

OLD PHENOLOGICAL DATA ON WILD PLANTS IN ITALY (XIX AND EARLY XX CENTURY)

DATI FENOLOGICI STORICI RELATIVI A PIANTE SPONTANEE IN ITALIA (SECOLO XIX E INIZIO XX)

Giovanna Puppi*, Anna Letizia Zanotti

Dipartimento di Biologia E.S., Università di Bologna

* Corresponding author: E-mail-giovanna.puppi@unibo.it

Received 15/12/2008 – Accepted 16/02/2009

Abstract

An overview of the oldest phenological data collected in Italy, for scientific purposes, with scientific criteria and methods, is presented. Following the example of Linnaeus, in the 19th century various Italian botanists such as Ottaviano Targioni, Teodoro Caruel, Alessandro Serpieri and Giuseppe Bertoloni, went on to create phenological calendars, with notes on the local climate and agricultural work. Besides, the earliest phenological network on both cultivated and wild plants was organized by Almerico Da Schio and Domenico Lampertico at the end of XIX century (1876-1884) in 16 localities of the Veneto and Emilia regions. The European Phenological Network founded by Hoffman and Ihne (1882) was joined by botanists working in the Italian Alps, like Wilhelm Pfaff, who was responsible for a very long series (1886-1933) of phenological records at Bolzano.

Keywords: phenology, historical data, flowering, leafing

Riassunto

Viene presentato una sintesi dei primi rilievi fenologici effettuati in Italia con metodi scientifici.

Seguendo l'esempio di Linneo, uno dei principali precursori della fenologia scientifica, nel corso del 19° secolo, vari botanici italiani come Ottaviano Targioni, Teodoro Caruel, Alessandro Serpieri e Giuseppe Bertoloni, realizzarono calendari fenologici delle flora spontanea e delle colture, da utilizzare anche per applicazioni agricole.

In questo secolo venne anche organizzata la prima rete fenologica italiana, per opera di Almerico Da Schio e Domenico Lampertico, in 16 località del Veneto e dell'Emilia. Inoltre, negli ultimi decenni del secolo, alcuni botanici che lavoravano nelle Alpi italiane, come Wilhelm Pfaff a Bolzano, realizzarono serie pluriennali di rilievi fenologici partecipando alla rete europea coordinata da E. Ihne.

Parole chiave : fenologia, dati storici, fioritura, emissione delle foglie

Introduction

The birth of scientific Phytophenology (the science that deals with the seasonal rhythms of plants) is quite recent. In the 18th century the following important steps stand out:

- a) the first phenoclimatic model based on the study of the relationships between temperature and phenophases occurrence (Réaumur, 1735)
- b) a prototype of phenological survey network (1751-53), carried out in accordance with a precise protocol regarding the choice of sites and the surveying method (Linnaeus, 1753)
- c) the first meteorological survey network (including phenological observations) covering large territories: the international network organised by the *Societas Meteorologica Palatina* (Mannheim 1781- 1792).

In the 19th century a widespread development of phenological studies raised mostly in Europe and USA. The phenological networks, which allowed the "phenological state" of the territory to be constantly monitored in space and time, were used for both research and applicative purposes.

National networks were set up: in Russia (from 1850), Britain (from 1857) and in the USA (in 33 states from 1851 -1859), covering plants, birds and insects.

Lambert Adolphe Jacques Quetelet (1796-1874), director of the royal observatory in Brussels, organised extensive meteorological observations and established a network of plant and animal phenological surveys (1840-1872) "*observations sur les phénomènes périodiques du règne animal et végétal*" with collaborators in several European countries, including Italy (the results are given in various memoirs published by the Brussels Academy). Hermann Hoffmann, of Giessen University, published the first phenological map of central Europe (1881) and founded in 1882 an European Phenological Network that remained active until the Second World War. His student, Egon Ihne, co-ordinated the European network for 59 years and every year from 1883 to 1941 he published the data coming from about 100 stations (later reduced to 88). The instructions for phenological observers suggested daily surveys and observations on many species; a list of 53 species was provided (a second list of 43 species was proposed for southern localities, where the northern species proposed in the first list were less fre-

quent or absent). Observations included both vegetative and reproductive phases; for vegetative phases, observations of several specimens were recommended. Ihne also provided, for reference, the phenological data of phase occurrence in Giessen arranged in order of date. Observation data were sent every year to Ihne in Darmstadt and published in the *Phaenologische Mitteilungen*.

