byssus filaments are fastened, would also need restoration. However, the main obstacle to the restoration is the difficulty of finding the raw material (the byssus itself).

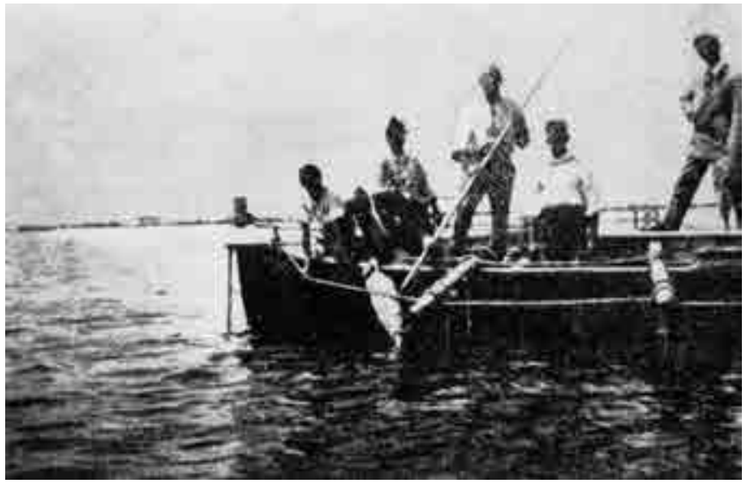
The fine byssus tuft also dates back to the nineteenth century.

These specimens appear to have been brought from Sardinia to the Sericulture Station of Ascoli Piceno and from there to Padua in 1958,

On the right:
Pinna nobilis and specimens in marine byssus.

when Dr. Lombardi, charged of the direction of the Institute of Padua, took with her the ancient collections and all the materials she grouped and organized in the collection called 'Ascoli' and which are still exhibited at the Museum.





Top:
Detail of *Pinna nobilis* fishing
(Mastrocinque, 1928).

Bottom:
Beniamino Mastrocinque looking for *Pinna* shells in the Mar Grande. Taranto, July 1927.
(Mastrocinque, 1928).

On the opposite page:
Marine byssus fibre ready to be spun. Photo by Chiara Vigo, archives of "Museo del Bisso". City of Sant'Antioco, Sardinia .

Quality assessment

Commercial characteristics of the cocoons

'The industrialist who is about to purchase a batch of cocoons (...) cannot have a certain notion of how the material he buys will behave at the reeling and of the quality of the silk that can be obtained from it and (...) must therefore confine himself to considering some characteristics of the cocoons that (…) can guide him/her in terms of knowledge he/she needs. However, I immediately note that even for the most experienced technician, the examination of the commercial characteristics (...) cannot give even remotely the confidence in judgment that only arises from a reeling test.

Apart from the content, as small as possible, of defective individuals, a technician values uniformity, in a given batch of cocoons. This indeed allows it, by applying a given processing system, (...) to achieve better yields in silk and hourly production and the best quality of silk compatible with the quality of the raw material. He/she also values, with the same silk yield, unwinding at bowl and hourly production, finer and more regular cocoons. (...) The homogeneity of a batch is inferred from the observation of the colour, volume, shape, texture, consistency of the silk shell, the appearance of the pupa, etc.' (Gallese, 1950))

Characteristics assessable with the naked eye

Colour: Its uniformity and intensity, are appreciated more than anything else, as they indicate a good drying process.

Silk shell grain (roughness to the touch): It is believed to be an indicator of filament fineness.

On the opposite page:
Reeling in the early '900.

STEELYARD

Description: Steelyard consisting of a rod graduated from 0 to 100 g with notches per g and numbers every 10 g. The sample to be weighed was placed in a bucket container and the weighing was done by sliding a special counterweight along the rod. It was possible to hang it with an overhanging hook.
Function: The presence of a container of this shape suggests that it was used to hold liquids. Probably useful for determining the cocoon volume indirectly, by immersion and subsequent weighing of the remaining water, and then calculating the displaced one by difference (operation similar to the Colombo volumimeter).
Author: Unknown
Cultural area: Italy
Dating: Early sec. XX
Category: Manufacturing activities
Typology: Scale (steelyard)
Materials: Metal
Size (cm): 32x25h, container Ø 4.3x8h
State of preservation: Good
Location: Esapolis, ground floor
Inventory number: III, 14

