SOME BIOLOGICAL AND EVOLUTIONARY ASPECTS OF THE VASCULAR FLORA OF TUSCANY (ITALY)[1]

Fabio GARBARI[2]

Dedicated to Prof. Pedro Montserrat, in the ocasion of his 70th birthday.

RESUMEN.—La región de Toscana pertenece a dos sectores climáticos: termo y pluviobioclimas. Si a esta situación unimos su extraordinaria variedad geológica y litológica, así como la capacidad morfológica, cariológica y adaptativa de cada grupo sistemático, podremos explicarnos la gran variedad y riqueza de la flora vascular de esta región. Destacamos aquí los aspectos biológicos evolutivos de algunas plantas endémicas o relictas de Toscana.

SUMMARY.—Tuscany lies in two distinct climatic districts: thermo- and pluviobioclimates. This position, the extraordinarily varied geological and lithological formation, together with the morphological, caryological and adaptive capacities of each systematic group, can explain the richness and variety of the vascular flora of this Region. Biological and evolutionary aspects of some endemic and relic plants of Tuscany are here remarked.

The Italian region called Tuscany is famed all over the world for its artists, men of letters, scientists and statesmen of the past. Some of the most brilliant Renaissance works were carried out in 15th and 16th century Florence.

The riches and longsightedness of Tuscany's wise rulers, that is her Gran Dukes, made them the chief authors of the cultural advantage that Tuscany has always been proud of.

But it was not just in Art and Letters that Tuscany excelled; studies in Natural Science were particularly cultivated and encouraged in the politics of the Gran Dukes of Tuscany. Theirs is the merit of attempting to link all fields of knowledge – art with science for instance. Famous painters were summoned to Court in Florence, to paint life studies of plants and animals; several splendid coloured drawings were discovered recently in Pisa University Library. They date from the 16th century and show some of the plants cultivated at that time in the Pisan Botanic Gardens. The Uffizi Gallery in Florence is packed with 16th and 17th century illustrations from Natural History (CIARDI and TOMASI TONGIORGI, 1984). Many documents like Andrea Cesalpino's Herbarium (MOGGI, 1981)

1 Research supported by Ministry of Public Education (Italy).

2 Department of Botany. University of Pisa (ITALY).

testify that Botany was already in the modern sense a well-developed and independent science in Pisa and Florence by the end of the 16th century (GARBARI 1980).

I mention all this to make it clear that Tuscany flora has been thoroughly and scientifically scrutinised since the 16th century and seems to have no secrets left to reveal.

One of the attractions for botanists in Tuscany is the richness and variety of this flora which is provided by the range of climatic, geological and historical conditions there.

We all know that climate and geomorphology are two of the main factors in determining vegetation and flora in an environment. Tuscany's range of climates is astounding. From the cold damp conditions in the highest points of the Tuscan-Emilian ridge and the Apuan Alpes it continues through the gamut of intermediate climate types (such as warm and temperate, sublittoral, sub-continental, etc.) to a hot dry climate on this sandy and rocky coast along the Tyrrhenian Sea and in the archipelago of which Elba is the largest island. From the bioclimatic standpoint the hot-temperate and sublittoral climates are *pluiviobioclimates* and here characterised by vegetative rest during the dry season while the subcontinental climates are *thermobioclimates* with vegetative rest during the cold season (PIGNATTI, 1980). The Tuscan coasts belong to pluviobioclimates whereas the Apuan Alps and the Apennine ridge to the thermobioclimates: Tuscany lies in an area divided between thermo- and pluviobioclimates. This position is of great biogeographic importance because it divides Tuscany into two distinct climatic districts allowing completely different floral types to meet here, in particular central-European and Mediterranean.

Tuscany's geological formations are extraordinarily varied too, ranging from the Paleozoic era, found in the Monti Pisani and in hills near Siena, to the recent Quaternary in plains near Pisa, Viareggio and Carrara.