The phenological phases are the following:

b= beginning of flowering ("erste normale Blüte öffnen")

BO=beginning of leafing ("Laubentfaltung", "erste normale Blattoberflächen sichtbar")

f = first fruit ripe or beginning of dehiscence ("erste normale Frucht reif")

W= green wood= leaf coverage (more than 50% of leaves completely opened) in wood ("Hochwald grün= allgemeine Belaubung")

LV=changing colours of leaves (more than 50% of leaves changed, including those fallen) ("allgemeine Laubverfärbung")

Old phenological data in Italy

a) Phenological calendars

In the 18th century Linnaeus drew up a detailed calendar of plant phenology (*Calendarium florum*, 1756) based on his own observations made in Uppsala, adding careful notes on the climate and the agricultural procedures. Following his example, various Italian botanists went on to create phenological calendars: Ottaviano Targioni, Teodoro Caruel, Giuseppe Bertoloni.

Ottaviano Targioni Tozzetti (1755-1826), physician and naturalist, was professor of Botany and Agriculture at the University of Florence. From 1801 to 1807, and then from 1813 to 1825, he recorded seasonal changes in vegetation around Florence chiefly for agricultural applications: these data were published year by year in the review "*Atti dell'Accademia dei Georgofili*".

Moreover, in 1810 he regularly collected phenological data on around 150 species of plants (cultivated and wild) in the Botanical Garden of Florence. The data were published in the review "*Annali dell'Agricoltura del Regno d'Italia*" (1811) and afterwards in the volume "*Osservazioni fenoscopiche sulle piante*" (1887) issued by the "*Ministero di Agricoltura Industria e Commercio*".

Besides the tables of data, the papers also include a brief analysis on meteorological characteristics of the year 1810. The dates of occurrence of 3 phenophases were recorded: leafing ("*generazione delle foglie*"), flowering ("*fioritura*"), fruit ripening ("*maturazione del frutto*"); in certain cases a single date is reported, but in most cases a period between two dates (beginning – end). In his "osservazioni" the author specifies that the real occurrence of phenophases should be within ± 4 days around the dates recorded, but did not specify the exact meaning of the phenophases observed.

Teodoro Caruel (1830-1898), naturalist and botanist, studied plant morphology and systematics. During the time he worked as professor of Botany at the University of Florence, Caruel recorded phenological rhythms of the local flora. These observations were used to produce a floral calendar of Florence (Caruel, 1859, 1871; Caruel and Levier, 1871).

Some years later he went to Pisa: there, in the Botanical Garden, he organized a phenological experiment during 1876, in order to detect the effect of air temperature on 47 plants (mostly exotic and ornamental) sown in pots (Caruel and Cazzuola, 1880).

Giuseppe Bertoloni (1804-1879), son of the famous Antonio Bertoloni, was botanist in Bologna.

His calendar of 1873, "*Calendario di Flora Bolognese per l'anno 1873*", contains detailed phenological observations on the flowering of over 200 wild plants around Bologna (the specimens are gathered in a phenological herbarium, now preserved in the Herbarium of the University of Bologna (BOLO)) collected in a year that had a very warm winter in Emilia and Veneto (especially in December 1872 and January 1873): among other things, he notes that spring plants such as *Viola odorata*, *Veronica hederifolia*, *Erodium cicutarium*, *Salvia pratensis*, *Trifolium pratense*, *Achillea millefolium*, *Anemone hortensis*, and *Daucus carota*, were already flowering in mid-January.

b) Phenoserries of single localities

Teodoro Caruel recorded a long series of phenological data in Florence from 1848 to 1864. The analytic data were published in the review "*Nuovo Giornale Botanico Italiano*" (Caruel, 1879) and later republished in the volume "*Osservazioni fenoscopiche sulle piante*" together with monthly mean temperatures and precipitations of the period.