PENDULUM SCALE

Description: Turned base with three feet, one of which is adjustable with a screw. Metal column ending with a ring at the upper extremity. Aluminium arc graduated from 0 to 3000 mg with notches every 10 mg and numbers every 100 mg. Needle with a small plate to hold the sample to be weighed at the opposite end of the index.
Function: Weight evaluation of single cocoon or yarn samples.
Author: Giuseppe Acquati mechanical workshop, Milan
Cultural area: Northern Italy
Dating: Late 19th century - early 20th century
Category: Manufacturing activities
Type: Pendulum scale
Materials: Iron, aluminium
Size (cm): 40x24x56h
State of preservation: Good
Location: Esapolis Museum, ground floor
Bibliography: Colombo, G. (1917); Colombo, G. (1945); Welsh, G. (1950)

Shape of the cocoons: The oval slightly constricted shape is preferable, because it has a regular unwinding to the end, as opposed to the pointed one (which has areas of fragility) and to the excessively strangled one (which becomes tangled at the end of the unwinding, increasing waste).

Volume of cocoons: It should be neither too small, which would be depreciated for the poor income, nor too large, as to those of medium volume have a greater percentage weight of chrysalyses and a thicker silk thread.

Silk shell consistency: Evaluated by compressing the cocoon between the thumb and index finger.

Appearance of the chrysalis: It gives useful clues regarding the health of the batch, the state of preservation and the way in which drying was carried out.

Characteristics assessable through laboratory tests

The characteristics of a batch of dried cocoons can also be studied through laboratory tests, such as the determination of the percentage of silk shells, the average weight of the cocoons, the average volume of the cocoons, the determination of the length and size of the thread, the permeability of silk shells. In any case, the utmost importance is given to the way by which the necessary sample is taken, so that it is significant.

Average weight: It is important to determine the uniformity of weight of the cocoons that make up a batch: if the weight is uniform, it means that the silk shells will have almost the same compactness, so that the cocoons will behave similarly to each other on subsequent operations (cooking, brushing, reeling). The weight is assessed per single cocoon using a balance with a cg scale dial. It is calculated as the average of 100 cocoon weights measurements (but the numerosity may increase as the sample weight increases).

Percentage of silk shell: It is the percentage ratio between the

weight of the silk shell and that of the cocoon and it is an index of the silk richness of the cocoons. It is obtained by cutting the cocoons that make up the sample and separating the silk from the chrysalides and the exuviae. Of course, not all of the silk shell is reelable because a part of it is represented by waste (the outer layers or "strusa" and the inner ones or "telette"). This index is strongly affected by the weight of the chrysalis. This test generally has a perfect match with the "rendita" tests.

Cocoon volume: The so-called volumimeters are devices capable of evaluating the cocoon volume by measuring the volume (Blanc, Gallese, Baroni volumimeter) or the weight (Colombo volumimeter) of the water moved by the complete immersion of a cocoon. Before this operation, the cocoon must be deflossed and varnished to make it waterproof.

Silk filament length: Obtained as an average of the length of the yarn achieved from separately reeled samples. It has considerable practical importance because it gives an estimate of the yield in silk and the reeling behaviour of the batch under examination.

'*…through the special reeling basin, the thread of sample cocoons is reeled separately, in order to obtain small skeins at counted turns…*'(Colombo, 1945)

Size of the filament: The uniformity of the thread is appreciated industrially through the determination of the size, that is the weight of each single sample of silk tested. A sample is made of 450 m and the unit of weight is the denier.

Permeability of the silk shell: The behaviour of the cocoon during the cooking process and reeling depends on it. It is higher in coarse-grained and larger cocoons. This characteristic confirms both the possibility of evaluating it empirically, and that '*the importance that once again can have the uniformity of a parcel regarding the weight and volume of the cocoons, which on turn affects the uniformity of the permeability and enable to treat cocoons with suitable cooking process.*' (Gallese, 1950)

