From Heliotrope to Helianthus: an overview

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Abstract

During the antiquity the authors mention different kinds of plants that present heliotropic characteristics which, nevertheless, are not all actually observable. During the middle ages different species belonging to the *Compositae* begin to appear as medical plants and their "solar" qualities are usually alluded to. Sunflower was imported in Europe in several times, starting from the first decades of XVI century, but only in 1716 it began to be utilized as an oil plant, when in England a method of oil extraction was set up.
In America, where sunflowers are native, Indians used different species for various purposes and in doing so they contributed to the diffusion and evolution of the genus Helianthus.
In the Southern Hemisphere sunflower usually maintains its heliotropism turning the inflorescence from east to west through north. However, individual plants turn their heads from east to west through south, thus they behave in an opposite way having apparently lost their heliotropism.

The Antiquity and the Middle Ages

Mankind seems to have been universally fascinated by the phenomenon of heliotropisme: as early as the 4 century b. C. THEOPHRASTUS of Eresus, the pupil and successor of Aristotle, in his *De Causis plantarum* (lib. II, cap. XIX, 1-5) gave a thorough description of the movements of the plants or of their different parts, branches, leaves and flowers, due to the influence of the sun and distinguished between "nutating (sleeping), turning or twisting, and opening and closing movements" (VON ERHARDT-SIEBOLD, 1938). Nevertheless the outstanding qualities of the two plants that he describes under the name of heliotrope (ηλιος= sun, τρεπειυ = to turn) in his other tract *De historia plantarum* (lib. VII, cap. XV,1 and cap. IX,2) do not seem to justify their name: the first is described as blossoming at the solstice, while the second is said to develop flowers for a long period. His descriptions are too scanty to allow any identification, but centuries later, in the first century of our era, the physician and botanist Pedanius Dioscorides of Anazarb, in his *De materia medica,* mentions two types of heliotrope, the Great Heliotrope (*Eliotropion mega* or *Scorpiuron*, from the aspect of its flowers that recall the tail of the scorpion) and the Small Heliotrope (*Eliotropion mikron* or *Scorpiurum*): the first is identified with a plant of the family *Boraginaceae,* genus *Heliotropium* (Linneus borrowed from this plant the name for his genus), while the second is generally interpreted as a variety of the former, the so-called scorpion grass, *Myosotis* L. According to Dioscorides the name heliotropion derives from the fact that the "foliage" of these plants turns with the sun. He mentions another plant, *Titymallos elioskopios* (σκοπειυ = to look at), which is now generally identified with the Sun-spurge or Wart-wort, *Euphorbia helioscopia* L., of which he says that it turns its "crown" with the sun, a statement as unfounded as the former regarding the movements of the leaves of the *Eliotropion*. Latin authors such as Pliny the Elder (PLINIUS) mention other qualities of

some heliotropes, or *solsequium* or *solago*, in particular that they turn following the sun, but then Pliny the Elder adds that the helioscope is a special type of the heliotropes and goes on making such a medley that it is almost impossible to identify the plants he describes. Anyhow all these plants were said to be "powerful" against the bites of snakes and scorpions, qualities that are mentioned in the herbals produced in the late antiquity, such as the so-called pseudoApuleius *Herbarium* (APULEIUS) of the V century A.D, and the pseudoDioscorides *De herbis femininis* (KASTNER, 1896,1897), which were the most spread pharmacopoeias during the middle ages. In the second treatise a new member of the heliotrope/helioscope family makes its appearance: the *intybus sylvaticus*, a plant identifiable with *Cichorium intybus* L., therefore belonging to the *Composita* plant family many members of which are known for their "solar" characteristics.