This 17 years data series is in fact incomplete (1855, 1856, 1861, 1862 are missing)

The list of species includes many common herbs and shrubs, but the number of observed species is quite variable over the years (only 1 species in 1857 and 58 species in 1863).

The phenophases refer to Quetelet's protocol (1845-51): "*fogliazione*" (leafing) means the phase when the first leaves are unfolded; "*fioritura*" (flowering) means when the first flowers open (beginning of flowering); "*sfioritura*" (withering) means when the petals of the last flowers are withered (end of flowering); "*fruttificazione*" (fructification) means when the fruit is completely ripe (beginning of seed dispersal); "*sfogliazione*" (leaves fall) means the phase when most of the leaves have fallen.

Alessandro Serpieri (1823-1885) taught physics at the University of Urbino from 1847 to 1884. His presence brought celebrity to Urbino, particularly for the foundation of a meteorological Observatory (1850) and for his studies on earthquakes. Beside the meteorological observations, in the period 1857-1867, he organized phenological surveys, following the methods of Quetelet, on about 280 species, mostly wild, in the territory of Urbino: these data were published in the "*Bullettino meteorologico di Urbino*" (Serpieri, 1866, 1867). The phenophase observed was the beginning of flowering: he compared the data collected in Urbino with those of Brussels and calculated the phenological gradients: 4 days per degree of latitude and 4 days per 100 meters of altitude (Serpieri, 1867; Barsali, 1922).

