

The history of Italian parasitology

Raffaele Roncalli Amici*

*Historian–American Association of Veterinary Parasitologists,
29 Louise Drive, Milltown, NJ 08850, USA*

Abstract

The history of Italian parasitology can be subdivided into two periods: pre-Redi and post-Redi. The first period includes the contributions to parasitology by savants who operated during the Roman, medieval and Renaissance eras; the second period started in 1668 when Francesco Redi published his experiments to debunk the theory of spontaneous generation; the work of Redi was subsequently continued by Vallisnieri, Spallanzani and others. The latter period includes classic contributions in the field of parasitology provided by veterinarians such as Ercolani, Perroncito, Piana and Rivolta, and by physicians such as Bassi, Grassi, Golgi, and Celli. Also, two outstanding pages of medical parasitology were written during this period — the unraveling and defeat of St. Gotthard's disease and the conquering of malaria on Italian soil — both accomplished through the generous efforts of dedicated individuals. © 2001 Elsevier Science B.V. All rights reserved.

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“Italy has the longest history in modern parasitology, based on the researches, first of Francesco Redi, the begetter of chemotherapy, Cestoni and Spallanzani, of Lancisi and Bassi and of countless others” Garnham (1971).

It is the purpose of this paper — a short history of Italian parasitology — to report on the contributions to the development of medical and veterinary parasitology — through the centuries — by Italians from the time of the Romans to the present day. The history of Italian parasitology can be subdivided into two periods: the pre-Redi period and the post-Redi period. The first period (250 B.C.–1668) is characterized by the reporting on parasitological matters by individuals, a number of whom were not trained in the medical field. The second period (1668 onward) starts with the biological observations of Francesco Redi in the 17th century and continues to the present time and deals with reports and findings in the realm of parasitology by qualified investigators.

* Tel.: +1-732-940-4070; fax: +1-732-940-7881.
E-mail address: raroncal@bellatlantic.net (R. Roncalli Amici).

1. The pre-Redi period

1.1. The Roman era

During Roman times, a group of agricultural and medical writers, with varying backgrounds, reported in their scripts a number of observations relevant to veterinary and medical parasitology. It is interesting to observe that numerous reports were relevant to sheep, a domestic animal species mostly appreciated at that time for wool and meat.

Marcus Portius Cato the Elder (or the Censor) (234–149 B.C.), the first of the Roman agricultural writers, in his *De rustica* (Chapter 96, *Oves ne scabrae fiant*) recommends, after shearing, the application of a mixture of olive oil dregs, lupine extract, good wine and bathing in seawater for the prevention and treatment of mange in sheep; the application of these methods also appeared to prevent the attachment of ticks (Cato, 1783).

Marcus Terentius Varro (116–27 B.C.), a Roman general and one of the first Latin encyclopedists, is remembered for his intuition on the cause of malaria which preceded Laveran by many centuries. In his *Rerum rusticarum de agricultura* (L. I, 12, 2), he prophetically reported that “in swampy places minute creatures live that cannot be discerned with the eye and they enter the body through the mouth and nostrils and cause serious diseases” (Varro, 1783).

Publius Virgilius Maro (71–19 B.C.), Caesarean poet, in 31 B.C. wrote the four books of *Georgics*, an agricultural manual. In the third book of *Georgics* he described how a winged pest (*Hypoderma* flies), called *Oestrus* by the Greeks and *Asilus* by the Romans, was driving cattle herds in terror through the groves (L. III verses 146–151). He also reported the problem caused by mange in sheep and its treatment by tar, grease and washing (L. III verses 441–451) (Virgilius, 1824).

Aulus Cornelius Celsus (30 B.C.–50 A.D.), the greatest of the Latin medical writers, in his *De re medica* (A treatise of eight volumes) described, following the Hippocratic classification, tapeworms (*Lombricus latus*) and roundworms (*Lombricus rotondus*) (L. IV, Chapter XXIV). He recommended several remedies for their elimination, including dilution of small roots of pomegranate in water (pomegranate cortex contains pellerine, an alkaloid with a specific anthelmintic action and even today — 20 centuries after Celsus — pomegranate is used in homeopathic remedies). Celsus reported on the presence of lice on the eyelids (*De pediculis palpebrarum*) and suggested pertinent remedies and measures to combat the infestation. He also described quartan, terzan and a subterzan form of malaria (L. III, Chapter III) (Celsus, 1785). Some historians credit Celsus with giving the term “scabies” to the disease, and with the first description of pustulae (Friedman, 1938). For the treatment of scabies in humans as well as in animals he recommended a mixture of pitch and sulfur.

Lucius Junius Moderatus Columella (ca 2–4 B.C.–40 A.D.), a Roman citizen born in Cadiz, Spain was an excellent writer, who would have a considerable influence on future generations of agriculture and veterinary authors. In his *De rustica* — a treatise of 12 books — he reported on the occurrence of mange in horses, cattle, sheep and dogs (two types of scabies in dogs — one mild and the other more vehement) (L. VI and VII) advocating the use of sulfur to control the disease. Columella, described fleas in dogs; to eliminate them he recommended the use of cimin (*Cummin cyminum*) mixed with white hellebore

(L. VII, Chapter XII). He reported on the presence of helminths in calves (*Toxocara vitulorum*) “*Solent autem vitulis nocere lumbrici, qui fere nascuntur cruditatibus*” (L. VI, Chapter XXV) and in horses, probably *Parascaris equorum*, which cause colics in foals “*Solent etiam vermes quasi lumbrici sunt nocere intestinis*” (L. VI, Chapter XXX). For the treatment of ascarids in calves Columella recommended the use of *artemisia* (wormwood) which is a source of santonin, a sesquiterpene lactone having anthelmintic activity. He also advised that no marshes should be near buildings or military highways, since they would breed “creatures armed with mischievous stings” (“*infestis aculeis armata gignit animalia*”) (L. I, Chapter V). Columella was one of the first agricultural/veterinary authors to advise the isolation of affected animals (Columella, 1745, 1783).

Gratius Faliscus (40 B.C.–20 A.D.), a Roman poet, wrote a long poem *Carmina venatico* or *Cynetigon* (500 hexameter verses) on the glory of hunting. In his poem he reports that dogs can become infested with mange and, to cure it, Faliscus advises to use bitumen, perfumed wine, tar and olive oil dregs (verses 408–429) (Johnson, 1699; Faliscus, 1832).

Pliny (Caius Plinius Secundus) the Elder (23–79 A.D.), another encyclopedist, wrote *Historia naturalis* consisting of 37 volumes; his history of animals is contained in volumes VII–XI (Plinius Secundus, 1507). Pliny described a variety of treatments for the control of mange in sheep including bathing in seawater and rubbing the lesions with salt. For the treatment of helminths he recommended the use of pomegranate with wine and also describes — as Galen did before him — the anthelmintic virtues of male fern. In the same treatise Pliny made several references to malaria, especially with regard to different types of fever (Celli, 1925).

In the 4th and 5th centuries A.D. veterinary art prospered in Rome with the work of three veterinarians: Chiron, Pelagonius and Vegetius.

Claudius Hermerius called Chiron (4th century), a veterinarian, was a writer of some interest. He wrote *Mulomedicina Chironis*, a treatise of 10 books, organized by body systems. Chiron described mange of horses (L. VII, 613–614) advocating a number of remedies including sulfur, liquid tar and dregs of pressed olives. He also described the presence of red and round worms (*cosse id est vermes rubros and rotundos*) on the anal region, probably with reference to oxyurids (L. VIII, 718–719) (Chiron, 1901).

Solonius Pelagonius (4th century A.D.), veterinarian, compiled a treatise, *Veterinaria*, probably in the second half of the 4th century. An incomplete text of this work was discovered in Florence in (Pelagonius, 1826). Chapter XXVI — *Medicamina ad scabiem, quaecumque in pecore nascit potest* (Remedies for any type of scabies which can affect livestock) of this treatise describes different remedies for the treatment of mange in animals. Unfortunately, Chapter XXXII — *De vermibus* (On worms), which would have given more information on animal parasites was lost.

