Sol Newsletter

Issue number 34
October 2012
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From the SOL Co-Chairs

Apart from SOL-2012 in Neuchâtel being a very successful meeting at a wonderful venue, it also marked a number of changes to the committee of the SOL organization that we call the SOL Co-Chairs. Precipitating these changes was the retirement of René Klein Lankhorst as Chairperson. In his last meeting as chairman, he implemented changes in personnel to get new people involved and to broaden the scope of the committee. As a result, we now have three new members (Alan Andrade, Christian Bachem, and Lukas Mueller) and a returning member Sandy Knapp, who has also taken on the task of chairperson. As "old hands", Mathilde Causse, Jeanne Jacobs, Glenn Bryan, and Sanwen Huang are continuing as co-chairs. Along with René, Harry Klee has also left the committee. The current co-chairs would like to thank the exiting members for their sterling work and we would also like to introduce ourselves in the form of short CVs. In the next issue of the Sol Newsletter, we plan to give you more on our tasks and vision for the future of SOL.

The Reorganized SOL-Co Chair Group 2012

CHRISTIAN BACHEM, new SOL co-chair: Christian is a German national but was born in Mexico, educated in the UK, and studied agriculture at the University of Bonn, continuing with a PhD at the MPI in Cologne under the late Jeff Schell. After a short post-doc in Edinburgh, Christian joined the Keygene Company in the Netherlands and four years later, transferred to Wageningen University where he has worked as a research scientist and university teacher at the lab of Plant Breeding since 1991. His main scientific interest is in the functional genomic analysis of potato tuber development and quality traits in *Solanaceae*. He also participates in and coordinates a number of large research projects on national, European, and international levels and is an active member of organizations such as Eucarpia, EPSO, the PGSC and now SOL.

ALAN C. ANDRADE, new Sol co-chair: Alan is a Brazilian plant scientist. He has a BSc in Agronomy and MSc in seed physiology from the University of Lavras (UFLA-MG). He got his PhD from Wageningen University working on fungal ABC transporters at the Department of Phytopathology. After his graduate studies, he continued working in Wageningen, as a posdoc (STW project), for three years. In 2002, he became an employee of Embrapa Genetic Resources and Biotechnology (Brasilia-DF, Brazil) and established his research group focused on coffee genomics. His main scientific interest is functional genomic analysis of drought tolerance in coffee. In addition, he aims to develop the genomic tools for applied coffee breeding and the establishment of a Genome Wide Selection program for coffee. He is also involved in teaching, taking part of the graduate program on plant biotechnology at the University of Lavras. He was the coordinator of the Coffee Biotechnology Program of the Brazilian Consortium of Coffee R&D and also took part in coordinating the Brazilian Coffee-EST project. In 2005, he was among the founding members of The International Coffee Genomics Network-ICGN and is a member of the steering committees of ICGN, The International Coffee Genome Sequencing Consortium, and the National Institute of Science and Technology of Coffee (INCT-Café).

Highlight Articles

Early history and iconography of the Solanaceae: 3. Tomato[1]

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[1]This SOL paper is the third in the series on the early history and iconography of the Solanaceae. The first covered mandrake (Janick & Daunay, 2007, SOL Newsletter 14), the second covered potato (Daunay & Janick, 2008, SOL Newsletter 21) and the present paper covers tomato. A more detailed treatment can be found in Daunay et al. (2007, 2008). The tomato images displayed here, as well as a few more, will be made available from SGN website. However, the use for publication of the images displayed here and originating from manuscripts requires the previous authorization from the libraries where these manuscripts are located.