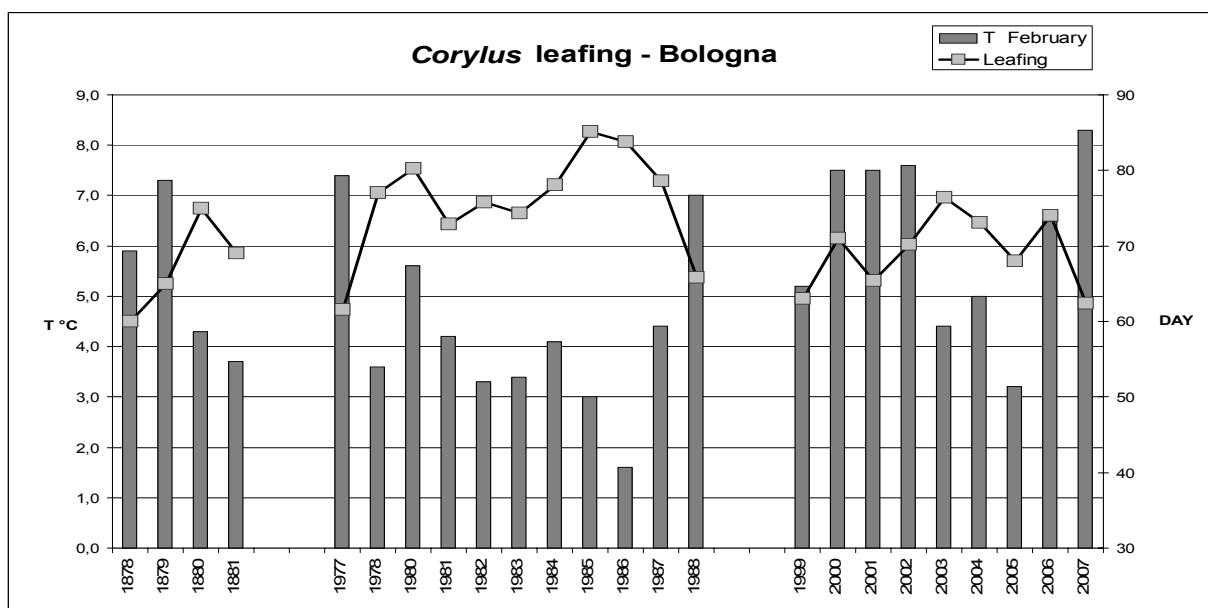


Fig. 1 - Mean temperatures of February are plotted together with the dates of start of leafing in hazelnut (*Corylus avellana*). Selected data of XIX century (Da Schio network) and recent data collected at Bologna (Puppi and Zanotti) are presented: old and recent phenological data seem to be comparable and show a significant relationship with the mean temperature of February ($R=0,68$).

Among old phenological records collected in the neighbourhood of Bologna, the most reliable and longer data series (1878-1881 at Villanova, by Don Cesare Manfredari) has been selected: in fact the quality of the other series of data (at Anzola) is doubtful. The recent records (collected by G.Puppi and A.L.Zanotti from 1977 to 1988 and from 1999 to 2008) come from the Botanical Garden of Bologna.

Fig. 1 - *Temperature medie di Febbraio e date dell'emissione delle foglie nel Nocciolo (Corylus avellana). Vengono riportati dati del XIX secolo (rete fenologica di Da Schio) e dati recenti osservati a Bologna (Puppi e Zanotti): i dati fenologici storici e quelli recenti sono comparabili e mostrano una correlazione significativa con la temperatura media di Febbraio ($R=0,68$).*

Tra i dati fenologici storici osservati nei dintorni di Bologna, è stata considerata solo la serie di dati più lunga ed affidabile (dati raccolti a Villanova, dal 1878 al 1881, da Don Cesare Manfredari), perchè la qualità dell'altra serie di dati (dati raccolti ad Anzola) è dubbia. I dati più recenti (raccolti da G. Puppi e A. L. Zanotti dal 1977 al 1998 e dal 1999 al 2008) provengono dall'Orto Botanico di Bologna.

c) Phenological networks in Italy

The earliest Italian network covering both cultivated and wild plants was organized by Count Almerico Da Schio and Dr. Domenico Lampertico at the end of XIX century (1876-1884 (1885)).

Count Almerico Alvise Cassiano Da Schio (1836, 1930), graduate in law, devoted his life to astronomy, meteorology and aeronautics (he planned and realized the airship "Italia" in 1905). He founded and directed from 1865 to 1918 the "Osservatorio meteorologico dell'Accademia Olimpica" in Vicenza. From 1873, Da Schio endeavoured to introduce phenological observations besides meteorological surveys in the province of Vicenza and in 1876 he succeeded in organizing a phenological network (in 16 localities of the provinces of Vicenza, Venice, Padua and Bologna)

The network worked for 9 years until 1884: the observed plants belonged to 102 common species, both cultivated and spontaneous: in fig.1 are reported observations on *Corylus avellana* leafing at Bologna in comparison with recent data .

In 1885 the Ministry of Agriculture launched a national campaign of phenological observations, extending the previous network. The species observed in 1885 were 79: cereals and crops, orchards, ornamental plants, forest trees and shrubs and some herbs of wild flora.

The phenophases observed were: First leaf extended ("Completamento della prima foglia"); Flowering ("Fioritura"); First fruit ripening ("Maturazione del primo frutto"); Leaves fall ("Caduta delle foglie"). The observers were amateurs and in several cases their reports are not entirely reliable.