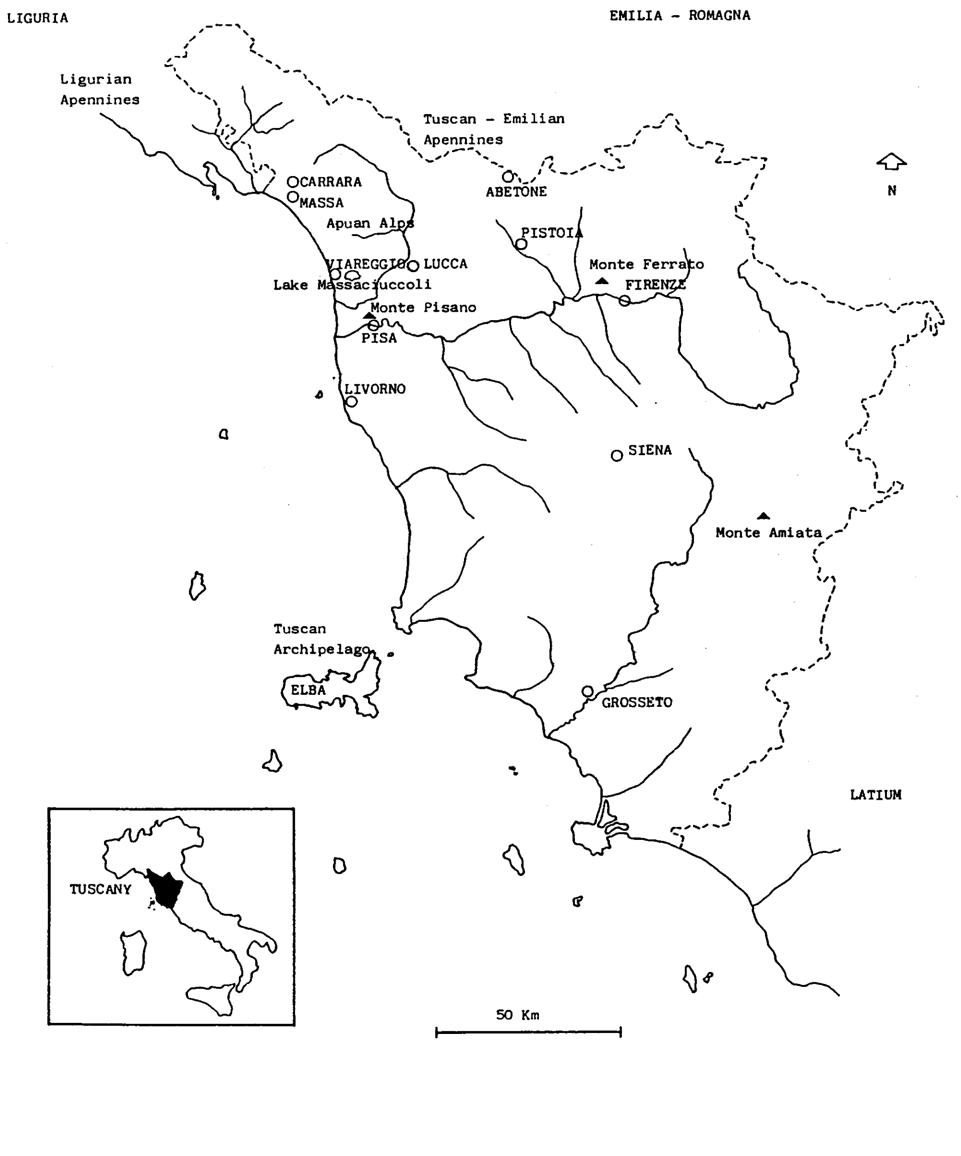
A similar degree of variety in lithology is found in Tuscany too, providing a highly differentiated selection of substrates which include limestone, sandstone, marl, ophiolites and serpentines.

Some particular geographical features have an important effect too. The Apuan Alps are about 2.000 metres high but only just over 20 kilometers from the coast; long, deep velleys separate the mountain groups; the coast is dominated by steep cliffs while gentler slopes face east. There are groups of islands too such as the Elban archipelago where some of the islands were once connected to the Corsican-Sardinian group and others, in more recent times, were connected to the mainland.

Finally, it must not be forgotten that Tuscany has been inhabited from Neolithic times and the activities of these peoples have had a profound effect on the landscape. The Etruscans for example, between the 7th and 2nd centuries B.C., chopped down and burned whole forests in their furnaces for smelting ores while Pisa, during the period of the Maritime Republics, built her vessels and ports with wood from the Apennine forests. The consequences can still be seen today, added to which is the devastation through urbanisation, land reclamation and industry in modern times.