Publius Vegetius Renatus (450–510 A.D.) born in Volterra (Tuscany) in the 5th century A.D. wrote the first veterinary treatise *Artis veterinariae sive mulomedicinae* (“The Veterinary Art”) in the Christian era. The work, which was first printed in 1528, consists of four books. In Chapter XLIV (L. I) *De lumbricis, cossis, tineis, et pediculis* of the treatise, Vegetius reports that the presence of worms may cause very strong pains in the belly of the horse; he also mentions the presence of parasites in the anus (*humor in ano fabae coctae similis*), probably with reference to larvae of *Gasterophilus hemorroidales*, which he defines similar to cooked beans. In Chapter LXXXI (L. III) *De scabie*, Vegetius recommends

several treatments including one of hot wine and sulfur for the treatment of mange in horses (Vegetius, 1783).

1.2. *The medieval period*

During the medieval period reports on parasitology were scanty; scabies, since visible and painful, was the most described parasitic disease for both humans and animals. The 13th century, which was the apex of the medieval civilization, saw the publication in Italy of interesting treatises in agriculture and veterinary medicine. Of interest is the depiction of scabies given by the most celebrated Italian poet, Dante Alighieri (1265–1321), who in his poem “The Divine Comedy” (Inferno, Canto XXIX, verses 79–87), described the cries of alchemists and forgers who were tormented by the pain of scab lesions which he compared to scaly fish skin (Alighieri, 1982).

Taddeo Alderotti (1223–1300), a famous physician, taught medicine at the University of Bologna. It is probable that Dante attended his lectures. Alderotti published *Consilia*, a collection of clinical cases and some of these (*ad scabiem*) were relevant to remedies for the treatment of scabies; case CVI describes an ointment containing hepatic aloe (*Aloes hepatica*), laurel oil, quicksilver and sage (Bazzi, 1958).

Human scabies is also often cited in the famous poem *Regimen sanitatis — Flos medicinae Scholae Salerni*, of the Medical School of Salerno, probably written between the 11th and 12th centuries. At that time, scabies, as other diseases, was regarded as caused by humoral deficiencies with the resulting formation of scab lesions on the body. In the same text, remedies for the treatment of fleas and lice infestation are also mentioned (Sinno, 1941).

Jordanus Ruffus (13th century), born in Calabria, chief veterinarian at the court of Frederick II in Sicily, in 1250 published *Medicina equorum*, a treatise on diseases of horses (Brunori Cianti and Cianti, 1993). According to Poulle-Drieux (1966) Ruffus described, under the name of “Scalmatus”, an enteritis characterized by fetid diarrhea and the elimination of small red and white worms. Ruffus also mentioned sarcoptic mange in horses, which he called *scabies*, with pruritus as a dominant sign; the lesions of this infestation were characterized by thick crusts giving to the skin a fish-like squamous appearance, a description similar to that given by Dante for humans.

Pietro de Crescenzi (1233–1310), born in Bologna, studied medicine, philosophy and law. He published *Trattato dell'agricoltura* (A treatise on agriculture), consisting of 10 books, which for many centuries enjoyed a great reputation and was translated into several languages. Sections of this treatise deal with animal diseases; in book IX (Chapter 72), and in book XI (Chapter 50), respectively, Crescenzi describes “bottle jaw” (appearance of sub-mandibular edema) and pale color of the ocular mucosa in sheep, clinical signs probably connected to fascioliasis (de Crescenzi, 1564).

Theodoric Borgognoni (1205–1298), a Dominican friar, became Bishop of Cervia (Romagna) and — at the same time — practiced human and veterinary medicine — a custom, which at that time was not unusual (Chiodi, 1957). He wrote medical texts as well as a book on hippiatry: *Pratica equorum composita a fratre Theodorico de ordine fratrum predicatorum phisico et episcopo Cerviensi*. In the Chapter *De vermibus* of this book, Borgognoni reported on strongyle infections of horses; he also described psoroptic mange of horses affecting the tail and mane (Poulle-Drieux, 1966).

Laurence Rusius (1288–1347), veterinarian in Rome, wrote during the first half of the 14th century a manuscript *Marescalcie*, which later appeared in printed form. In Chapter LXXII, Rusius (1532) describes at length psoroptic mange lesions on the tail and mane of horses; also he provides the reader with a dozen recipes to treat the problem. Of interest is a recipe consisting of an ointment containing sulfur, alum, black hellebore, and quicksilver; in some cases Rusius recommends blood letting of the affected horse, a practice which, unfortunately, will be followed for several centuries.

Bartolomeo Grisone was a veterinary practitioner from Bologna. In his treatise on oxen and horses (Grisone, 1429), dedicated to God and St. Eloy, the patron saint of veterinarians, Grisone described — for the first time — the presence of *Thelazia* spp. on the eye region of cattle; he recommended to extract the worms with a stick and then to wash the eyes (Ercolani, 1851).

1.3. *The 1500s and the Renaissance*

In the 1500s — during the Renaissance — because of the importance of the horse as an animal for pleasure, a famous school of horsemanship developed in Italy; some of the masters of this school dabbled in veterinary medicine and wrote texts with descriptions of equine diseases including those connected with parasites. Finally, in this century, new treatises written by physicians, and solely dedicated to parasitology, began to appear.

1.4. *Hippiatrics*

In 1518 Agostino Columbre (or Colombre), a veterinarian from San Severo (Puglia), compiled a treatise of three books on the nature of horses and the method of curing their diseases; the treatise was well received and run into several editions. In Chapter 43 (L. II), Columbre (1561) describes colics in horses (which he attributes to worms), *Gasterophilus* spp. larvae (which, as was done earlier by Vegetius, he calls “cooked beans”), and oxyurids which are present around the anus. Ercolani (1851) is of the opinion that this is a good description of pinworms in horses. Columbre produces several recipes to combat the worms and, in Chapters 26 and 27 (L. III), he describes scabies and pertinent treatments.

Phillip Scacco of Tagliacozzo (Abruzzi) in 1591 published in Rome *Opera di mescalzia* (A work in marshalry), a treatise in four books. This work, which contains a large number of illustrations depicting various diseases in horses, came out in several editions with different titles. In the edition of 1603, under *Delli lumbrici, & vermi* (L. I), Scacco describes *Gasterophilus* spp. larvae and clinical signs of oxyuriasis; he also provides information — with pertinent illustrations — on remedies to be administered orally with the horn or as an enema to combat the worms (Scacco, 1603).

Pasqual Caracciolo, a Neapolitan nobleman, in his treatise *La gloria del cavallo* (The glory of the horse), a truly encyclopedic work on the horse in 10 books, published in Venice in (Caracciolo, 1566), dedicates several pages to the treatment of mange; also, he mentions the presence of bots in horses.

Carlo Ruini (1598), a Senator from Bologna, published *Dell'anotomia, et dell'infirmitta del cavallo* (The anatomy of the horse, diseases and treatment) in two volumes. The very

famous first volume is dedicated to the anatomy of the horse, while the second volume, often ignored, deals with diseases. Ruini, an accomplished anatomist, observed at necropsy the presence of *Gasterophilus* spp. larvae and worms (probably ascarids and oxyurids) in horses; for the treatment of the latter he recommends, while fasting, to administer one and one-half ounces of bran mixed with sulfur every morning for 3–4 days.

1.5. *The physicians*

In the 1500s, two physicians Ippolito Brilli from Lendinara (Veneto) and Girolamo Gabucino from Fano (Marche) wrote the first two monographs on worms. Brilli (1540) published a book in Venice describing the worms of the intestine in humans. The book from Gabucinus (1547) “*De lumbricis alvum occupantibus . . .*” became well known and, as a result, several editions were printed in Italy and abroad. The work, which consists of 18 chapters, is considered to be the first treatise on parasitology. Gabucino reports on parasites in humans and in animals; of interest is a case of ascariidiosis in a *puclissima ac pulcherrima* (most chaste and beautiful) woman who ejected an ascarid from her mouth. He describes fluke in sheep — as resembling watermelon seeds — and oxyuris in horses; also he reports the first case of *Coenurus cerebralis* in sheep and finally reviews the therapy used against parasites at that time. In the same century a physician, Scipione Mercurio (1550–1616) published in 1595 a celebrated book on obstetrics *La commare o raccogliatrice* (The midwife or woman gatherer). In the third book of the treatise Mercurio describes roundworms in children and different methods of treatment including aloe and myrrh (Chapter LI). In Chapter LIII he reports on the head louse in children and pubic louse in adults; to control head lice he recommends the use of several remedies among which an ointment based on oil, alum, white hellebore, and vinegar (Mercurio, 1652).