The Modern Age

During the XVI century the medical and botanical knowledge began to widen: the works of the great Greek physicians circulated widely, both in Greek and in translation thanks to the printing presses all over Europe. An outstanding place among these works was taken by the new editions (and subsequent translations) of Dioscorides, *De materia medica* (PEDANII DIOSCORIDIS), that brought to attention the original Greek botanical lore. In the same time there was a growing interest for the new species discovered in the New World: the news got around quickly among the specialists who were also interested in growing the new plants themselves. One of the plants that aroused great interest was the sunflower or *Flos solis*, a translation of *Chiamalatl* "the flower of the sun" as it was called in the language of the Aztecs but which is probably a Toltec word (CLARICI,1726 quoted by RAVAGNAN, 1993) and then defined as *indicus* or *peruvianus* or *Chrysanthemum perunianum* (by ROBERT DODOENS), *Pianta massima* or *Coppa di Giove* (by Iacopo Antonio Cortuso, (MATTIOLI), *Corona solis* (by Joseph Pitton de Tournefort, 1656-1708) etc. until Linnaeus named it *Helianthus annuus*. As it is well known, the plant was imported in the first decades of the XVI century and first grown in the royal gardens of Madrid whence it spread in the other European countries, exciting the curiosity of the botanists because of the outstanding dimensions of its flower and the height of its stem - from the 24 feet of the exemplar in Madrid, to the 10/11 of those seen by Dodoéns (DODOENS, 1568). First described by FRANCISCO HERNANDEZ, towards the middle of the century, the plant became object of research by the great botanists of the period: in the correspondence of C. Clusius, R. Dodoéns, P.A. Mattioli, U. ALDROVANDI and I.A. Cortuso there are various hints to the plant, to its aspect, the difficulty to obtain the seeds, all pieces of information that found a way in the botanical treatises that from 1568 onwards contain accurate descriptions of the plant (l.c. and DE LOBEL, 1591,1576). But it was I.A. Cortuso, *praefectus* of the botanical garden of Padua from 1590 to 1603 (DE TONI, 1922), the first to experiment and describe the qualities and intrinsical characteristics of the plant that he could observe and study in exemplars grown from seeds sent to him by Clusius. In his letter to Mattioli which was published in the 1568 edition of Dioscorides (MATTIOLI,1568), Cortuso deals at length with the characteristic movements of the sunflower that follows the course of the sun - although he clearly states it has nothing to do with the heliotrope of Dioscorides or any other kind of helioskopios - and states that it is an oil plant ("è pianta oleracia") and, having himself dared to taste it - "forse sarò stato il primo a pormi questo rischio di mangiarne" ('I think I have been the first to run the risk of eating of it'), he found that the buds grilled taste like

artichokes, while he has not yet discovered any medical quality. Little more is added in the treatises of the following two centuries: although some authors try to list some medical virtues, still the plant has no practical use.

Sunflower in America

In America, where about 50 species are native, sunflowers were taken into account by the Indians several centuries before Columbus. YARNELL (1964) reports that remains of sunflower were found in Ohio, Nebraska and Missouri caves dated back to at least 800-500 A.D. CUTLER (1966) reports ethnohistorical evidence that *Helianthus annuus, H. petiolaris* and *H. anomalus* were used for cerimonial face powder, medicine, magic, adornment, cigarette 'match', by the Anasazy ("the ancient ones") cultures in the Glen Canyon, Colorado and San Juan River (Utha) areas possibly around 11th-14th century, but only *H. tuberosum* was used as a food. It is possible that Anasazy, ancestor of Zuni, Hopi, Tano and Keres tribes, greatly contributed to the diffusion of such native species, encouraging natural hybridization and their evolution by a process of introgression (ANDERSON, 1971). PALMER (1878) reports that the seed of *H. petiolaris, H. lenticularis* and native sunflower form "one of the staple articles of food by many Indians (and) the agreeable oily nature of the seeds renders them very palatable and very nutritious". HAVARD (1895) refers that sunflower as well as its related Jerusalem artichoke are two species developed by the Indians from wild and cultivated forms from Canada to Mexico, West and East of the Mississippi, being for many of them a staple article of food. He reports that sunflower oil, obtained in the quantity of 20%, is an excellent table oil which the Indians "mostly used for onointing their hair and skin". The uses of plants by the Indians of the Missouri River Region were noted by GILMORE (1911) who reports that *H. annuus* was called yellow flower, yellow weed, yellow eyes respectively by Dakota, Omaha-Ponca, and Pawnee tribes. It was also cultivated by the Arikara, Mandan and Hidatsa tribes in North Dakota. Among the Teton Dakota a remedy for pulmonary troubles was made by boiling the heads of sunflower after removing the bracts. According as saying of this population when the sunflowers are tall and in full bloom the buffaloes are fat and the meat good.