Now, all these factors have to be considered if we are to have an understanding of the origin, differentiation, geographical distribution, ecology and biological characters of present-day flora in Tuscany. But these alone do not explain everything: each systemtic group has followed its own pattern in evolution according to its genetic, morphologic and adaptive capacities.

Let me explain the fundamental principles by which the present Tuscan flora developed with a few examples. Y shall draw in particular from what are the most noble expressions of vascular flora, that is endemics and relics.



Situación de las localidades citadas en el texto.

First let me deal with endemics.

A species found exclusively on Apuan limestone and in a few places in the nearby Apennines where the rock formations are in sandstone but bound with limestone cement, is *Globularia incanescens.* It is the only species of the genus *Globularia* to have an undivided corolla upper lip. From the systematic standpoint therefore it is quite distinct and isolated, to the extent that De Candolle assigned it to the genus *Carradoria.*

Globularia incanescens it is also a biological curiosity in that it is always diploid and shows apomictic phenomena producing aposporic female gametophytes as well as a normal amphimictic reproduction (CORSI and GARBARI, 1971). Its morphological and reproductive peculiarities, diploid chromosome number and its being geographically isolated strongly indicate it as an ancient species, definitely going back at least to the Tertiary era. According to Favarger's classification *Globularia incanescens* is a conservative paleoendemism (FAVARGER and CONTANDRIOPOULOS, 1961).

In a similar manner *Rhamnus glaucophyllus,* a dioecious species from limestone rocks in the Apuan Alps, *Silene lanuginosa,* too, often found above 1.000 m in cracks, *Salix crataegifolia* and *Polygala carueliana,* found on rocks where the light is good, can all be considered paleoendemics, not forgetting *Galium palaeoitalicum,* a 1-2 cm high Rubiacea which only grows in sunny, well-lit and windy spots where its hardiness enables it to avoid competition with larger plants. Interestingly enough its morphology, ecology and chromosome number, 2n=20.

EHRENDORFER, (1971) is of the opinion that this species is phylogenetically linked to *Galium olympicum* from Asia Minor and that *G. palaeoitalicum* originated in eastern Mediterranean mountain populations but before the Pleistocene it migrated from the east in a north-westerly direction along the Apennine chain. There are traces of this migration long ago in a population of *Galium palaeoitalicum* on Monte Pollino in southern Italy between Basilicata and Calabria.

The discovery that Tuscany's endemic orophylous contingent has links with eastern Mediterranean floras may come as a surprise; nonetheles the fact is that many paleoendemic species there have their closest representatives on the Greek mountains. The already-mentioned *Ramnus glaucophyllus* and *Silene lanuginosa* have corresponding taxa respectively in *Rhamnus sibthorpianus* and *Silene auriculata,* both from Southern Greece.

The species systematically closest to *Athamanta cortiana,* a few plants of which survive on the highest peaks of the Apuan Alps, is *Athamanta densa* from southern Albania and central Greece (FERRARINI, 1987). Certain anatomical details in the fruits, recently studied by PAGNI et *al.* (1986), are evidence of this relic-type endemic's antiquity.

The chorological analysis of other *Umbelliferae* (e. g. *Trinia dalechampii, Carum appuanum)* highlights the historical connections between Tuscan flora and that from the eastern Mediterranean basin (FERRARINI, 1987).

Tuscan endemics are not confined to these forms alone; other elements are found there, which derive from central and western Mediterranean, rather than oriental, flora.

Let us consider an example, *Santolina pinnata.* This is a diploid with 18 chromosomes and is commnonly found on limestone all along the Apuan chain. It has a vicarian species, *S. ligustica,* further north in the Ligurian Apennines, recently described by ARRIGONI (1977). Another vicarian species, found in the Tuscan Apennines and on Monte Amiata is *Santolina etrusca* and yet another, *S. neapolitana,* comes from the south of Italy. Although all these species are found in widely separated areas morphologically and caryologically they are extremely similar to each other (MARCHI and D'AMATO, 1973). This means that they probably all derive from one entity through the break-up of what was once an uninterrupted area and they have conserved a substantial genomic unity. These are schizo-endemics, which evolve gradually instead of by abrupt speciation. It should be noted that some species of *Santolina (S. insularis* and *S. corsica)* are polyploids exclusively found in Sardinia and Corsica (MARCHI and D'AMATO, 1973).