Antonio Brasavola Musa (1500–1550), physician/veterinarian and botanist, taught theoretical medicine at the University of Ferrara and became physician to Pope Paul III and to some noble families such as the Farnese. He was one of the first medical pharmacologists with an interest in parasitology. In 1537, while examining, at necropsy, horses of Prince Farnese he discovered in their stomachs “red worms” shaped like pumpkin seeds “*cucurbitae*”, probably larvae of *Gasterophilus* spp, Brasavola Musa (1541) Brasavola reintroduced black hellebore into medicine and recommended the use of mercury for the treatment of worms in humans (Burserii, 1753).

Gerolamo Fracastoro (1478–1553), a physician of the Renaissance period, famous for his poem on syphilis, also wrote a poem in Latin on hunting dogs, as was done centuries before by Faliscus. Fracastoro too mentions in his poem the serious problem of mange in dogs and its treatment (Fracastoro, 1739). A book containing the two poems by Faliscus and Fracas was published by T. Johnson in London in 1699.

Andrea Cesalpino (1519–1603), physician, anatomist and botanist, taught medicine at the University of Pisa; he was also personal physician to Pope Clemens VII. In his treatise *Questionum medicarum* (L. II) Cesalpino described the presence of *Dioctophyma renale* in an emaciated dog and in the kidney of a marten; he also noted mites in the skin of man (Parona, 1894b; Enigk, 1986; Penso, 1973).

Ulisse Aldrovandi (1522–1605) is the first master who appears in the history of Italian parasitology. According to Berlese (1909) in his young years Aldrovandi (1602) was

suspected of heresy and sent to Rome, where fortunately he was exculpated. After obtaining a degree in medicine and philosophy at the University of Bologna in 1553, he taught medicine there for over 50 years. During that time he accumulated a vast amount of scientific material, which was used for the writing, in Latin, of “Natural History”, a series of 12 treatises covering a large number of subjects. Treatise VII, *De animalibus insectis, libri septem cum singulorum iconibus ad vivum expressis*, consisting of seven volumes, and published in 1602 in Bologna was the first book in the world to describe insects in a systematic way, establishing entomology as a science. In this book, sections are dedicated to the morphology of the insect and the many figures of insects (more than 700) produced in the book are quite good, especially if one considers the time in which they were produced. From a veterinary standpoint the description of ticks is of particular interest. The entire chapter five of L. V of treatise VII is dedicated to ticks and is entitled “De Ricino”. Aldrovandi narrates on ticks which are attached to the skin of animals, suck blood (“*sanguine satur est*”) and are born in the grass (“*in herbis nascuntur?*”). Aldrovandi brings out the name of “Ricinus” for the title of his chapter (ticks do resemble ricinus seeds) and he even mentions that ticks are called “garapatas” by the Spaniards. Aldrovandi describes flies and mosquitoes and their deleterious action; he is credited for having coined the term *acarus* for mite. Aldrovandi knew oxyurids, which he called “lumbriculi” and *Gordius* defined as *Seta* or *vitulus acquaticus* (Busacchi, 1972). Unfortunately, so far, his opus on insects has been largely ignored; hopefully, some time in the future, there will be a “raisonnée” translation of *De animalibus insectis*.

2. The Redi and post-Redi period

2.1. The 1600s — The Academies, the microscope and the introduction of experimental medicine

At the beginning of the 1600s two interesting publications on worms came to light in Italy. The first, *De vermibus tractatus* was by the Neapolitan De Urso (1601). In this treatise, which is divided into 14 chapters, he discusses the worms present in the human body, as well as their prevention and treatment. The second publication, “Trattato sopra li vermi”, a booklet of 30 pages, is the work of Salando (1607), a physician from Verona. Being written in Italian and with large type, the book had a wider diffusion with the public at large than previous publications in Latin; it deals with the problem of worms in humans and with methods for their elimination.

The Academies represented some of the fruitful expressions of the 1600s. They were founded and attended by individuals interested in the advancement of particular disciplines by way of experimenting. While England and France saw the foundation of the Royal Society and the Académie Royale des Sciences, respectively, in Italy two small academies were established: the Academia dei Lincei (Lyncean Academy) in Rome and the Accademia del Cimento (Contest Academy) in Florence. Galileo Galilei (1564–1642), the Italian astronomer, in addition to the telescope, also became interested in perfecting the microscope to use as a tool for scientific research. He provided a very simple microscope to the members of the Lyncean Academy; one of them, Francesco Stelluti (1557–1653) from

Fabriano (Marche), used this microscope to study the exterior surface of the bee and depicted his findings in precisely drawn plates published in a book “*Persio Tradotto*” (Stelluti, 1630). This was the first book to contain illustrations of natural objects as seen through the microscope (Norman, 1991). The availability of a microscope as an investigative tool will be of extreme importance for future research in the 1600s in Italy, especially in the area of parasitology.

The study of parasitology received a great impetus with Francesco Redi (1626–1697). Born in Arezzo, he obtained his medical degree at the University of Pisa at the age of 21. Redi did most of his research work in Florence where he became court physician to the Medici family. An excellent writer, he “developed his arguments with subtle logic and clarity of interpretation” (Castiglioni, 1946). One of his major contributions is to have debunked the theory of spontaneous generation by demonstrating that flies are born on putrefacted flesh only when other flies deposit eggs, thereby confirming Harvey’s dictum — *omne vivum ex vivo*. In his book “*Esperienze intorno alla generazione degli insetti*” (Experiments on generation of insects) (1668) he described that ectoparasites “hanno il lor natale dalle uova fatte dalle lor madri, fecondate mediante il coito” (are born from eggs generated from their mother and fecundated via coitus) (p. 151)”. In this book, Redi, who was a microscopist of great merit, published lucid illustrations (29 engraved plates) of insects. Among the illustrations which stand out are those relevant to ticks, including deer and tiger ticks; they are the first rendition of ticks with eight legs. Also in the book there is a depiction for the first time of a larva of *Cephenemyiinae*, the nasal bot of deer, as well as the liver fluke (*Fasciola hepatica*) of sheep (Fig. 1). Years later Redi (1684) published another great treatise “*Osservazioni intorno agli animali viventi che si trovano negli animali viventi*” (Observations on living animals, that are in living animals). In this book, he records the descriptions and the drawings of more than 100 parasitic organisms. Also, he evidenced the difference between the earthworm and *Ascaris lumbricoides*, the

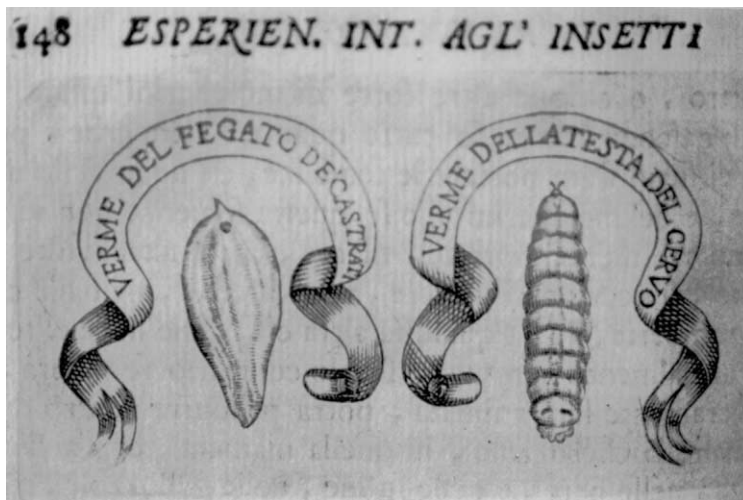


Fig. 1. Redi (1668) — adult *F. hepatica* of sheep and *Cephenemyiinae* larva of deer.

human parasite. In this book, Redi records the results of his experiments in chemotherapy; he carried out *in vitro* controlled trials (39) on earthworms and leeches and also on humans (10), cat and fish worms (2); among the substances found to be effective: santonin and copper sulfate (de Carneri, 1967). In his experiments Redi employed, for the first time, an experimental design using groups of untreated animals which are now called “controls”. Redi also contributed to the research on human scabies effected by Cestoni and Bonomo. He lived and operated at a time when it was dangerous — as was demonstrated by the condemnation to the stake of the philosopher Giordano Bruno, and of the imprisonment of another philosopher Thomas Campanella and the astronomer Galileo Galilei — to express new ideas contrary to theological tradition of the Holy Scripture. Conscious of this, Redi carefully produced a new interpretation based on *omne vivum ex vivo* of passages from the Bible, which could have been interpreted under the perspectives of the spontaneous generation. Redi, who was also an accomplished poet, is considered to be, by a number of historians, “the father of parasitology”.