Tomato (*Solanum lycopersicum*) is now one of the most important world crops and is widely consumed fresh and processed with a production of 152 millions tonnes (FAO, 2010). The ancestral form of the cultivated tomato was originally confined to the Peru-Ecuador area and spread north possibly as a weed in pre-Columbian times, but was not extensively domesticated until it reached Mexico, and from there the cultivated forms were disseminated (Jenkins, 1948). The wide genetic diversity found in Mexico in both wild and cultivated forms indicated an ancient introduction in this country. De Candolle (1890) suggests a Peruvian domestication, but Harlan (1975) assumes that the biloculed domesticated forms found in southern Mexico and Guatemala are the oldest cultivated types. The original site of domestication of cultivated tomato still remains speculative (Peralta and Spooner, 2007).

Figure 1. Colombian spindle whorl (500 - 1000 CE) reproducing tomato flower features. Source: McMeekin 1992.

First Records

In a set of decorated spindle whorls (dated 900–1500 CE), one type from Colombia dated 500 to 1000 (Fig. 1) may represent a tomato flower (McMeekin, 1992), but this interpretation is controversial. Tomato was common is Mexico at the time of the conquest by Hernán Cortés in 1521, and Estrada Lugo (1989) mentions the use of tomatoes by the Aztec as a medicinal plant in the *Florentine Codex* (Sahagun, 1540-1585). A doubtful pre-Columbian image entitled *Tomazquitl* and depicting a plant with entire leaves and bunches of five globular red fruits is present in the *Codex Badianus* (Walcott Emmart, 1940). The Spanish friar Diego Duran, describing the Aztec ways of life before 1521 from direct witnesses notes that tomato was common in religious offerings and markets (Hodge, 1994, p.64). Hernán Cortés, in a letter dated September 3, 1526, mentions tomatoes (Charnay, 1996, p.404). J. de Acosta (1589) notes that tomatoes were used for preparing sauces. All these brief mentions of tomato provide evidence that tomato was common in the New World, although it should be pointed out that there is confusion in the early literature between tomato and other solanaceous species, in particular *Physalis* spp., both being referred to by the Aztec name *tomatl*.

Tomato is first mentioned in the European literature in a chapter on mandrake (Matthioli, 1544), with the following description:

> *Another species* [of Mandrake] *has been brought to Italy in our time, flattened like the melerose* [a type of pink apple] *and segmented, green at first and when ripe of a golden colour, which is eaten in the same manner* [as the eggplant—fried in oil with salt and pepper, like mushrooms].

The association of tomato to mandrake by Matthioli can be explained by the similarity of their globular golden berries, since the tomato fruits observed in 1544 were yellow. In his later 1554 publication, Matthioli adds that the Italian name for tomato is *Pomi d'oro*, and its Latin equivalent *Mala aurea*, and takes note of a red type.

The precise date of the first European image of tomato is unknown because contemporary images were produced by several Renaissance herbalists, some being published mid-16th century, and the others unpublished for centuries until their "discovery" during the 20th century. Dodoens (1553) is the first to have published a woodcut of tomato, but the image is mediocre and the fruits barely visible (Fig. 2). In the Oellinger manuscript which was completed before 1553 and only published in microfiches in 1996, two tomato drawings show fruits in clusters; the fruits are large, deeply ribbed, and turning from green to either red, folio 541 (Fig. 3, left) or orange, folio 543 (Fig. 3, middle). The third drawing displays a plant with small globular light yellowish fruits, folio 545 (Fig. 3, right). In Vienna codex, Fuchs provides an image that was published by Baumann et al. in 2001. This image, painted by Albrecht Meyer between 1549 and 1556 (Fig. 4) displays single erect fruits of various shapes (globular, globular, and flattened, with or without ribs), sizes (small and large), green, yellow, or red. Gesner's images (Fig. 5 and Fig. 6), respectively, dated 1553 and 1565, display details of flowers and fruit.

Figure 2. First published tomato image. Source: Dodoens 1553. Courtesy: Library of Missouri Botanical Garden.