Lescarbot (1618) reports of *H. tuberosus* roots that he brought to France where they began to be sold under the name of topinambaux. The savage, he says, call them chiquebi. According to DE CANDOLLE (1884) the English name, Jerusalem artichoke, is a corruption of the Italian Girasole, combined with its particular taste. *H. tuberosus* was grown in the Cardinal Farnese's garden in Rome where it was called *Aster peruanus tuberosus*. It become to be extensively cultivated in Great Britain before the introduction of potatoes.

P.de Charlevoix in 1721 mentions sunflower as one ot the crops used by tribes of Eastern Canada for the extraction of the oil after boiling the seeds. This simple technique is still today used in some native African populations living in the Southern Mozambique.

Only few sunflower species were imported to Europe where they crossed themselves and spread out in South-East Europe as weedy populations.

The process of introgression, meaning recombinational speciation, as origin of new species of sunflower has been claimed several times by Heiser (ANDERSON, 1971) and recently through DNA analysis by RIESEBERG et al. (1990,1990,1991,1993).

Heliotropism in Sunflower Grown in the Southern Hemisphere

Sunflower reacts quickly to the heliotropism: at Padua, plants with 10-14 leaves transplanted in open field were able to develop inflorescences turning in the right position, e.i. following the course of the sun from east to west passing through south. No exceptions were found in large populations belonging to several species when observed in North America and Europe. However, in the Southern Hemisphere exception was found in *H. annuus* crops according to the variety (genotype) as well as the environmental conditions. At Maputo, Mozambique (26° latitud. South) several populations and lines introduced since 1992 from Europe, were sown in March 1995 (i.e. high temperature and long daylength). During the flowering stage, at midday, the percentage of plants with the head oriented toward South (i.e. opposite to the sun position) varied from 0 to 14%. These plants with negative heliotropism have been called "contrassol", against the sun. For some populations the percentage decreased when the sown occurred in August, with low temperature and short daylength. Apparently, the seed yield is not affected by negative heliotropism.

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Bibliography

ALDROVANDI U. Storia naturale. Bologna 1559-1608

ANDERSON E. Man as maker of new plants and new plant communities. In T.R.Detwyler ed.:"Man's impact on environment". Mcgraw Hill Book Co. New York. 1971.

APULEIUS BARBARUS, ANTONII MUSAE. De herba vettonica liber, Pseudo-Apulei Herbarius, Anonymi De taxone liber, Sexti Placiti Liber medicinae ex animalibus etc. - ed . Howald E. and H. E. Sigerist - Corpus Medicorum Latinorum 4 - Leipzig 1927.

CLARICI PAOLO BARTOLOMEO, Istoria e coltura delle piante che sono pe'l Fiore più ragguardevoli, e più distinte per ornare un Giardino in tutto il tempo dell'Anno. Con un copioso Trattato degli Agrumi, opera postuma consacrata a sua eccellenza il sig. Gerardo Sagredo Procuratore di S.Marco, in Venezia, presso Andrea Poletti, 1726.

CUTLER H. C. Corn, cucurbits and cotton from Glen Canyon. Appendix. Antropological papers. Univ. of Utah. 80:1-116.1966.

DE CANDOLLE A. Origin of cultivated plants. Kegan,Trench & Co. London. 1884.