Giovanni Cosimo Bonomo (1663–1696) and Diacinto Cestoni (1637–1718). The scientific accomplishments of these two scholars are connected with Francesco Redi and, to a certain extent, with Vallisnieri. Bonomo, born in Leghorn, obtained his degree in medicine and philosophy at the University of Pisa. In a letter to Redi, “Osservazioni intorno a pelicelli” (Observations on scabies mites) published in Leghorn, Bonomo (1687) accurately described for the first time *Sarcoptes scabiei*, the mite of human scabies. In particular, he detailed the eggs, the differentiation between female and male mites and the fact that mites do not generate spontaneously but are transmitted from man to man. As Chandler (1940) points out “this was the first demonstration of a specific cause for a disease and was a clear break from the divine, humoral or other ancient theories of spontaneous origin of the disease which had dominated medicine since the time of Hippocrates and Galen”. It was a demonstration that man was not any longer the “generator of worms” but, conversely, it was a minute entity, like the mite, which assaulted him. Bonomo also described the contagiousness of the disease and noted that scabies could be controlled by external application of remedies, while internal administration was of no use.

Cestoni, was born in Montegiorgio (Marche) and worked as a pharmacist in Leghorn. He cooperated with Bonomo, especially in the area of microscopic observations, in his work with mites of human scabies and it is regrettable that his name does not appear as co-author with Bonomi in the famous letter (Osservazioni, etc. vide supra). Cestoni had a long correspondence with Vallisnieri on numerous parasitologic topics, which was later published by the latter. In one of his letters (19 August 1697) he describes in minute detail the life cycle of the flea; unfortunately this vivid description was ignored by researchers and historians.

Bonanni (Buonanni) Filippo (1638–1725), a Jesuit and zoologist, succeeded Athanasius Kircher (1602–1680), the German zoologist, as teacher of mathematics at the Collegium Romanum in Rome. Bonanni made extensive studies in the field of entomology using one of the early microscopes made by Giuseppe Campani. In 1691, he published *Micrographia curiosa*, one of the earliest Italian treatises on microscopy; the quality of his illustrations of various insects was excellent, in particular those on *Culex* and the louse. Glorification of the microscope was beautifully rendered by Bonanni in the frontispiece of his book (Figs. 2 and 3).



Fig. 2. Bonanni (1691) — glorification of microscope.

In the 1500s and 1600s rich noblemen with a love for hunting dogs in France and Italy reported their observations on the health condition of their beasts, and occasionally on parasitic findings. Francesco Birago (1552–1640?), a nobleman living in Lomellina (Lombardy), made the first observation of heartworms in dogs. Birago (1626) published a treatise on hunting, in which he described the presence of worms in the heart (*Dirofilaria immitis*) and the kidney (probably *Diocotophyma renale*) in a greyhound at autopsy.

Continuing on the tradition of Redi was Marcello Malpighi (1628–1694), physician, biologist and parasitologist. At 28 years of age he was professor of medicine at the University of Bologna. Malpighi is well known for his histological studies and can be considered as the founder of the anatomy of insects. Malpighi (1669) in his famous treatise, *De Bombice*, published in London at the suggestion of the British Royal Society, he described the complete structure of the larva, nymph and the adult silkworm; this treatise is the first complete work conducted on an arthropod; before its appearance it was thought that the silkworm had no internal organs. Malpighi also studied human and veterinary parasitology with his work on pulmonary cysts from *Echinococcus* in humans, tapeworms in humans and dogs, *F. hepatica*

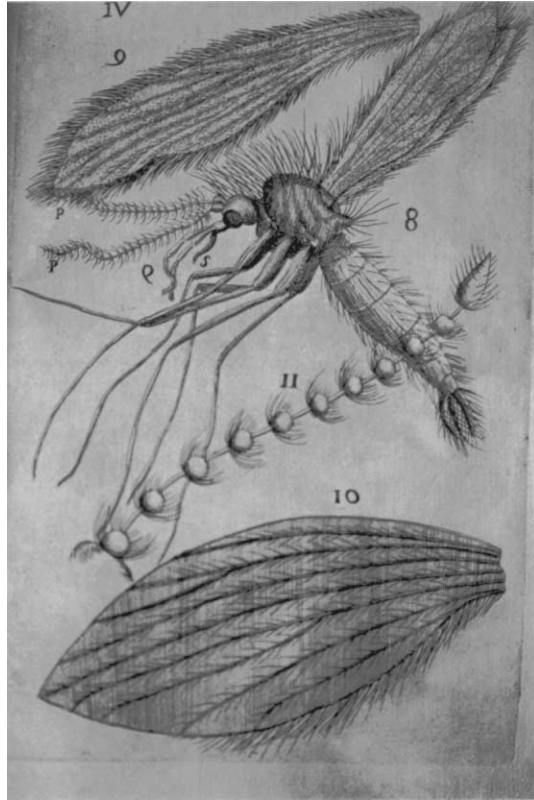


Fig. 3. Bonanni (1691) — adult fly — Psychodidae family.

in humans and cattle, and cysts of *Cysticercus cellulosae* in pigs; as reported by Vallisnieri (1713a), he also described the presence of bots in the stomach of donkeys.

Antonio Vallisnieri (1661–1730), physician, naturalist and parasitologist, taught theoretical medicine at the University of Padua. The studies of Vallisnieri on insects can be considered a continuation of those by Redi and support his attack on the doctrine of spontaneous generation. He published a number of books containing his observations on human and animal parasites. Two of them are of particular interest: “Saggio de’ dialoghi sopra la curiosa origine di molti insetti” (Essay on dialogs on the origin of many insects) published in Venice in (Vallisnieri, 1696), and “Esperienze, ed osservazioni intorno all’origine, sviluppi e costumi di varj insetti” (Experiences and observations on the origin, development and customs of various insects) also published in Venice in (Vallisnieri, 1713b). Vallisnieri described, with good illustrations, larvae and flies of *Hypoderma* spp. of cattle and of *Oestrus ovis* of sheep; he also described the presence of the latter parasite in the frontal sinuses in humans and its life cycle in sheep. In a letter to Senator Garzoni of Venice, a well-known hippiatric, Vallisnieri reported on the life cycle of *Gasterophilus* spp. of horses (Vallisnieri, 1713a). Also of interest are his studies on ascaris of man and *Neoascaris vitulorum*, including excellent drawings of their reproductive organs, which are reported

in “Considerazioni, ed esperienze intorno alla generazione di vermi ordinarj del corpo umano” (Considerations and experiences on the generation of ordinary worms in human bodies) published first in Vallisneri (1710) and later in Vallisneri, 1733.

Giovanni Maria Lancisi (1654–1720), physician, epidemiologist, hygienist and pontifical archiater, studied medicine at the University of Rome, where he later taught anatomy. In his book *De noxiis paludum effluviis, eorumque remediis* (1717) Lancisi (1717) recommends the drainage of pools and swamps of marshy regions to combat malaria. He is also of the opinion that during the malarial fevers “worms” (*vermes*) enter the blood vessels and circulate; also, he suggests to examine the blood microscopically — repeatedly — to search for “insects” (*insectos*) responsible for the disease. Lancisi provided the book with an engraved map depicting a drainage scheme for the Pontine Marshes south of Rome.

Francesco Torti (1658–1741), a physician, received his medical degree in Bologna and was Professor of Medicine at the University of Modena. Torti (1712) wrote a famous treatise reporting the effectiveness of cinchona bark (quinine) given during the apyretic phase of malaria; he also recommended the administration of a dose of quinine commensurate to the seriousness of the case, thereby rejecting the therapeutic dogma of the time that the dosage of quinine should never exceed two drachms given with wine. Torti is also credited with bestowing the name malaria (mal air) to the disease.

Carlo Musitano (1635–1714), born in Castrovillari (Calabria), was a priest and physician. He was a prolific writer and author of many medical works. In his book *Trutina Medica* Musitano (1688) speaks of intestinal worms and mites and discusses their origin; he was a strong supporter of the dictum: *omne vivum ex ovo*. Musitano was the first author to report that the acarus may be recovered from the end of its burrow in the skin (Friedman, 1938).

2.2. The 1700s

In the 1700s, as a result of the political and military situation in Italy, the great cultural centers of the country suffered. In spite of this, two great figures — Morgagni and Spallanzani — emerged and, in their work, made valid contributions in the field of parasitology.