PERFECTED SERIMETER

Description: Precision dynamometer, fixed to the bottom of a wooden and glass case, which must be hung vertically on the wall. Traction is exerted by a trolley that falls with almost uniform motion. A pointer fixed to the upper thread clamp of the appliance marks the total elongation of the wire at breakage. The tensile strength is indicated by a counterweight in the shape of an angle lever that rises along a graduated arc.
Function: Device that simultaneously measures the tensile strength and elasticity of the silk thread, generally operating on a thread length of half a meter
Author: Stagionatura Anonima, Milan
Cultural area: Italy
Dating: 1870-1890
Category: Manufacturing activities
Typology: Serimeter
Materials: Wood, brass, aluminum, glass
Size (cm): 43x19.5x144 h
State of preservation: Excellent
Location: Esapolis Padua Museum, ground floor
Inventory number: III 526
Bibliography: Carboni, P. (1947); Colombo, G. (1917); Gallese, G. (1950); Quaiat, E. (1887); Quaiat, E. (1889)

TESTER

Description: The base of the instrument is in varnished iron. A crank with a wooden handle allows the movement of the fast metal reel, which has a tachometer dial divided into 100 parts, with 1 division equal to 1 m of wound wire, on which a hand moves. The thread reaches the reel after passing through one of the ten barbs carried by a metal arm of the instrument. A bell rings when the predetermined length is reached.
Function: Wrapping of 450 m long skeins of silk (specimens), which are then weighed to determine the size (fineness) of the filament.
Author: Acquati Giuseppe, Milan
Cultural area: Northern Italy
Dating: Late 19th century - early 20th century
Category: Manufacturing activities
Type: Tester
Materials: Metal, wood, glass
Size (cm): 40x41x44 h
State of preservation: Good
Location: Esapolis Museum, ground floor
Inventory number: II, 499
Bibliography: Carboni, P. (1947); Colombo, G. (1917); Colombo, G. (1945)

TESTER

Description: Iron base fixed on wooden support. A crank with wooden handle allows the movement of the fast metal reel, which has a tachometer dial divided into 450 parts, corresponding to 450 m of wound thread, on which a hand moves. A bell rings when the predetermined length is reached.
Function: Wrapping of 450 m long skeins of silk (specimens), which are then weighed to determine the size (fineness) of the filament.
Author: Stagionatura Anonima, Milan
Cultural area: Northern Italy
Dating: Late 19th century - early 20th century
Category: Manufacturing activities
Type: Tester
Materials: Metal, wood, glass
Size (cm): 45x30x44 h
State of preservation: Good
Location: Esapolis Museum, ground floor
Bibliography: Carboni, P. (1947); Colombo, G. (1917); Colombo, G. (1945)

TITRATING SCALE

Description: Circular base with three iron feet, one of which is adjustable with screw. The supporting column ends at the top with a ring, and the horizontal axis carries the index in a thin metal foil, that serves as both a pointer and a support for the hook, which must hold the specimen to be measured. The scale is in deniers, graded from 0 to 40, with notches every 1/2 units and numbers per each unit.
Function: The size of a filament, expressed in denier, is the weight in grams of a 450-meter-long sample of filament and is an expression of the fineness of the fibre.
Author: La Meccanotecnica, Milan
Cultural area: Italy
Dating: Late 19th century - early 20th century
Category: Manufacturing activities
Type: Titrator scale
Materials: Metal
Size (cm): 35X22X45 h
State of preservation: Good
Location: Esapolis museum - ground floor
Inventory number: III, 13
Bibliography: Carboni, P. (1947); Colombo, G. (1917); Colombo, G. (1945)

HEXAGONAL SMALL REEL FOR THE STUDY OF DEFECTS (Reviseur de grèges)

Description: Several raw silk threads unravel from a series of spools and are examined with a magnifying lens before winding themselves on a hexagonal reel, which is controlled by hand by the same person who is examining the thread. The faces are made up of movable glass plates; black or white paper or a light source could be applied under the slabs.
Function: Observation of the thread in order to identify and count any defects.
Author: Giuseppe Acquati mechanical workshop, Milan
Cultural area: Northern Italy
Dating: 1900-1950
Category: Manufacturing activities
Typology: Tool for the study of yarn defects
Materials: Metal, glass
Size (cm): 35x42x45h
State of preservation: To be restored. The handle of the crank and the transmission belt are missing.
Location: Esapolis Museum - ground floor
Inventory number: III, 496
Bibliography: Colombo, G. (1945); Gallese, G. (1959)