Dodoens (1557) describes the fruits as large apples, flat, ribbed, of red, whitish, or yellow color, and the woodcut, the same as in the 1553 edition, shows small ribbed and flattened fruits. In his later publications (1574, 1608), Dodoens used another more realistic woodcut with lateral shoots and clustered large flat and ribbed fruits. A colored illustration in the Camerarius' Florilegium (*MS 2764*) dated 1576-1589, represents a branch with leaves, a truss of flowers, and globular slightly flattened green and red fruits.

In 1585, Durante published a stylized drawing, with globular flattened and ribbed fruits. Matthioli (1586) displayed on a single woodcut several fruit types (small or large, globular or flattened, ribbed or smooth. The simplified painted image by Aldrovandi (second half of the 16th century) represents only a branch with two flattened, ribbed, reddish and green fruits, one inflorescence and four leaves. A tomato illustration dating to the close of the 16th century can be found in *The Drake Manuscript* written by an anonymous Frenchman (Fig.7) (Janick, 2012). Realistic tomato fruits (still large, globular, flattened and ribbed) as well as clearly recognizable leaves, are found on a bronze door of the Pisa cathedral (Fig. 8) dated to 1601. The texts by Gerard (1597) and Parkinson (1629) describe fruits of sizes varying between a goose egg and a large apple, bright shining red, pale reddish, yellow or pale yellow. Several authors mention the "foul" odor of tomato vegetation.

Names

The name *tomate* (Spanish, French) and *tomato* (English) derive from *tomatl, tomates,* or *miltomates* in the Nahuatl language (Estrada-Lugo, 1989). However, this name was applied to different solanaceous plants, including species of *Solanum* (*Lycopersicon*), *Physalis,* and *Saracha.*

There were many names for tomato in 16th century Europe. Some authors thought that the plant was the *Lykopersikon* mentioned by the Greek physician Galen (131–ca. 200), or the *Glaucium* of Dioscorides. *Solanum pomiferum* and other similar denominations are found in various herbals, such as *Pomum amoris, Poma amoris, Pomum aureum, Pomum aureiium, Solanum pomiferum vel amoris, Solanum pomiferum aureum, Mala aurea, Aurea Apffelkraut, Gulden Appelen* (High and Low German); and *Golden Apples, mala, Lycopersicum* (Latin); *Pomi d'oro* (Italian); *Pommes d'amours* and *Pommes dorées* (French); *Gold Oppffel, Goldt Apffelkraut, Gulden Appelen* (High and Low German); and *Golden Apples, Amorous apples, Apples of love, Love apples* (English).

Figure 3. Tomato, Oellinger 1553, Manuscript 2362: (Left) folio 541; (Center) folio 543; (Right) folio 545. Source: Erlangen, University library.

The name *Lycopersicon*, also spelled *Lycopersicum*, means peach (*persikon*) of wolf (*lykos*) and indicates some distrust toward this plant. The name was taken from the Galen's *Lykopersikon* which designated a plant from Egypt whose sap was malodorous. In the 18th century, the species was named *Solanum lycopersicum* by Linnaeus, and then as *Lycopersicon esculentum* by Miller, but modern taxonomy has brought tomato back to the genus *Solanum* (Spooner et al. 1993).

While the majority of tomato fruits cultivated at present are red, the appellation *gold* or *yellow* which was commonly used in the past, indicates that many of the early tomatoes introduced were yellow. Why it was named *Love apple* is unclear. This popular name could be linked to the red color, which is associated with the flush of passion. Parkinson (1629) reported that he had tomatoes in his garden only for curiosity and for the amorous aspect or beauty of the fruit.

Figure 4. Tomato, Fuchs' Vienna Codex 11 122, 2(3), folio 161, painted by A. Meyer 1549–1556. Source: Meyer et al. 1996. Copyright: Austrian National Library, picture archive, Vienna.