Giovanni Battista Morgagni (1682–1771), physician and pathologist, obtained his medical degree at the University of Bologna in 1706. In 1711, at the age of 29 he was given the chair of theoretical medicine at the University of Padua (the same chair previously occupied by Vallisneri) and, 4 years later, that of anatomy which he held for more than 50 years. Morgagni in his numerous publications described the occurrence of *Trichuris* in the cecum and appendices of humans and *Echinococcus* cysts in humans and in animals and *Spirocerca lupi* in dogs (Parona, 1894b).

Lazzaro Spallanzani (1729–1799), an abbot, naturalist and physician, studied the issue of the spontaneous generation of infusoria; by repeating numerous tests he was able to demonstrate that the spontaneous generation of infusoria did not take place (Spallanzani, 1784).

Giovanni Battista Borsieri (1725–1785), a physician, pupil of Morgagni and Vallisneri, taught medical clinics at the University of Pavia. He wrote, in Latin, a very popular book, *Institutiones medicinae practicae* (1781–1789), which was later translated into Italian and English. Borsieri recommended the use of emetic tartar against tapeworms; also, in *De anthelminthica argenti vivi facultate* (1753) he reported on the successful use of mercury for the expulsion of roundworms.

2.3. *The 1800s — The century of discovery in medical and veterinary parasitology*

The 1800s is the century when the unity of Italy was achieved and a number of Italian researchers such as Ercolani and Bozzolo saw action in attaining this goal. It is also the century when new discoveries on parasites and their life cycle take place in many countries including Italy. In parallel with the unification of Italy there was a flourishing of studies in a number of veterinary schools, especially in the field of veterinary parasitology. This work was spearheaded primarily by two veterinarians — Ercolani and Perroncito. The interest in medical and veterinary parasitology was also shared by zoologists and entomologists; some of them resided in the northeastern section of the country which, at that time, was under the domination of the Austro-Hungarian Empire. Starting from the middle of the century more and more parasitological studies were carried out in new and better-equipped laboratories. Progress was also made in the field of entomology with the creation of new entomological stations. In the middle of the 1800s a group of Italian researchers tackled, successfully, the problem of St. Gotthard's disease. At the end of the century, Italian physicians and zoologists, mostly associated with the medical school of the University of Rome, embarked on an intense program with a view to discovering the cause of malaria; although no laurels were received by these workers, their contributions ought to be remembered.

2.4. *The zoologists*

Filippo de Filippi (1814–1867), professor of zoology at the University of Turin, made important observations in the area of trematodes and in encystment of cercariae. de Filippi (1837) described new worms in some mollusca to which he gave the name of *redia* in honor of Francesco Redi. In subsequent studies (1855–1859) he reported that *redia* was a larval stage in the development of trematodes.

Michele Stossich (1857–1906), physician and zoologist, studied medicine and zoology at the University of Innsbruck and Vienna. He taught in a Triest high school and studied the helminthic fauna around Triest and in the Venetian territory. Stossich (1892) was the author of a large number of publications on systematics of parasites, including a monograph on flukes of mammals; his name is associated with a number of genera and species of parasites of domestic animals.

Raffaele Molin (1825–1887), physician, zoologist and parasitologist, received his medical degree at the University of Vienna and taught at the University of Padua. He worked in the province of Venice particularly on *Filaria* and *Spiroptera* and described for the first time (1858) *Capillaria annulata*, the chicken parasite (Enigk, 1986). He left his noteworthy collection of helminths to the Museum of Natural History in Vienna. As was the case for Stossich, his name is associated with a number of genera and species of parasites of animals.

2.5. *The physicians*

Valeriano Luigi Brera (1772–1840), professor of medicine at the University of Pavia, wrote two treatises on worms of man, which were translated into French and German. The first text, with a section on the administration of remedies for the treatment of worms,

was published in (Brera, 1802) and the second in (Brera, 1811); both books contain good illustrations of worms.

Stefano Delle Chiaie (1794–1860), physician, botanist and parasitologist, obtained his medical degree at the University of Naples and taught medicine and botany at the medical school of that university. He wrote a treatise “Elmintografia umana” (Delle Chiaie, 1825) — with beautiful reproductions of human and animal parasites — mostly for didactical purposes. The work contains three sections: classification of worms, generation of worms, and clinical and therapeutic aspects of worm diseases. The publication was very successful having five editions between 1825 and 1856.

Agostino Bassi (1775–1856), lawyer, physician and biologist, worked in different fields. His key contribution was the discovery of the cause (a hyphomycete fungus today called *Botryotis bassiana*) of the muscardine disease of silkworms (Bassi, 1835, 1836); this was the first time that a living micro-organism was recognized as the cause of a disease (Théodorides, 1966). Bassi was a precursor of the modern control methods and is to be considered as the founder of the doctrine of pathogenic micro-organisms (Norman, 1991). With Bassi we enter into a new period of studies and discoveries which extends to the second half of the 19th century.

Prospero Sonsino (1835–1901), physician and parasitologist was born in Tunis of Italian parents; he obtained his medical degree at the University of Pisa and spent most of his time in North Africa and the Middle East. Sonsino worked in many research areas; he published 139 works and 70 were dedicated to parasitology. His major contribution to parasitology was the first description of *Schistosoma bovis* (Sonsino, 1876) and his work on filariae of dogs and *Taenia saginata*.

2.6. The veterinarians

Count Giovanni Ercolani (1817–1883) — veterinarian, parasitologist and patriot — obtained his veterinary degree at the University of Bologna in 1826 and taught at the Universities of Turin and Bologna. A strong believer in the unification of Italy, he participated in historical events such as the battle “del Vascello” in Rome. In 1851, Ercolani edited one of the most complete books on the history of veterinary medicine at that time; in the text he also methodically reviews all the advances in veterinary parasitology through the centuries. A few years later Ercolani (1859) published “Nuovi elementi teorici e pratici di medicina veterinaria” (New elements — theoretic and practical — of veterinary medicine); a section of this book (513 pages, liberally illustrated) was dedicated to parasites and parasitic diseases of animals. This was one of the first complete treatises on the emerging discipline of parasitology made available to veterinary students. Ercolani worked in the field of echinococcosis, strongylosis, filariosis and fascioliasis. He studied ancylostomiasis both in man and in dogs; in 1859 he described for the first time *Ancylostoma caninum*. In 1874, he published an important paper on nematodes, including filariae, of dogs. In this study Ercolani (1874) acknowledges that if the filariae are not present in the heart, they may be present in the subcutaneous tissues of the dog. With this work he opens the pathway for determining the life cycle of *Dirofilaria repens*.

Sebastiano Rivolta (1832–1893), veterinarian, bacteriologist, and parasitologist, received his veterinary degree at the University of Turin where he became a disciple of Ercolani.

Rivolta taught at the Universities of Turin and Pisa and studied a variety of parasites. Rivolta (1873) published a well-known treatise on plant parasitology; also he reported on coccidia in birds (*Psorospermium avium*), in rabbits (*Psorospermium cuniculi*) and in cats (*Isospora rivolta*) and in association with Silvestrini on sporulation of oocysts (Rivolta and Silvestrini, 1873). Rivolta and Delprato (1880) wrote a treatise on diseases of poultry; a number of chapters of the book are dedicated to bird parasitology. Rivolta described several tapeworms in sheep including *Stilesia globipunctata* and *Avitellina centripunctata*; Rivolta (1884) discovered *Ophistorchis felineus* (originally described as *Distomum felineum*) in the biliary passages of a cat.

Gian Pietro Piana (1852–1911). Like Perroncito, Piana was a disciple of Ercolani. He taught pathologic anatomy (an important subject in the teaching program of Italian veterinary schools through which several aspects of animal parasitology are reviewed) at the Veterinary School of Milan. Piana, who was an excellent illustrator of parasites, worked on demodectic mange of cattle, *Trichina spiralis* and *Simonsia paradoxa* of pigs and parasites of chickens such as the life cycle of *Railletina tetragona* (*Taenia botroplitis*) (Piana, 1881) and *Dispharynx* (*Acuaria*) *nasuta*, a parasite of the proventriculus (Piana, 1897). Piana and Galli-Valerio (1895) described for the first time the presence of *Babesia canis* in a hunting dog. The patient was treated, apparently with success, with pills containing calomel, aloe, quinine sulfate and some Marsala wine.