All the data described above were published in 1887 (Ministero per l'Agricoltura, 1887 "Osservazioni fenoscopiche sulle piante" Roma). Later, these records, together with other data, were utilised by Michelangelo Minio (Minio, 1951) in the assessment of the phenological gradient with altitude in Italy.

d) Italian stations of European Phenological Networks

The European network of Adolphe Quetelet had some formal collaborators in Italy: the botanist Giovanni Passerini (1844, 46, 47) in Guastalla (RE), the physicists and

Tab. 1- Summary table of old phenological records on wild plant species in Italy

Tab.1 – *Tabella riassuntiva dei dati fenologici storici relativi a piante spontanee in Italia*

Responsible	Province	Station	Start	End	years	published in
Targioni Ottaviano	FI	Botanical garden of Florence	1810	1810	1	Targioni, 1811
Caruel Teodoro	FI	neighbourhoods of Florence	1848	1864	13	Caruel, 1879
Serpieri Alessandro	PU	neighbourhoods of Urbino	1857	1867	6	Serpieri, 1866,1867
Bertoloni Giuseppe	BO	neighbourhoods of Bologna	1873	1873	1	Bertoloni, 1873
Da Schio Almerico	VI, VE, PD, BO	16 stations in 2 regions	1876	1884	9	Ministero A.I.C., 1887
Ministero Agric. I.C.	Italian network	12 regions	1885	1885	1	Ministero A.I.C., 1887
Pfaff Wilhelm	BZ	neighbourhoods of BZ	1886	1933	48	Phaenologische Mitteil., yearly
Fiori Adriano	FI	Vallombrosa and Florence	1905	1905	1	Fiori, 1905
Minio Michelangelo	BL	neighbourhoods of BL	1912	1916	5	Minio, 1915, 1917
Dalla Fior Giuseppe	TN	province of TN	1922	1961	40	Studi Trentini Sci.Nat., 1934-1963
Minio Michelangelo	Italian network	13 regions	1922	1936	15	Bull.Soc.Bot.It.-N.Gior.Bot.It. yearly

FI= Florence, PU= Pesaro-Urbino, BO= Bologna, VI= Vicenza, VE= Venice, PD= Padua, BZ= Bolzano, BL= Belluno, TN=Trento

meteorologists Francesco Zantedeschi (from 1843 to 1860) in Venice and Antonio Colla in Parma, and the entomologists Camillo Rondani in Parma and Achille Costa in Naples. Furthermore, other Italian scientists also followed his methods (Caruel, Serpieri).

The European network co-ordinated by Ihne had collaborators working also in Northern Italy, mostly in the Italian Alps, in Arco and Bozen-Gries. Phenological data from Arco were collected by Emil Diettrich-Kalkhoff; those from Bozen-Gries by Wilhelm Pfaff.

The lawyer Wilhelm Pfaff (1859-1933) collected a very long series (1886-1933) of phenological records at Bolzano (Bozen-Gries). The phenological phases observed, according to Ihne were: b, BO, f and LV (phase W was not considered).

He collected long series of data (covering more than 25 years) on the flowering of 38 species, leafing of 6 species, leaves yellowing of 8 species and fructification of 9 species. The longest observation series (48 years) refer to the start of flowering in *Prunus avium*, *Cydonia vulgaris*, *Crataegus monogyna*, *Cornus sanguinea*, *Aesculus hippocastanum*, *Syringa vulgaris* and *Sambucus nigra*. Average data were published by Pfaff in 1915 and then by Dalla Fior (1951).

e) Phenology in the 20th century: first decades

At the beginning of the 20th century phenological calendars were made by the famous field botanist Adriano Fiori at Valdarno in Tuscany (1905) and by the mathematician and naturalist Michelangelo Minio (1915, 1917) at Belluno in the Veneto region.

At Bozen-Gries, after Pfaff, phenological observations were carried out in 1934-1935 by G. Nicolussi, in 1937-1940 by G.Ganzer (published in the *Phaenologische Mitteilungen*), and in 1942-1943 by Kalkschmid. Observation data of the period 1934-1943 are deposited at the Museo Regionale di Storia Naturale di Trento (average data were published in 1951 by G. Dalla Fior).