SKEIN CLEANSING TOOL

Description: The object consists of a vertical wooden support and a variable inclination crosspiece, to which a 'juge flottes' is fixed, an instrument consisting of two hollow rollers, rotating on their axis, whose mutual distance can be made vary depending on the reeling of the skeins.
Function: Tool for the husking of silk, used for the eye evaluation of yarn defects, by contrast when passing over a black board
Author: La Meccanotecnica, specialized workshop, Milan
Cultural area: Northern Italy
Dating: Uncertain
Category: Manufacturing activities
Type: Skein husking
Materials: Wood
Size (cm): 45x40x128 h
State of preservation: Good
Location: Esapolis Museum - first floor

DETECTION TABLE FOR MAJOR DEFECTS

Description: Wooden board with a black background, displaying samples of potential defects detectable on silk yarn
Function: Table proposed internationally for the quantitative and qualitative evaluation of defects in raw silk, assessed by examination on the black table.
Author: Stagionatura Anonima, Milan
Cultural area: Northern Italy
Dating: 1920-1950
Category: Manufacturing activities
Typology: Table
Materials: Wood, silk
Size (cm): 18x0,8x50 h
State of preservation: Good
Location: Esapolis Museum - first floor
Bibliography: Carboni, P. (1947); Colombo, G. (1945)

SILK CLEANSING TOOL

Description: The object consists of a vertical iron support and a wooden crosspiece with variable height and inclination, to which a "juge flottes" is fixed, an instrument made up of two hollow rollers, rotating on their axis, whose reciprocal distance can be varied depending on the spindle of the skeins. The instrument is equipped with a black metal table, on which the presence of defects in the yarn can be assessed.
Function: Tool for the husking of silk, used for eye assessment of yarn defects, by contrast when passing over a black board.
Author: Isidoro Sommaruga, mechanical builder, awarded factory, Milan 1884
Cultural area: Northern Italy
Dating: Around 1900
Category: Manufacturing activities
Type: Cleansing tool
Materials: Wood, iron
Size (cm): 100x47x124 h
State of preservation: Good
Location: Esapolis Museum - first floor
Inventory number: III; 493
Bibliography: Colombo, G. (1917); Colombo, G. (1945)

Control and quality assessment of the raw silk

Raw silk trade requires a comprehensive set of tests, that enable the classification of silk for the market.

For each test, according to the same market criteria, the limits are specified within which the raw silk under examination must fall in order to be classified into a certain category.

The tests to be carried out on the raw silk relate to the spooling behaviour, the regularity of the filament size, the dynamometric properties, thread cleanliness and purity, and cohesiveness. Other tests that may be performed on both raw and processed raw silks, include determining the commercial weight, weight loss during degumming, and evaluating silk load.

Spooling test: It assesses the behaviour of the hank at reeling and it is measured as the number of breaks per unit of time, from which depends the number of reels that a worker can supervise simultaneously. The test must be conducted in an environment maintained at a standard humidity of 65%.

Filament size: It is the weight, expressed in deniers (1 den = 0.05 g, a measure of thickness) of a 450 m-long skein. These skeins, commonly called sample, are prepared with manual reels with bells or with electric reels equipped with revolution counters and automatic stop. The skeins must be weighed on special scales with graded index dial in deniers.

Dynamometric tests: These tests are carried out at 65% humidity with special dynamometers called serimeters. These are devices designed to simultaneously measure toughness as a load at break and elasticity as an elongation of the silk thread at breakages. To compare different samples, the toughness must be related to the area of the breaking section, resulting in the toughness per denier being calculated as a ratio between the toughness and strength of the threads under examination.

Inspection at the "seriplane": The examination at the seriplane allows for a quick and reliable assessment of the thread neatness, that is, the numerical expression of the presence of defects, counted and evaluated by an experienced operator either by the naked eye or with the aid of lenses, contrasting against the thread's passage on a black table. There are standard reference tables for the classification of defects and their relative importance.

Cohesion tests: These are mostly performed on silks that are designed for direct weaving without twisting. When a thread is subjected to friction, the degree of cohesiveness is the resistance that filaments oppose to their separation. This may happen with devices that have a rubbing part that moves on a stationary thread or vice versa, at the speed of 200 oscillations per minute, monitoring the number of open threads every 20 passes. In order to classify the yarn in under examination, the average number of rubbings required is calculated and compared with standard values tables.