Roberto Bassi (1830–1914), a veterinarian and also a disciple of Ercolani, described for the first time (Bassi, 1875) *Fascioloides magna*, a trematode mostly found in deer and cattle of North America (the interesting drawings of the anatomy of the trematode were the work of Piana). Bassi (1881) observed the parasite in the liver of deer and antelopes kept in a park near Venaria Reale, in Piedmont; it appears that infected Wapiti deers (*Cervus canadensis*) had been imported from North America. He also described — for the first time in Italy — parasites (*Syngamus trachea*) of pheasants.

2.7. The entomologists

Giovanni Canestrini (1835–1900), entomologist and anthropologist, received his doctorate in philosophy and natural science at the University of Vienna. He taught natural history at the University of Modena and zoology at the University of Padua and founded in Padua the first chair of anthropology in Italy. For more than 20 years he worked on mites from Italy, New Guinea, Australia, Bolivia and Burma. Canestrini wrote a number of classic monographs, including “Sistema per la classe degli Acaroidei” (System for Acaroidei class) and “Prospetto della Acarofauna Italiana” (Prospect of Italian Acarofauna); a work of eight volumes published between 1885 and 1899. Canestrini and Kramer (1899) published “Demodicidae und Sarcoptidae”; Canestrini was the first one to describe *Boophilus annulatus* (Canestrini, 1887). The genus *Cheyletiella* (1886) and the families *Psoroptidae* (1892) and *Listrophoridae* (1892) have also been ascribed to Canestrini.

Antonio Berlese (1863–1927), zoologist and entomologist, graduated in zoology under Canestrini at the University of Padua. He worked in Florence (in the newly created entomology station), in Naples and again in Florence. Most of his work concerned mites. Berlese (1882–1903) was a prolific writer and a gifted draftsman thereby providing himself with the illustrations for his works. He wrote “Acari, Myriapoda, and Scorpiones hucusque

in Italia reperta” in 10 volumes (1882–1903) — with 988 engravings drawn by the author — and “Gli insetti, loro organizzazione, sviluppo, abitudini e rapporto con l’uomo” (Insects, their organization, development, habits and relationship with man) in two volumes (Berlese, 1909–1925). The latter treatise was used in Italy for many years as a standard text of entomology. The genus *Trombicula* (1905) and the family *Pediculoididae* (1907) have been ascribed to Berlese; he is also remembered for the development of a useful apparatus to collect arthropodes.

2.8. *The agrarian academies*

Fascioliasis of sheep and cattle was a big problem in the entire Italian peninsula. During the 1800s numerous publications on this disease were issued by veterinarians and other researchers. Of interest is a booklet on this parasitic disease written by Salvagnoli-Marchetti and sponsored by the Academia dei Georgofili of Florence (one of the objectives of this institution was to divulge information on important animal diseases to farmers). The booklet, published in (Salvagnoli-Marchetti, 1856), 3 years after a serious *F. hepatica* epidemic in sheep raised in Maremma (Tuscany), deals with the clinical and pathological aspects of the infection and of the methods to prevent and to treat it.

2.9. *St. Gotthard’s disease*

For a number of years thousands of Italians, especially miners, furnace workers and peasants died of unknown causes. The cause of the disease, as revealed later, was *Ancylostoma duodenale*. This discovery in all its aspects — etiology, epidemiology, clinics, and therapy was accomplished by a group of Italians, including Dubini, Parona, Parona, Grassi, Perroncito and Bozzolo, and represents one of the best pages in the history of Italian parasitology.

Angelo Dubini (1813–1902), physician, pathologist and parasitologist, studied medicine at the University of Pavia and obtained a medical chair at the University of Padua. In 1838, while working at the Ospedale Maggiore in Milan he first found, at autopsy, a new nematode in the intestines of a peasant woman. Dubini (1843) described his findings and named the nematode *Agchylostoma (duodenale)*, a name which was later corrected into *Ancylostoma*; the worm was subsequently shown to be the causative agent of human hookworm disease. Dubini (1850) published “Entozoografia umana”, a treatise enriched with excellent engravings of human worms and ectoparasites. Dubini was a very good draftsman and author of many drawings of parasites, which were later reproduced, with due credit, by other authors. The genus *Ancylostoma* is ascribed to Dubini. He also made notable contributions in the field of neurology.

The brothers Ernesto Parona (1849–1902) and Corrado Parona (1848–1922) — both physicians — worked with Grassi in solving the problem of ancylostomiasis. In continuing the work of Dubini they described the eggs and the first larval stages of *Ancylostoma*, thus facilitating the diagnosis of the disease that until that time was based on the presence of worms (Grassi et al., 1878). Corrado Parona, a graduate in medicine from Pavia, taught first at the University of Cagliari in Sardinia and later at the University of Genoa. Parona (1894a) published “L’elmintologia italiana da’suoi tempi all’anno 1890”, a comprehensive

historical and bibliographic review of Italian helminthology. In the same year he issued a list of 61 helminths present in animals in Sardinia.

Edoardo Perroncito (1847–1936), veterinarian, pathologist, bacteriologist, parasitologist and disciple of Ercolani, received his veterinary degree in Turin in 1867 and in 1874 became professor of parasitology and veterinary pathological anatomy at the University of Turin where he remained for 48 years. He studied numerous parasites including liverfluke, *Gasterophilus*, *Trichinella*, *Echinococcus* and *Taenia saginata*. To Perroncito goes the credit of the discovery that the serious anemia, in miners working in St. Gotthard tunnel, was due to infection by *A. duodenale*; this in spite of the doubts cast by a number of physicians working with him on the disease (Penso, 1973). The fascinating story of the resolution of a problem, which cost the lives of more than 10,000 miners, peasants and furnace workmen, was recounted by Perroncito (1910) in a classic book “La malattia dei Minatori dal S. Gottardo al Sempione. Una questione risolta”. (The disease of miners from St. Gotthard to Sempion. A question resolved.) Perroncito (1882, 1886) published two comprehensive texts on parasites of humans and animals; also he discovered that male fern extract (*Aspidium filix mas*) was effective against *A. duodenale* (Perroncito, 1880) as well as against *F. hepatica* (Perroncito, 1885).

Camillo Bozzolo (1845–1920), physician, studied medicine in Pavia and became Director of the Medical Clinic at the University of Turin. In 1866, he served with Garibaldi in the Trentino. Bozzolo studied the etiology (hookworms) of St. Gotthard’s disease with Perroncito and Pagliani (1847–1932) and introduced the use of thymol for its treatment (Bozzolo, 1879).

2.10. Grassi and his collaborators — G. Noé e S. Calandruccio

Giovanni Battista Grassi (1854–1925) is one of the most famous Italian parasitologists. Physician and zoologist, Grassi possessed a fertile and inquisitive mind and was a tireless investigator; he worked on a variety of parasites of both medical and veterinary interest. Grassi obtained his medical degree in Pavia and taught first at the University of Catania and later at the University of Rome where in 1895 he was elected to the chair in comparative anatomy. Early in his career (1878), Grassi worked with the brothers Parona in the fecal diagnosis of hookworm disease (vide supra). Grassi (1879) published a work of great importance on the life cycle of *Strongyloides stercoralis*, which at that time was called “anguillula” because of its eel-shape; in the same year Grassi erected the genus *Strongyloides*. Grassi and Rovelli (1889) worked on the life cycle of *Dipylidium caninum* in the flea; later, in (Grassi and Rovelli, 1892) they published a monograph on the biology, anatomy and embryology of tapeworms. Also, with Salvatore Calandruccio he described for the first time *Dipetalonema reconditum*, a non-pathogenic filarial worm of dogs; they showed that the parasite completed its development in human fleas (*Pulex irritans*) (Grassi and Calandruccio, 1890). Grassi and Noé (1900) studied the life cycle of *Dirofilaria* spp.; in particular the propagation of filariae from the blood by means of blood sucking mosquitoes. He greatly participated in the study of malaria; among his contributions is the indication that *Plasmodium* undergoes its sexual phase only in the *Anopheles* mosquito; Bignami and Bastianelli also participated in these studies (Grassi et al., 1899). Of note also is his work with Antonio Dionisi on the evolutive cycle of haemosporidia (Grassi and Dionisi, 1898). Earlier (1890), Grassi, in cooperation

with Raimondo Feletti, had published several works on malarial parasites in birds. In 1900, he issued “Studi di un zoologo sulla malaria” a treatise summarizing his work on malaria, dedicated to P. Manson, “with the best illustrations of the various stages of the malaria parasite published at that time” (Norman, 1991). Grassi (1907) wrote the first good account of the structure and life history of the sand-fly (*Phlebotomus*). Grassi was a modest man and a dedicated researcher; unfortunately, because of his character (he had a strong jealousy for his work) he was prone to diatribes even with his fellow-workers, and one of these was a sad polemic with Ronald Ross on the priority of the discovery of the malaria agent. In 1902, Ross received the Nobel Prize for it; perhaps today the prize would have been given to both. In spite of his personality problems which were the cause for strong criticism both in Italy and abroad, it is undeniable that Grassi made great contributions to both medical and veterinary parasitology.