At a regional level, the most significant series of data is that of the network of Trentino region, coordinated by

Giuseppe Dalla Fior, which was active for around forty years from the 1920s to the early '60s.

While the first important series of national phenological surveys on wild plants in 20th century was carried out by the "Rete Fenologica Italiana", promoted and coordinated by Michelangelo Minio from 1922 to 1936 (Minio, 1951), and then by the count Alessandro Marcello (one of the most important Italian phenologists) from 1953 to 1965 (Lorenzoni, 1988).

Conclusions

Phenological studies on wild plants in Italy seem to have started in Tuscany at the beginning of the 19th century and then spread to other regions (Marche, Emilia, Veneto, Trentino-Alto Adige) from the mid-century onwards. Early phenology in Italy is affected by several problems: temporal gaps, spatial gaps, different lists of species, likeness of methods.

The survey methods were not homogeneous (some were self-made, others referred to Quetelet or Ihne) and not always well defined (number of plants observed per species, periodicity of surveys, description of phases). Generally the data were collected by expert botanists in an intensive way (many species) but over few years; therefore, only a few cases exist of long series of data regarding the same locality, species and phases (Pfaff was responsible for the longest phenoseries in Bolzano).

Nevertheless, there are historical accounts of a number of other Italian scientists in the 19th century who collected phenological data that are nowhere to be found: the recovery of these data (manuscripts or local issues) could help to fill some gaps.

Acknowledgements

We would like to deeply thank the "Osservatorio Meteorologico A. Serpieri" of the "Università degli Studi di Urbino Carlo Bo" and in particular P. Paolucci for providing copies of the "Bullettino meteorologico di Urbino" issued by Serpieri. We thank too Dott. Paolo Zam-

botto, head of the library of the Museo Tridentino di Scienze Naturali and the head of the civic library “Bruno Emmert” in Arco (Trento) for providing copies of the *Phaenologische Mitteilungen*.

We are grateful to T. Nanni at the Isac-Cnr of Bologna for supplying the meteorological data for Bologna in the 19th century and to A. Managlia and U. Mossetti at BES of Bologna University for providing G.Bertoloni’s herbarium. We thank in particular Gaston Demarée of the Royal Meteorological Institute in Brussels for communicating information about Quetelet’s collaborators. Many thanks also to all the Italian friends of the COST 725, G. Dal Monte, L. Mariani, S.Orlandini, for exchanging information and documents.