Dyeing tests.

SERIPLANE

Description: It is used for evaluating the quality of raw silk by inspecting it under controlled conditions for variations in yarn diameter as well as imperfections and content. The device consists of a spool holder, from which the thread unwinds, by means of a thread guide controlled by a worm screw, wound on a black wooden board, which rotates on a longitudinal axis by means of a crank, so that it is sometimes parallel and close.
Function: Inspection of the thread to identify and count any defects. The black tablet can be removed to keep a sample of yarn for comparison.
Author: T. Speroni, Milan
Cultural area: Northern Italy
Dating: Early XXth century
Category: Manufacturing activities
Typology: Seriplane
Materials: Metal, wood
Size (cm): 40x38x30h
State of preservation: Good
Location: Esapolis Museum - ground floor
Inventory number: III, 497
Bibliography: Carboni, P. (1947); Colombo, G. (1917); Colombo, G. (1945)

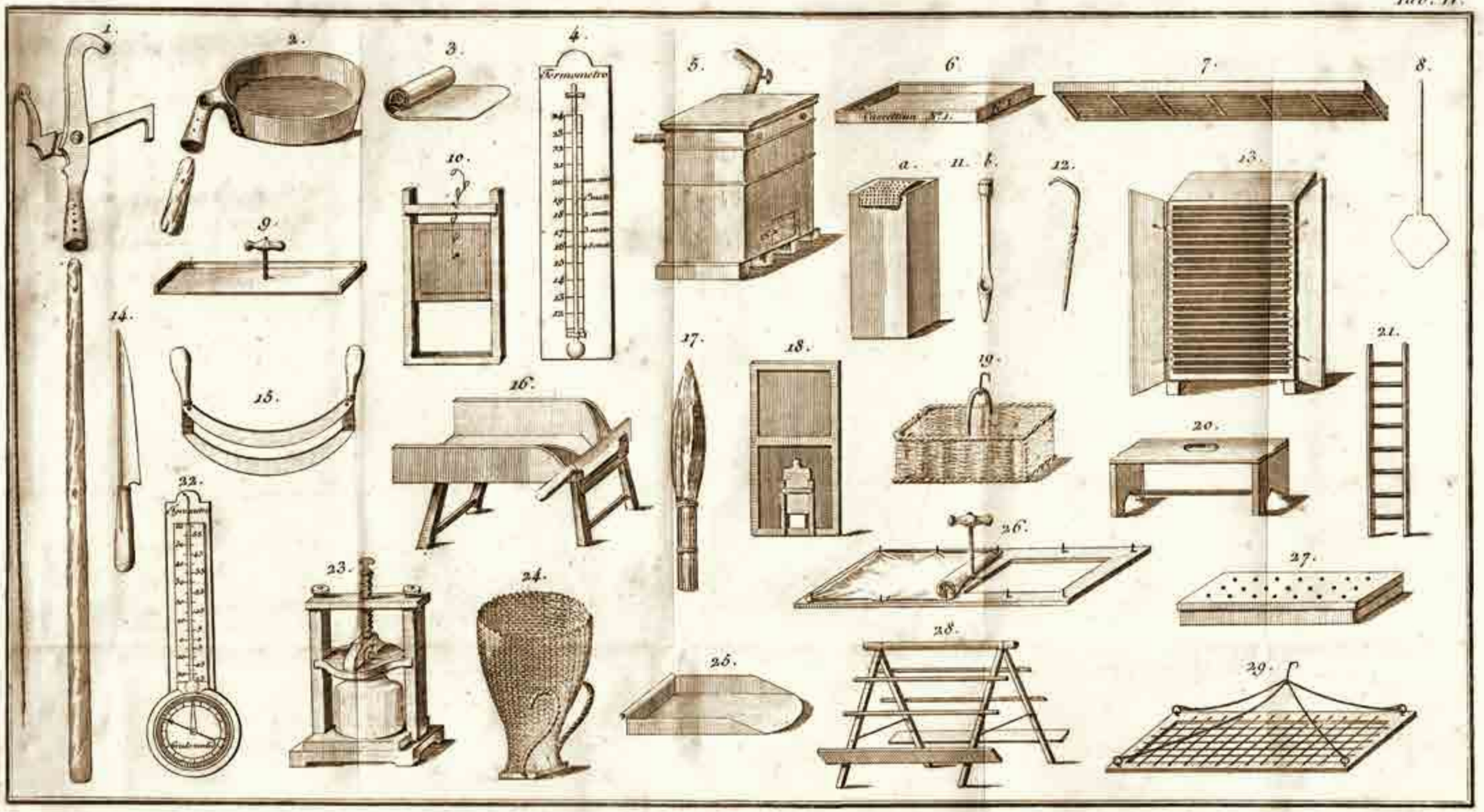
The Historical Library

A flagship of the ancient collections of the former Sericulture Station is undoubtely the Historical Library, which documents much of what was written on the subject of silkworm rearing from the beginning of the 1700s. It also serves as testimony to the work carried out by the researchers of the same Station, both in experimental and documentary fields.

> *'The first book written in Italy on the silkworm was certainly that of Lodovico Lazzarelli from S. Severino, which was published in Rome around 1493 and which has the title* Opuscolum de bombice *dedicated to Angelus Colotium.'* (Quaiat, 1896).

The small volume, of which Quaiat had a handwritten copy made from the original Latin version, preserved in the municipal library of Staffolo (Ancona), features a text in which, according to Quajat himself, 'philosophical, natural, divine, and mythological matters intertwine, all heaped into just a few pages ...'. In reality, beyond some references to more or less sacred or pagan superstitions, the silkworm farming advice and arguments reported are comparable to the knowledge of the era just prior to Quajat, even though four centuries had passed. The great turning point came indeed at the end of the 19th century, when Pasteur's discoveries in the microbiological field were applied to rearing and agriculture, demonstrating the infectious nature of diseases and the possibility of using the microscope as a means of investigation to verify their actual etiology.