Senecio apuanus belongs to the same category as *Santolina pinnata;* it differentiated from the widespread *S. nemorensis* from which it is distinguished by its striking morphological individuality (GIORDANI et *al.*, 1980). This is a schizoendemic which has the same ploidy level (2n=40) as *S. nemorensis* but is found all over the Apuan Alps and on the nearby Apennine relief. One case of extremely narrow distribution –what I would call a "spot location" of an endemic– is represented by *Centaurea montis-borlae,* described and known for a single locality only on the Apuan Alps. Systematically, it resembles *Centaurea procumbens* which is a Provencal endemic, but it is highly polyploid having 84 somatic chromosomes (VIEGI and CELA RENZONI, 1981). This is an example of apoendemic, formed relatively recently since it can be distinguished from the probable mother species *(C. procumbens)* by only a few characters. This is a novative endemism, that is an endemism by novation, it is not a relic.

In contraposition to this we might consider *Cerastium apuanum* which is diploid (GARBARI *et al.,* 1980) whereas a similar species, *C. arvensis,* is tetraploid. For this reason, *Cerastium apuanum* is considered a patroendemic.

These examples illustrate how chromosomes analysis can help us in understanding the historical and phylogenetic links among taxa, clarifying when and how a species developed.

Now I shall proceed to speak of a few endemic from the pluviobioclimate which is that of the islands in the Tyrrhenian sea and the Tuscan coastal region.

One of our most interesting examples is *Solidago litoralis,* found exclusively on the sandy stretches of coast in western Tuscany. It derives from the common *S. virgaurea* from European mountain forests and has adapted to survive on salty substrate and in strong sunlight, making it ecologically differentiated from *S. virgaurea.* Moreover althoug it has the same chromosomal number it has its genome rearranged in such a way that the caryotype of these two entities is slightly different. *S. litoralis* flowers very late which prevents it from crossing with *S. virgaurea* (GARBARI, 1979). It is possible to retrace the time when *S. litoralis* originated, since the geological and climatic events which created the Tuscan coastline after the most recent ice age are well understood and it is quite certain that the present situation goes no further back than ten thousand years since when it has remained substantially unchanged. The coastal phytocoenoses and halophytic communities emerged on this period. *S. litoralis* which is now genetically and ecologically isolated from *S. virgaurea* may have emerged no more than 100 centuries ago.

Let us now take a look at the Tuscan Archipelago. Two types of endemic can be found here, one is Sardinian-Corsican-Balearic and the other –less numerous– exclusive to one or more islands of the archipelago itself.

The former category, numbering some 35 entities(DEL PRETE and GARBARI, 1985), concerns *Arum pictum, Arenaria balearica, Borago pygmaea, Cymbalaria aequitriloba, Pancratium illyricum* and *Soleirolia soleirolii* among others. These originated when the Sardinian-Corsican plate broke away from the coasts of Spain and southern of France during the Tertiary era. Later, when the Tyrrhenian plate was broken up and the palaeogeographical links with the mainland were destroyed, the flora differentiated even further. A common heritage of endemic species covering a relatively wide area was transformed into a series of entities confined to one island or a small group. An emblematic case is that of *Viola ilvensis,* exclusive to Elba. It evolved within a group of morphologically similar entities with a common genomic inheritance. MERXMÜLLER and LIPPERT (1977) had studied this group and believe that *Viola ilvensis* is a subspecies of *Viola corsica* from the Corsican mountains, just as is *Viola limbarae* from the peaks of Mounts Limbara and

Gennargentu in Sardinia. Other endemics exclusive to islands in Tuscany are *Linaria capraria, Centaurea aetaliae, C. gymnocarpa* and *C. veneris* (CELA RENZONI and VIEGI, 1983).

Now we must return to mainland Tuscany where endemics of another sort are plentiful, those originated in highly particular ecological conditions such as the serpentine or ophiolitic rocks on Monte Ferrato. They are linked to chemically "ill-balanced" soils where elements commonly toxic to plant life, such as nickel and cobalt, are present. In such places we find *Alyssum bertolonii, Thymus ophioliticus, Armeria denticulata, Centaurea carueliana, Stachys serpentini, Euphorbia prostrata, Minuartia ophiolitica* (ARRIGONI *et al.*, 1983), *Leucanthemum pachypyllum* decaploid with 90 chromosomes (MARCHI and ILLUMINATI, 1975) and others.