References

- Barsali, E., 1922 - *le osservazioni fenologiche del P. Serpieri ad Urbino dal 1857 al 1865- Adunanza dell'8 Aprile: comunicazioni- Bollettino della Società Botanica Italiana, Aprile 1922, n.4:pp. 46-47.*
- Bertoloni, G., 1873 - *Calendario di Flora Bolognese per l'anno 1873- L'Agricoltore Anno III (every month, from Jan. to Dec.).*
- Caruel, T., 1859 - *Del calendario di flora per Firenze- Annuario del Museo di fisica per l'anno 1859.*
- Caruel, T., Levier, E., 1871 - *Saggio di un calendario florale per Firenze- Nuovo Giornale Botanico Italiano, vol. III : 121-165.*
- Caruel, T., 1871 - *Statistica botanica della toscana - Pellas: 374 p.*
- Caruel, T., 1879 - *Osservazioni fenologiche sulle piante di Firenze fatte dall'anno 1848 all'anno 1864 - Nuovo Giornale Botanico Italiano, vol. XI (3) : 303-311.*
- Caruel, T., 1880 - *Osservazioni sull'influenza della temperatura sulle piante fatte nell'orto botanico pisano - Nuovo Giornale Botanico Italiano, vol. XII n.1.*
- Dalla Fior, G., 1951 - *Un terzo decennio di osservazioni fenologiche a Trento e risultati di analoghe osservazioni compiute in altre stazioni del Trentino Alto Adige. Studi Trentini Sci. Nat., 28: 1-32.*
- Da Schio, A., 1881 - *Le stazioni di osservazione per servire alla meteorologia ed alla idrografia istituite nel Veneto, nel Trentino e nell'Emilia dal 1873 al 1880 per cura di Almerico da Schio.- Tip. S. Giuseppe, Torino.*
- Da Schio, A., 1884 - *Almanacco Astronomico e Meteorologico per l'anno 1884. Anno terzo. Drucker & Tedeschi, Verona-Padova.*
- Da Schio, A., 1885 - *Almanacco Astronomico e Meteorologico per l'anno 1885. Anno quarto. Drucker & Tedeschi, Verona-Padova.*
- Fiori, A., 1905 - *Osservazioni fenologiche fatte nel Valdarno nella primavera del 1905 - N. Giorn. Bot. Ital. N.S.VII : 441-456.*
- Ilhne E., 1899 - *Phaenologische Mitteilungen - XXXIII Bericht der Oberhess. Ges. f. Natur- u. Heilkunde zu Giessen, 30 pp.*
- Lorenzoni, G.G., 1988 - *Cento anni di Fenologia in Italia - Volume celebrativo del Centenario della S.B.I., Biemmegraf, Macerata: 809-820.*
- Minio, M., 1915 - *Sulla flora invernale dei dintorni di Belluno - N. Giorn. Bot. Ital. N. S. XXII : 77-100.*
- Minio, M., 1917 - *Ancora sulla flora invernale di Belluno 2° biennio di osservazioni - N. Giorn. Bot. Ital. N. S. XXIV : 172-182*
- Minio, M., 1932 - *Quelques valeurs du retard des floraisons du à l'altitude tirées des séries d'observations italiennes 1870-1885- Acta Phaenologica, 1, La Haye : 97-105.*
- Minio, M., 1943-44 - *Il gradiente fenologico in Italia : valori numerici e loro variazioni: relazione con altre zone europee. Atti dell'Istituto Veneto di Scienze Lettere ed Arti, CI, parte II, classe Sc. Mat. e Nat.: 625-656.*
- Minio, M., 1951 - *Fenologia vecchia e nuova e ricostituzione della rete fitofenologica. Nuovo Giorn. Bot. Ital. n.s. 58: 496-503.*
- Ministero Agricoltura Industria e Commercio, 1887 - *Osservazioni fenoscopiche sulle piante. Roma: tip. E.Sinimberghi.*
- Pfaff, W., 1915 - *Pflanzenphaenologische Beobachtungen aus Bozen-Gries - Phaenologische Mitteilungen von E.Ilhne, Jahrg. 1914, Heft 17 der Arbeiten. Darmstat.*
- Pfaff, W., 1919 - *Über den Einfluss der Hohenlage auf den Eintritt der Vegetationsphasen - Phaenologische Mitteilungen.*
- Serpieri, A., 1866 - *Osservazioni sull'epoca della fioritura di alcune piante.- Bollettino meteorologico di Urbino, anno 1866, (issued in 1867), fascicolo I: pp. 32-40*
- Serpieri, A., 1866 - *Erborizzazione al Monte Catria: piante trovate in fiore nel dì 11 giugno 1866 - Bollettino meteorologico di Urbino, anno 1866 (issued in 1867), fascicolo I: pp. 49-52.*
- Serpieri, A. and Federici, A., 1867 - *Flora dell'Agro Urbinate - Bollettino meteorologico di Urbino, anno 1867 (issued in 1868) fascicolo II. pp. 32-38*
- Targioni Tozzetti, O., 1811 - *Tabella della temperatura dell'atmosfera presa dalle piante nel clima di Firenze nell'anno 1810 - Annali dell'Agricoltura del Regno d'Italia” ed. Filippo Re, tomo 9 Gennaio, Febbraio, Marzo 1811, p.194-195.*