DE LOBEL M. Icones Stirpivm sev Plantarvm tam exoticarvm. qvam indigenarvm_- ex officina Plantiniana - Antwerp 1591.

DE LOBEL M. Plantarum seu stirpium historia, ec., cui adnexum est adversariorum volumen - ex officina Plantini - Antwerp 1576.

DE TONI G. B., Spigolature aldrovandiane XIX. Il botanico padovano Giacomo Antonio Cortuso nelle sue relazioni con Ulisse Aldrovandi e con altri naturalisti - Officine grafiche Carlo Ferrari - Venezia 1922.

DODOENS R. Florum, et coronarium odorataumque nonnullarum herbarum historia, Remberto DodonÆo Mechiliensi Medico auctore. Ex officina Christophori Plantini. AntverpiÆ 1568.

ERHARDT-SIEBOLD E. VON. The Heliotrope Tradition. Osiris 3 (1938), 22-46.

GILMORE M. R. Uses of plants by the Indians of the Missouri River Region. Bur. Am.Ethnol.Rep.33:45-154. 1919.

HERNANDEZ F. Rervm medicarvm novæ Hispaniæ Thesavrvs sev Plantarvm animalivm mineralivm mexicanorvm historia ex Francisci Hernandez ... a Nardo Antonio Reccho ... collecta ac in ordinem digesta a Ioanne Terrentio ... illustrata, Ro..., ex Typographeio Vitalis Mascardi, 1651.

KÄSTNER H. F. - Pseudo-Dioscoridis De herbis femininis - Hermes 31 578-636, 1896.

KÄSTNER H. F. - Addendum ad Pseudodioscoridis De herbis femininis ed. Hermae XXXI 578' - Hermes 32, 160, 1897.

MATTIOLI P. A. I discorsi nelli sei libri di Pedacio Dioscoride Anazarbeo della materia medicinale. Appresso Vincenzo Valgrisio. Venezia. 1568.

PALMER E. Plants used by the Indians of the United States. Am.Nat.,12:593-606. 1878.

PEDANII DIOSCORIDIS ANAZARBEI de Materia Medica Libri V - ed. M. Wellmann. Berlin 1906-14.

PLINIUS SECUNDUS C. - Naturalis Historiae libri xxxvii - ed. K. Mayhoff, L. Jan. Lipsia 1875-1906 = Stuttgart 1967-70.

RAVAGNAN G. M. Sunflower in Africa. Istituto Agronomico per l'Oltremare. Firenze. 1993.

RIESEBERG L. H., BECKSTROM-STERNBERT, S. AND DOAN, K. *Helianthus annuus* spp.*texanus* has chloroplast DNA and nuclear ribosomal RNA genes of *Helianthus debilis* ssp. *cucumerifolius*. Proc. National Acad. Sci., USA, 87, 593-597. 1990.

RIESEBERG L. H., BECKSTROM-STERNBERT, B., LISTON, A. AND ARIAS, D. Phylogenetic and systematic inferences from chloroplast DNA and isozyme variation in *Helianthus* sect. *Helianthus* (Asteraceae). Syst. Bot., 16,50-76. 1991.

RIESEBERG L. H., H. CHOI, R. CHAN AND C. SPORE.Genomic map of a diploid hibrid species. Heredity, 70:286-293. 1993.

RIESEBERG L. H., SEILER, G. Molecular evidence and the origin and development of the domesticated sunflower *(H.annuus* L.). Econ. Bot., 44, 79-91. 1990.

THEOPHRASTI ERESII Opera quae supersunt omnia - ed. F. Wimmer . Frankfurt a.M. 1964 = Paris 1866.

YARNELL R. A. Aboriginal relationship between culture and plant life in the upper Great Lakes Region. Anthrop. Papers Mus.of Anthrop.,Univ. Michigan, No.23. 1964.