Giovanni Noé (18?–1947), zoologist, worked with Grassi on the life cycle of *Dirofilaria immitis* in dogs at the University of Rome; he also studied *Dipetalonema grassii* (Noé and Grassi, 1907). In 1912, he moved to the Medical School of the University of Chile to be a teacher and a researcher; in that country he worked on hookworms, echinococcosis and Chagas disease (Pizzi, 1974).

Salvatore Calandruccio (1858–1908), physician and biologist; disciple of Grassi, worked with him at the University of Catania in Sicily on many topics including parasites of sheep, pigs and dogs; of interest is the work effected with Grassi on the life history of the common eel (*Anguilla anguilla*). Calandruccio is well known for studying the life cycle of parasites on his person. He infected himself with more than 13 species of parasites (Pampiglione and Giannetto, 1998).

2.11. *The malariologists*

Malaria has been a devastating disease affecting Italians for centuries. At the beginning of the 1900s malaria was present in nearly two-thirds of the Italian territory and affected two million people with a resulting loss of 15,000 lives and two million working days per year (Grassi, 1900, Anonymous, 1929). Over the centuries, attempts to overcome malaria by way of reclaiming marshes, especially those near Rome, were made by potentates including Julius Caesar (Bolognini, 1759), Pius VI and Napoleon. A turn for the better took place when the government of the new Italy issued laws (1882–1886) with a view to reclaiming marshy territories. At the same time a group of malariologists emerged in Italian universities, institutes and research stations, primarily near Rome, aiming at solving the old problem of malaria. Considerable progress was made but the disease was not completely defeated. In the 1920s and 1930s new laws were promulgated and by the end of the second decade all marshes were reclaimed, new towns built in what was once the Pontine Marshes and malaria was, at last, defeated. Among the investigators who conducted research on malaria, in addition to Grassi, Golgi, Marchiafava, Celli, Bignami, Bastianelli and Missiroli should be remembered.

Camillo Golgi (1844–1926), physician and histologist, obtained his medical degree at the University of Pavia and was professor of histology at the same institution. In addition to his work in the field of neuroanatomy, for which he received a Nobel Prize, he studied malaria and was able to describe for the first time the existence of two types of malarial fevers:

tertian fever (benign) and quartan fever (more serious) and of the asexual development of the causative parasites (Golgi, 1889). In 1890, Golgi published the first photomicrograph of *Plasmodium malariae* (Kean et al., 1978).

Ettore Marchiafava (1847–1935), physician and parasitologist, received his medical training at the University of Rome where he later became professor of pathology. He and Celli gave the first accurate description of the malaria *Plasmodium*, discovered by Laveran in 1880, and were the first to adopt the name *P. malariae* (Marchiafava and Celli, 1885). Marchiafava and Bignami (1892) made the classification of the malarial fevers — winter/spring and summer/autumn; the latter type included the malignant infections which sometimes develop cerebral symptoms. Marchiafava and Bignami (1902) published “L’infezione malarica”.

Angelo Celli (1857–1914), physician, hygienist, and parasitologist, obtained his medical degree at the University of Rome where later he taught medical hygiene. His research was predominantly of an epidemiological nature. He worked with Marchiafava on the development of malarial parasites in erythrocytes (1885–1986) and with Sanfelice on the presence of malarial parasites in the red cells of birds (Celli and Sanfelice, 1891). Celli was elected member of the Italian Parliament; he fought for the passage of legislation aimed at the distribution of quinine to laborers working in the marshes. He was author of a celebrated treatise on the history of malaria in the Roman marshes, published posthumously (1925).

Amico Bignami (1862–1929), physician, pathologist, and parasitologist, obtained his medical degree from the University of Rome; he worked under Marchiafava and received the chair in medical pathology at the same university. Bignami studied the anatomo-pathology of malaria (especially liver lesions) pointing out the correlation of clinical signs with pathological changes (Bignami, 1890). In cooperation with Grassi and Bastianelli he worked on the development of malarial parasites in the body of *Anopheles claviger* (1898–1999).

Giuseppe Bastianelli (1862–1959), physician and parasitologist, was professor of semeiotic at the School of Medicine of Rome from 1926 to 1956. He worked with Bignami on the life cycle of *Anopheles claviger* sent to him by Grassi and fed with blood of individuals affected with malaria (Bastianelli et al., 1898).

Alberto Missiroli (1883–1951), physician and parasitologist, graduated from the University of Bologna. He founded the School of Malariology in Nettuno (near Rome) in 1918 and worked intensely on the anatomy — especially on the Malpighian tubules (Missiroli, 1927) — and biology of *Anopheles* spp. and of *Phlebotomus papatasi*. In 1944, Missiroli evaluated the effects of DDT against mosquitoes in the province of Latina.

Among other researchers in the 1800s, we should remember Majocchi (1879, 1900) (University of Bologna) for his publications on *Demodex folliculorum* in humans and Pietro Oreste (1839–1934), who worked at the Veterinary Schools of Milan and Naples, for his work on *D. folliculorum* in dogs (Oreste, 1870).

2.12. The 1900s

The beginning of the 1900s saw the continuation of the studies on malaria. The interest in veterinary parasitology in Italy diminished during and between the two world wars. On the other hand, with regard to medical parasitology, as mentioned earlier, the interest was kept alive for a number of decades by the various antimalarial campaigns. During the

Italian presence in Africa, a number of parasitologists — veterinarians (like Carpano, 1914) and physicians (including Castellani) — worked in Libya, Eritrea, and Somalia; numerous reports of the parasitological fauna in humans and animals of these countries were published.

2.13. *Veterinary parasitology in Italy in the XX century*

After some 50 years of oblivion, the interest in veterinary parasitology in Italy resurfaced in the 1940s–1950s when, in some veterinary schools, the teaching of veterinary parasitology was introduced as an elective subject and/or as an intrinsic part of other subjects such as pathologic anatomy and meat inspection. A big step forward was accomplished in 1972 when a new ordinance, agreed to in Brussels by the EEC countries, resulted in the establishment of two subjects in the veterinary schools: “parasitology” for the morphologic study of parasites and “parasitic diseases of domestic animals” (Baldelli, 1984).

Over the years much research has been conducted in the area of *Dirofilaria* spp. (especially on prevalence) a very important parasite of dogs and, in certain areas, cats in Italy. Of particular interest is the work conducted at the Veterinary School in Milan, under the leadership of Claudio Genchi, in the field of *Dirofilaria immitis* (epidemiology, vectors, and control) in dogs and cats (Genchi et al., 1992, 1995, 1998). In recent years, this group has been involved in the study and discovery of *Wolbachia*, endosymbionts of filarial nematodes, including *D. immitis* (Bandi et al., 1998; Sironi et al., 1995) showing that these bacteria play a role in the immune response of the infected host and in the pathogenesis of the disease and may represent a target for control.

Contributions have also been made by a number of parasitologists of the Veterinary School in Bologna — Mantovani in the field of canine filariasis (*Dirofilaria repens* (Mantovani and Restani, 1965) and *D. immitis* (Mantovani and Kagan, 1967)), Pampiglione (1957) in the area of *Oestridae* both as veterinary and human entities, Restani et al. (1961) in the field of *D. repens* and Poglayen in the area of parasites of horses (Poglayen and Zoffoli, 1976) and wild animals.

At the Veterinary School of Bari Puccini and Tassi (1887) have conducted research on *Hypoderma* spp. and *Przhevalskiana silenus*. Noteworthy is the work by Balbo and Panichi (1968) and Rossi et al. (1993) at the Veterinary School of Turin on canine filariasis and parasites of wild animals in the Alps (Balbo, 1973). Casarosa (1985) from the Pisa Veterinary School published a comprehensive textbook on veterinary parasitology which has been reprinted several times; G. Macchioni from the same school worked on the epidemiology of cattle grubs in Italy. Baldelli from the University of Perugia conducted research on trichinosis, while Principato, from the same university, worked with distinction in the field of electromicroscopy of parasites (Principato and Tosti, 1988). L. Sobrero of the Zooprophyllactic Institute of Puglie has conducted pioneering research on Ixodidae. The fauna of domestic animals in Sardinia has been the object of studies by numerous parasitologists including Carta, Corticelli, Arru, Deiana, Lai, and Quesada.