> *'While handing the food to the worms and tending to them, you renew the full bed, you must avoid disturbing their sleep, since once they are disturbed, they never regain their previous calm, and diseases can result, causing serious harm. They eat too greedily, their stretched skin becomes transparent and they exude pus from their ruptured belly. Therefore, if you notice some that do not fall asleep and find a pose, or that show a shiny white and swollen skin, or, they stain the leaves, which are offered as a suitable food, with a milky fluid, and have a crinkled mouth resembling a black crystal (...) you must remove and dispose of them in the trash, so that with their corrupted fluid they*



Utensils used in the art of silkworm rearing, table taken from: *The Art of Rearing Silkworms* (Dandolo, V. 1829).
1. Mulberry shoot pruner/harvester. **2.** Copper pot with long handle for fumigating trees. **3.** Cloth for silkworm eggs. **4.** Thermometer. **5.** Brick stove to control temperature in the rearing room. **6.** Carboard boxes for egg hatching. **7.** Racks to hold the cardboard boxes. **8.** Spoon for silkworm eggs. **9.** Transport board for eggs or larvae. **10.** Adjustable opening for ventilation. **11.** a) Perforated paper; b) Tool to perforate. **12.** Small rake to move the eggs. **13.** Transport box for eggs or larvae. **14.** Knife. **15.** Double leaf cutter. **16.** Large leaf cutter. **17.** Melic grass brush. **18.** Hatch on the door. **19.** Square basket for leaf. **20.** Bench or stool to feed the upper shelves. **21.** Ladder to feed the upper shelves. **22.** Hygrometer. **23.** Fumigation apparatus to ameliorate the air quality in the rearing room. **24.** Backpack basket to transport frass from bed cleaning. **25.** Silkworm frass shovel to clean rearing beds. **26.** Frames for moth mating. **27.** Perforated box to store moths waiting for mating. **28.** Framework to lay clothes for moth oviposition. **29.** Rope frame for egg preservation.

do not contaminate the leaves for the others. There's no remedy for them, but you'll greatly benefit by ensuring that the deadly disease doesn't spread to the remaining ones.' (Lazzarelli, L. *The silkworm,* translated by *Opuscolum de Bombyce,* 1493).