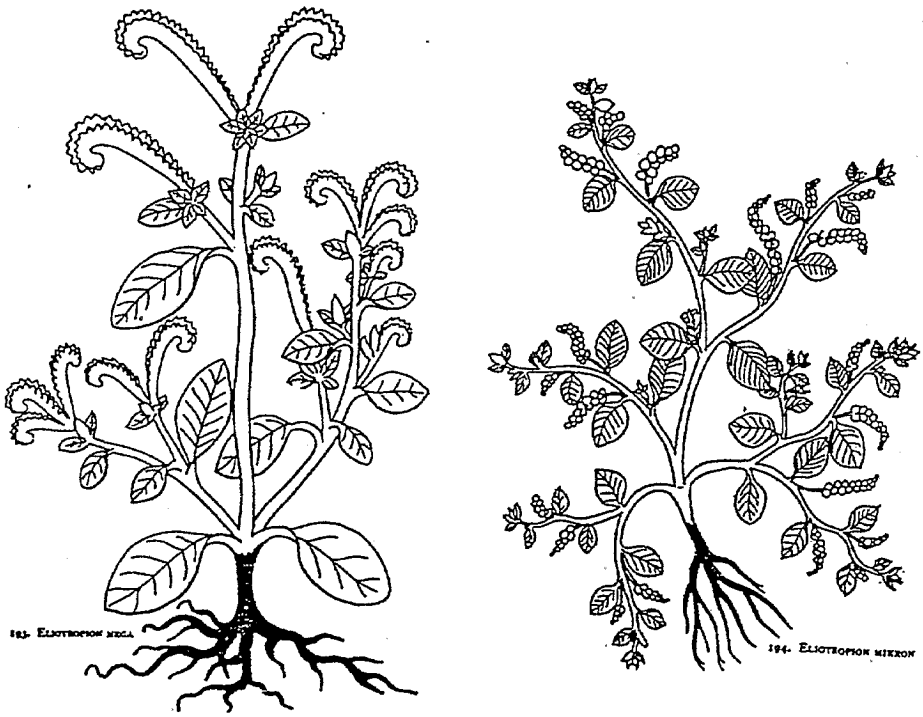

Figure 1. *Eliotropion Mega* and *Eliotropion Mikron* from the manuscript Wien, Öst.Nat.Bibl., Med Gr.1, A.D. 512, two traditional heliotropic plants.

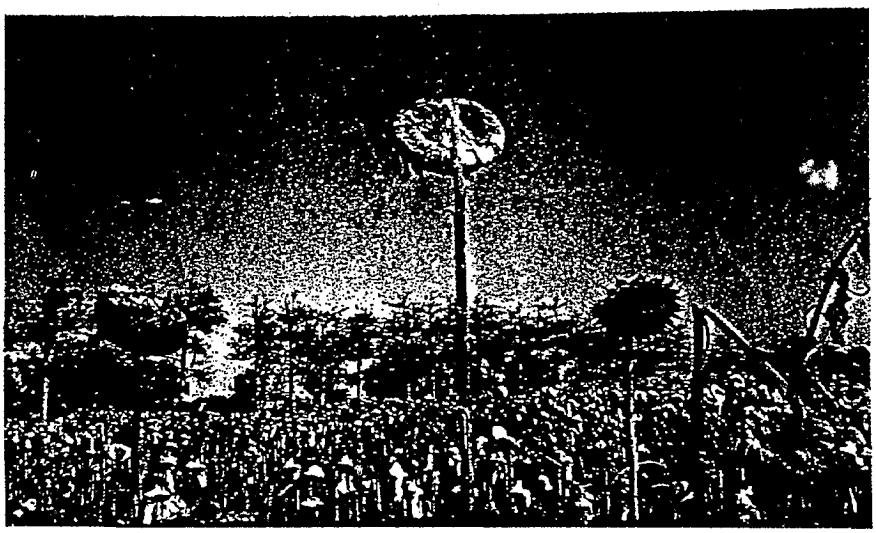

Figure 2. Plants of *Helianthus annuus* with different heliotropic behaviour, grown at Umbeluzi, Maputo (Mozambique).