Uses

Tomatoes are described as medicinal plants in the *Florentine Codex.* Dodoens (1557) noticed that the plant was found only in the gardens of some herbalists; flowered in July and August, and ripe in August and September. Gerard (1597) stated that the *Apples of love* grew in Spain, Italy, and such hot countries. Dodoens (1557) and Gerard (1597) considered tomato of a "cold" nature and quite different from the dangerous mandrake.

Gerard (1597) believed that the fruits brought very little nourishment to the body, while Dalechamps (1653) affirms that this food was bad and corrupted. In 1600 Olivier de Serres suggested that the fruits, although not good for eating, were appropriate as medicine and were pleasant to handle and smell.

Despite some negative opinions, tomatoes clearly were consumed from the beginning of their presence in Europe, first in sauces, according to Olivier de Serres (1600, ed. 1804). Matthioli (1544) as well as Gerard (1597) and Dalechamps (1653) noted that they were commonly fried in or boiled with oil, salt, and pepper. They were eaten in Spain and Italy with oil, vinegar, and pepper as a sauce for meat (Gerard, 1633).

Figure 5. Tomato, Gesner, Ms 2386, folio 42, dated 1553. Source: Erlangen, University Library.

Conclusion

The tomato was well known by the Aztecs, but it is difficult, in the absence of New World iconography, to ascertain when tomato is involved in the textual sources, given that the common Nahuatl word *tomatl* was used for several solanaceous plants, including tomato. The first European description of tomato is by Matthioli (1544), while the first published illustration is by Dodoens and dates to 1553. Renaissance iconography shows that a great diversity of fruit shapes, sizes, and colors was early available in Europe, with a dominance of large multiloculate, ribbed fruits. The common use of names involving "gold" suggests that many early introductions had yellow fruits. The early naturalists clearly knew that tomato was related to the European nightshades, and hence they considered it with some suspicion in view of the European antipathy toward these plants. The many tinted early tomato illustrations, such as those of Oellinger, Fuchs, and Gesner demonstrate that botanists were eager to include this new species into their medico-botanical treatises. Soon after, tomato was rapidly adopted as a food crop in southern European countries where it well adapted.

Figure 6. Tomato. Gesner, Ms 2386, folio 37v, dated 1565. Source: Erlangen, University Library.

Figure 7. Illustration of tomato in the Drake manuscript (end of 16th century). Source: The Drake manuscript.

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Figure 8. Large, ribbed tomato with leaves on bronze door of the Pisa cathedral, Italy, 1601. Source: J. Janick.

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Acknowledgements: The authors thank A. Whipkey (Purdue University, USA) and J. Van Eck (BTI, New York, USA) for assistance with the images.

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Towards a better interaction between European Solanaceae germplasm holders and Solanaceae Omics researchers

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In Europe, the collaboration between germplasm holders of agricultural and industrial crops has been organized and coordinated by the European Cooperative Programme for Plant Genetic Resources (ECPGR, www.ecpgr.cgiar.org) for over 30 years. ECPGR has also established the European Genebank Integrated System (AEGIS) initiative (http://aegis.cgiar.org/), which is formalizing the long-term commitment of the European countries for conservation and management of crop germplasm. For each crop, including solanaceous crops, the AEGIS initiative is creating a decentralized "European collection" consisting of unique accessions in the public domain, being held by any of the germplasm holders accepting the commitment for long-term conservation on behalf of AEGIS.

ECPGR is structured into crop and thematic groups, including the Solanaceae Working Group (www.ecpgr.cgiar.org/networks/vegetables/solanaceae.html) and the Potato Working Group (www.ecpgr.cgiar.org/networks/sugar_starch_fibre_crops/potato.html), which set up work plans and meet periodically. ECPGR products are accessible on-line (e.g. for cultivated potato and wild potato, tomato, capsicum peppers, eggplant, pepino, tree tomato, and ground cherry), including centralized crop databases, that are progressively completed. Key activities include the creation of guidelines for seed regeneration and storage, and identification of key (minimum) phenotypic descriptors to be used by the genetic resources community and entered into the European Central Crop Databases. These agreed minimum lists of descriptors have been selected from the full descriptor lists (www.bioversityinternational.org/publications/search.html) of Bioversity International (formerly IBPGR, IPGRI) which, for solanaceous crops, were published in 1977 (cultivated potato), 1985 (potato variety descriptors), 1990 (eggplant), 1995 (pepper), 1996 (tomato), and 2004 (pepino). The descriptor list for Tree tomato is in press.