2.14. *Human parasitology in Italy in the XX century*

During the XX century human parasitology in Italy was always in great favor primarily because of the unsolved problem of malaria. An interesting development took place in

1934 when the Rockefeller Foundation offered (and the offer was personally accepted by Mussolini) one million dollars for the erection of the Istituto Superiore di Sanità (Garnham, 1987). A department of parasitology, created within the institute offered, for years to come, a great opportunity to a number of Italian scientists to make valid contributions in the field of parasitology. Among those to be remembered: Corradetti and Saccà. Augusto Corradetti (1907–1986), physician and parasitologist, obtained his medical degree in Rome and later studied in the USA. His major area of research was in the field of malaria (classification and immunity). With Biocca, he organized the First International Congress of Parasitology in Rome in 1964. Saccà, an entomologist, is remembered for his work on *Oestrus ovis* as a zoonosis affecting the shepherds of Sardinia (Saccà et al., 1965). In recent years, extensive work has been conducted by E. Pozio and E. Maroli in the area of *Trichinella* and *Leishmania* and phlebotomine sandflies.

The Institute of Parasitology of the University of Rome has also greatly contributed to medical parasitology. The teaching of this discipline at the University of Rome goes back to the academic year 1883–1884 when Corrado Tommasi Crudeli, a pathologist, gave a special parasitology course. Over the years a bevy of distinguished parasitologists worked at the Institute. Giulio Alessandrini (1886–1954), physician and parasitologist, obtained his medical degree from the University of Rome; he was the first in Italy to obtain the “libera docenza” (university teaching qualification) in parasitology in 1904. Alessandrini taught medical parasitology from 1906 to 1936 — first as appointee and in 1925 as full professor when the chair in parasitology was established at the University of Rome. He worked in the area of ancylostomiasis (anatomy of *A. duodenale*) in Italy, and of malaria in Italy, Argentina and Bolivia. Alessandrini (1929) published a treatise on parasitology of man and domestic animals, which for a long time was a standard text for medical and veterinary students.

Ettore Biocca, parasitologist and anthropologist, received his medical degree at the University of Rome in 1935. At first Biocca worked at the Rockefeller Institute in Budapest and in New York and at the Butantan Institute in San Paulo, Brazil. He taught medical parasitology at the University of Sassari and at the University of Rome. Biocca has worked in many areas of parasitology including trypanosomiasis, ancylostomiasis, parasitic fauna of wild animals in the Alps, and human dermatitis; in (Biocca, 1960) he described a dermatitis in humans produced by *Schistosoma bovis*. In the 1940s and 1960s he explored the Amazonian region in Brazil and wrote a well-known anthropological treatise (Chabaud, 1996).

Oleg Starkoff, a Russian émigré, wrote a comprehensive monograph on ticks of Italy and also taught medical parasitology at the Institute of Parasitology of the University of Rome. Berlinguer (1964) published the first monograph on the fleas of Italy; also in (Berlinguer, 1988) he produced an amusing booklet on the history of fleas and his experience in this area. Mario Coluzzi, who at present holds the chair in parasitology of the Institute, has distinguished himself with his work on malaria (mosquitoes) and dirofilariosis. Coluzzi and Trabucchi (1968) reported that some species of mosquitoes were resistant to infection with *Dirofilaria* because of the presence of a particular bucco-pharyngeal armature which lacerates the cuticle of microfilariae during the ingestion of blood. Mario Coluzzi is the son of a malariologist, Alberto Coluzzi, who with Raffaele directed the first DDT campaign in Italy in Cassino then devastated by the war (Raffaele and Coluzzi, 1949). Gabriella Cancrini,

of the same Institute, has conducted pioneering work on dirofilariosis of cats (Cancrini et al., 1979).

Ivo de Carneri (1927–1993), chemist and biologist, was professor of medical parasitology at the University of Pavia. He worked in the field of experimental chemotherapy and conducted research on cutaneous leishmaniosis among the Indians of Mato Grosso (de Carneri, 1964); he also published extensively on human parasitology and drugs used in cestode diseases. A foundation, which bears his name, was established after his death for the purpose of promoting control strategies against parasitic diseases in developing countries and encouraging research in parasitology.

2.15. *Italian parasitologists abroad*

In the 1900s there have been Italian parasitologists who, for different reasons, have spent a good part of their life abroad making important contributions to the parasitology of foreign countries; five of them should be mentioned: Bruno Galli Valerio, Aldo Castellani, Antonio Carini, Elvio Herbert Sadun and Francesco Veglia.

Bruno Galli Valerio (1867–1943), studied veterinary medicine in Milan and human medicine in Lausanne. He taught general pathology at the University of Milan and later parasitology, bacteriology and experimental medicine at the University of Lausanne. Galli-Valerio (1899) studied and reported on the parasitic fauna of animals in Lombardy and Switzerland (Galli-Valerio and Bornand, 1927).

Aldo Castellani (1876–1971), physician, microbiologist, and parasitologist, received his medical degree in 1899 at the University of Florence. He studied in Bonn, Germany, where he developed the Castellani test (absorption of agglutinins) and also attended the London School of Tropical Medicine. In 1902, the British Government sent Castellani along with two Britishers (G. Low and C. Christy) to Uganda to study sleeping-sickness. There Castellani (1903) isolated and described *Trypanosoma gambiense*. A few years later (1905) he described *Spirochaeta pertenuis*, cause of spirochetal hemorrhagic bronchitis. Castellani (1914) was one of the first, if not the first, to suspect that toxoplasmosis could affect humans. With Castellani and Chalmers (1910), he wrote “Manual of tropical medicine” for a long time a standard text of tropical medicine (1910). Among his patients: B. Mussolini and King Victor Emanuel the Third.

Antonio Carini (1872–1950), physician, worked at the Pasteur Institute first in Paris and then in San Paulo. He remained in Brazil for 35 years before returning to Italy. Carini is well known for his work on leishmaniosis and for describing in the lungs of guinea pigs what is today known as *Pneumocystis carinii* (Kean et al., 1978).

Elvio Herbert Sadun (1918–1974), zoologist, immunologist, parasitologist, was born in Livorno. He left Italy, after having studied for some years in Pisa, for the USA because of racial persecution. Sadun received a Ph.D. degree from John Hopkins University with a thesis on “Immunity in chickens to *Ascaridia galli*”; later he worked in Thailand on the biology, epidemiology, and distribution of *Fasciolopsis buski* and other helminths. In 1959 he became head of the Department of Medical Zoology at the Walter Reed Army Institute of Research in Washington, DC. Sadun (1969) distinguished himself for studies on immunology and malaria; in 1969 he published a treatise on experimental malaria and later edited with Cohen “Immunology of Parasitic Infections” which was published in (Cohen

and Sadun, 1976), after his death. In 1968, the University of Rome conferred upon him an honorary “libera docenza”.

Francesco Veglia, veterinarian and parasitologist, graduated in veterinary medicine from the University of Turin. Disciple of Perroncito in 1912 he joined Arnold Theiler in his research laboratory in Ondesterpoort in South Africa (Gutsche, 1979). Veglia (1915, 1923, 1928) worked primarily in the area of ruminant parasitology and published three distinguished papers, one on the anatomy and life history of *Haemonchus contortus* (1915) and two on the life history of *Oesophagostomum columbianum* (1923) and oesophagostomiosis in sheep (1928), respectively. Veglia and le Roux (1929) described, for the first time, *Schistosoma matthei* in sheep. On the basis of Veglia’s experience, he published, in Italian, a book on diseases of animals in South Africa (Veglia, 1914).

In Italy, presently, there are two publications solely devoted to parasitology: “Rivista di Parassitologia” founded in 1940 and “Parassitologia” established by Biocca, Corradetti e Starkoff in 1959.

The writer apologizes for the events and/or parasitologists that he has overlooked — there are so many from which and from whom to draw; also, in the space constraints of an article for a journal, it is not possible to report all of them. The history of Italian parasitology continues and the incumbency of reporting old and new episodes will fall upon future chroniclers.

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