To wind up I should like to mention a few examples of relic flora, of the boreo-Alpine or even arctic-Alpine type and some of the Atlantic type.

The presence of boreal flora in Tuscany can only be explained by retracing the palaeogeographical events during the Quaternary glaciation, in particular during the Wurmian period.

Nowadays the only natural forest of *Picea abies* in the whole of Apennine chain is tucked away in the Sestaione valley near Abetone (MAGINI, 1973). It is interesting to note that wherever the geomorphological traces of the Quaternary era are most evident, plants of an Alpine moor or snow beds can be found. Examples are *Viola biflora*, the fern *Athyrium distentifolium* and *Rhododendron ferrugineum;* the nearest place where these species, together with others, are found, is the Alps.

In the Lake Massaciuccoli *Sphagnum* bogs, near Viareggio and at sea level, *Drosera rotundifolia* can be found (TOMEI and GARBARI, 1981) and on the Monti Pisani *Gentiana pneumonanthe*, a species which is extinct on the Apennines (TOMEI and MARIOTTI, 1978).

Finally, on the coast of northern Tuscany, where there are cool, damp conditions during the Summer, there is an interesting and sizeable number of Atlantic relics. These are all species which can probably be traced back to the interglacial phases of the Recent Quaternary and include –among others– *Anagallis tenella, Hibiscus palustris* (TOMEI et *al.*, 1985) and *Hymenophyllum tunbrigense* (FERRARINI and MARCHETTI, 1985). Let me mention two more plants which in the whole of Italy are found only in Tuscany: these are *Hypericum elodes* (CORTI, 1956) and *Ophioglossum azoricum* (FERRARINI et *al.*, 1986).

* * *

I have tried here to describe how varied and interesting the Tuscan flora is. New enties, such as *Festuca apuanica, Rhinanthus apuanus, Biscutella mollis,* are being discovered all the time; only in 1986, *Viola etrusca* has been described for a locality between Grosseto and Siena. Another endemic violet, *Viola eugeniae* dedicated by Filippo Parlatore, the founder of the Florentine Herbarium, to his wife, has been chosen as the emblem for the 100th anniversary of the founding of the Italian Botanical Society, to be celebrated in Florence this year (1988). For the occasion, a paper including all the geobotanical literature of Tuscany has been printed (MOGGI *et al.*, 1987).

BIBLIOGRAPHY

ARRIGONI, P.V. (1977). Santoline italiche nouve. *Webbia*, 32 (1): 129-134.

ARRIGONI, P.V.; RICCERI, C. & MAZZANTI, A. (1983). *La vegetazione serpentinicola del Monte Ferrato in Toscana.* Centro Studi Sc. Nat. Prato, 5-27.

CELA RENZONI, G. & VIEGI, L. (1983). *Centaurea cineraria* s.l. (Asteraceae) in Italia. Revisione citotassonomica. *Atti Soc. Tosc. Sc. Nat. Mem. B,* 89: 99- 144.

CIARDI, R.P. & TONGIORGI TOMASI, L. (1984). *Immagini anatomiche e naturalistiche nei disegni degli Uffizi.* Secc. XVI e XVII. Gabineto Dis. Stampe Uffizi, 60: 5-149. L.O. Olschki, Firenze.

CORSI, G. & GARBARI, F. (1971). Aspetti citotassonomici ed embriologici del contingente endemico apuano. II. Globularia incanescens Viv. *Atti Soc. Tosc. Sc. Nat. Mem. B,* 78: 46-54.

CORTI, R. (1956). Piante atlantiche nel versante tirrenico della Liguria e della Toscana. *Webbia,* 15: 417-424.

DEL PRETE, C. & GARBARI, F. (1985). Le piante endemiche dell'Arcipelago Toscano. Saggio introduttivo. *Riv. Ital. Studi Napoleonici,* suppl. 1: 51-62 (1983).