Many European public germplasm holders get insufficient national support for the maintenance, characterization and long-term security of the collections, with damaging consequences in some cases, such as aging seeds, no safety duplication, or even loss of accessions. As a way to remedy to this situation, INRA and CGN organized cooperation between breeding companies for the evaluation and regeneration of germplasm accessions held respectively in France and The Netherlands. This model may also be considered by other germplasm holders. Furthermore, better interactions with the scientific research community are important for determining the value of the germplasm. Possibly also the cost of germplasm maintenance and use in research and breeding can be shared.

On the side of research, the structuring of the international scientific community investigating Solanaceae genetics and "omics", is more recent. The *International Solanaceae Initiative* was initiated by Cornell University in the early 2000s, and under its supervision the consortium *Solanaceae Genomics Network* –SGN- works at enhancing international collaboration and at facilitating exchange of information between scientists working on solanaceous crops, in particular via its website and the annual workshops organized since 2004. While research was anchored in only one or a few genotypes until recently, the capacity of the high throughput and next generation technologies now allow working at the level of germplasm collections. For instance, allele diversity can now be characterized at the species level and new alleles of specific traits can be discovered via association genetics. Hence, in the coming years, access to and characterization of germplasm are going to be strategic steps, and from the research standpoint, there is clearly a need to strengthen interaction with the community of Solanaceae germplasm holders.

During the SOL 2011 meeting held in Kobe, Japan, it was pointed out that there is a discrepancy between sequencing experiments across species and platforms, which share fundamental data and similar analysis tools, whereas phenotyping experiments have few common standards. The existence of standardized solanaceous crops descriptors set up by Bioversity International (see above) deserves to be promoted among the communities of researchers and germplasm holders. Conversely, germplasm holders need to be made aware of the phenotypic traits that are most needed by "omics" research. In the last few years, the SGN project (http://solgenomics.net) has developed vocabularies for the description of phenotypes [Solanaceae Phenotype ontology (SP)], and to allow interfacing with the larger initiatives of the database community [Gene Ontology (GO), http://geneontology.org], Plant Ontology (PO, http://plantontology.org/) and Phenotype and Trait Ontology (PATO). Some of the Bioversity vocabularies have been mapped to the SP ontology. SGN could therefore play a central role in coordinating phenotypic descriptors and data, and collaboration via common projects would be beneficial to both germplasm and research communities, and contribute solving the post-genomic era problem of linking the phenome (a wide set of phenotypic data) to the genome.

A minimal step towards a better interaction between European Solanaceae germplasm holders and "omicians" is to provide links between the ECPGR Solanaceae Working Group and SGN websites (already available at www.ecpgr.cgiar.org/networks/vegetables/solanaceae.html), between the Potato Working Group and SGN, and conversely. Beyond this first step, there is a need to establish a dialogue between the ECPGR Solanaceae Working Group, the Potato Working Group and the ECPGR Documentation and Information Network on one hand, and SGN on the other hand, in order to start building fruitful and sustainable interactions, including improved germplasm access and phenotyping. This could be initiated for instance via a round table to be organized at the 2013 SOL conference in Beijing, involving representatives of all sides.

Acknowledgements

The authors are pleased to acknowledge L. Maggioni and J. Engels (ECPGR, Rome, Italy), J. Prohens (COMAV, Universitat Politèchnica de València, Spain), Ch. Sauvage and M. Causse (INRA, UR1052, France) for their helpful comments on draft versions of this paper.