Other works of undeniable scientific interest, as well as historical-descriptive, are those of the Venetian Vincenzo Dandolo (1758-1819), a pharmaceutical chemist, translator of Lavoisier's work into Italian. In the last years of his life, he devoted himself to agronomic science studies, in particular by working on the development of what he himself called rational silkworm farming. To achieve this, he conducted experiments and tests in appropriate farms to debunk superstitious or unreasonable practices traditionally adopted in this type of rearing. As a good scientist, he did not forget to always prepare a control sample where the worms were not subjected to any treatment. In this way, he managed to increase, and sometimes to duplicate the product while also reducing the amount of leaf used. His writings were very popular at the time, so much so that in Lombardy-Venetia and Piedmont, the silkworm farms conducted according to his methods were called 'dandoliere'. Of particular interest are his correspondences with silkworm farmers, which were included as appendices in many of his works.

'I have examined how the cultivation of silkworms is generally carried out. I have read what several dedicated men have written about this important subject. I myself have delved into it; and after all this, I am convinced that instead of an art founded on principles, and organized with well-deduced precepts, we have little more than a blind practice. For the majority of cultivators, this very practice is also hampered by very harmful misconceptions; and so far many well-deserving writers who have dealt with this subject have not been able to provide great assistance, as they failed to combine the necessary scientific knowledge and extensive experience. I have therefore concluded that both Italy and other nations still lack the basic book that easily and reliably guides the cultivator, whoever he may be, to consistently obtain the greatest amount of excellent cocoons from the least quantity of mulberry leaves using the simplest and least expensive means. I have thus taken it upon myself to create and publish this book.' Dandolo, V. (1829).

Among the volumes present in the historical library of the Institute, first to be remembered for sure are those by Redi and Bassi, and then by Pasteur, which certainly contributed to the demonstration of the etio-

logical causes of the diseases afflicting the farms and therefore allowed to finally apply adequate prevention criteria.

In addition to works of scientific interest, the library also boasts collections with a more literary and informative flavour, such as poetic compositions in praise of the silkworm and its valuable work. It should be noted, however, that often these are works that merge the artistic-literary aspect with the historical-scientific one, appending quotations from classical Greek and Latin poets, complemented by the authors' annotations, which document the knowledge of the contemporary sericulture situation. In addition, they sometimes attempt to summarise and interpret the knowledge of the time regarding the ailments of the silkworm and their possible causes, testifying the firm belief that these discomforts were caused to the animal solely due to incorrect rearing practices, overlooking their actual etiology. (Betti, 1765).

Scientists have also drawn on these sources in later periods, taking them as the historical documents of knowledge of past times; in this regard, the aforementioned poem by Betti contains autographed notes by Quajat.

In addition to this, the library stands as testimony to the research work carried out by the staff of the Institute and documents the results with the collections of complete issues of the Bulletin of the Station. There with a wealth of details, methods of use and purposes for the realisation of machineries, anatomical preparations and collections of cocoons, which we find in the historical collections handed down to us, are described.

IL FILUGELLO.

OSIA

IL BACO DA SETA.

POEMETTO IN LIBRI III.

DELL' ABATE

GIANFRANCESCO GIORGETTI.

CON ANNOTAZIONI SCIENTIFICHE ED ERUDITE,

ED UNA DISSERTAZIONE SOPRA L'ORIGINE DELLA SETA.

DEDICATO

AL MOLTO ILLUSTRE SIGNOR

GIANNANTONIO PORTA.

Ad usum mei Comitis Andreæ Fidelis Asparagandensis D: 1798:

IN VENEZIA

Appresso PIETRO VALVASENSE

A San Giovanni Nuovo.

MDCCLII.

CON LICENZA DE' SUPERIORI.

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Index of the catalogue entries

Editor's note about the compilation of the entries

For each tool, the main historical and technical data have been described, i.e.:

Technical description
Function
Author (building company)
Place and date of manufacturing (where possible)
Date and cultural sphere or area
Dimensions in cm (length x width x height)
Conservation status (Excellent-Good-Fair-To be restored)
Inventory number

On the other hand, with regard to preparations and other specimens of biological origin, it was decided to report:

Collection to which they belong
Category of specimen
Taxonomy
Place and date of origin
State of preservation

Instruments and machineries

Biological specimens and anatomical preparations

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