EHRENDORFER, F. (1971). Evolution and eco-geographical differentiation in some South-West Asiatic Rubiaceae. *In* DAVIS, P.H.; HARPER, P.C. & HEDGE, I.C., *Plant life of South West Asia,* 195-213. Bot. Soc., Edinburgh.

FAVARGER, C. & CONTANDRIOPOULOS, J. (1961). Essai sur l'endemisme. *Bull. Soc. Bot. Suisse,* 71: 383-408.

FERRARINI, E. (1987). Note tassonomiche e corologiche su alcune Umbelliferae delle Alpi Apuane. *Webbia,* 41 (1): 45-60.

FERRARINI, E.; CIAMPOLINI, F.; PICHI SERMOLLI, R.E.G. & MARCHETTI, D. (1986). Iconographia palynologica Pteridophytorum Italiae. *Webbia,* 40 (1): 1-202.

FERRARINI, E. & MARCHETTI, D. (1985). Hymenophyllum tunbrigense (L.) Sm. sulle Alpe Apuane. *Boll. Mus. Sc. Nat. Lunig.,* 3: 5-26 (1983).

GARBARI, F. (1979). Cytotaxonomical and biosystematic aspects of the Mediterranean Flora of Italy. *Webbia,* 34 (1): 337-355.

GARBARI, F. (1980). Nasce presso lo Studio pisano, nel XVI secolo, la botanica moderna. *In: Livorno e Pisa: due città e un territorio nella politica dei Medici,* 527-535. Nistri Lischi and Pacini, Pisa.

GARBARI, F.; MICELI, P. & MONTI, G. (1980). Numeri cromosimici per la Flora italiana: 682. *Inform. Bot. Ital.,* 12 (2): 111.

GIORDANI, A.; MICELI, P. & MONTI, G. (1980). Numeri cromosomici per la Flora italiana: 793. *Inform. Bot. Ital.,* 12 (3): 331-332.

MAGINI, E. (1973). L'abete rosso *(Picea abies* Karst.) della riserva naturale di Campolino. *Ann. Accad. Ital. Sci. Forest.,* 21: 287-321 (1972).

MARCHI, P. & D'AMATO, G. (1973). Numeri cromosomici per la Flora italiana: 145-150. *Inform. Bot. Ital.,* 5 (1): 93-100.

MARCHI, P. & ILLUMINATI, O. (1975). Notizie e considerazioni su i *Leucanthemum* della Flora d'Italia. *Ann. Bot. (Roma),* 33: 167-187.

MERXMULLER, H. & LIPPERT, W. (1977). Veilchenstudien V-VII. *Mitt. Bot. Munchen,* 13: 503-534.

MOGGI, G. (1981). Andrea Cesalpino botanico. *Atti Mem. Accad. Petrarca Lett. Arti Sci.,* n.s., 42: 235-249 (1976-1978), Arezzo.

MOGGI, G; MILLETTI, N. & PAOLI, P. (1987). *Bibliografia geobotanica Toscana.* Museo Bot. Univ. Firenze.

PAGNI, A.M.; CORSI, G. & CAPPELLETTI, E. (1986). Fruit morpho-anatomical aspects and secretory structures in three related Athamanta species (Umbelliferae). *Bot. Jahrb. Syst.*, 106 (2): 211-220.

PIGNATTI, S. (1980). Natural vegetation. *In:* PINNA, M. & RUOCCO, D. (eds.). *Italy: a Geographical Survey*, 114-140. Istituto Geografico Italiano, Naples.

TOMEI, P.E.; AMADEI, L. & GARBARI, F. (1985). Données distributives de quelques Angiospermes rares de la Région Méditerranéenne d'Italie. *Atti Soc. Tosc. Sc. Nat. Mem. B*, 92: 207-240.

TOMEI, P.E. & GARBARI, F. (1981). Considerazioni introduttive sulla flora e sulla vegetazione delle paludi di Massaciuccoli e di Porta. *Atti Soc. Tosc. Sc. Nat. Mem. B*, 88: 301-309.

TOMEI, P.E. & MARIOTTI, L. (1978). Studi sulla flora e vegetazione del Monte Pisano (Toscana Nord-Occidentale). IV. Nota preliminare sulle sfagnete di S. Lorenzo a Vaccoli. *Atti Soc. Tosc. Sci. Nat. Mem. B*, 85: 261-267.