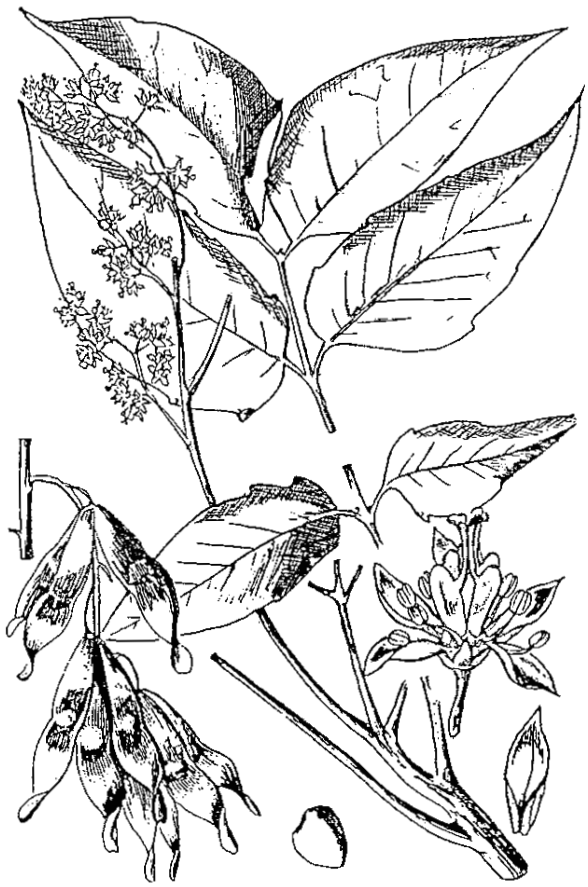
DIPARTIMENTO DI BOTANICA ED ECOLOGIA VEGETALE
UNIVERSITÀ DEGLI STUDI DI SASSARI

5th International Conference on the Ecology of Invasive Alien Plants



Ailanthus altissima (Miller) Swingle
(from: Flora Vascular de Andalucía Occidental - B. Valdés *et al.*, 1987)

13-16 October 1999

Teatro Longobardo

La Maddalena, Sardinia - Italy

Dipartimento di Botanica ed Ecologia vegetale
Università degli Studi di Sassari
Italy

PROCEEDINGS

of the
5th International Conference on the Ecology of Invasive Alien Plants

13-16 October 1999
La Maddalena, Sardinia - Italy

PROGRAMME

WEDNESDAY, 13TH OCTOBER 1999

10.00 -10.30 - Opening cerimony
10:30 - 13:30 - I session - Chairman: Ignazio Camarda

Sandro Pignatti
University of Rome - Rome - Italy
Mediterranean Invasive Plants

Ingo Kowarik
Technical University of Berlin - Berlin - Germany
Invasion potential and invasion success: On the relevance of man-made interactions.

Mark Williamson
University of York - York - United Kingdom
Can the impacts of invasive species be predicted?

Harald Auge
UFZ Centre for Environmental Research Leipzig-Halle - Halle - Germany
Native plant species richness and invasibility of ecosystems.

Petr Pysek
Academy of Sciences of the Czech Republic - Pruhonice - Czech Republich
Persistence of stout clonal herbs as invaders in the landscape.

12:10 - 12:30 - Coffee break

Françoise Boillot
Conservatoire Botanique national Méditérranéen de Porquerolles - Hyères - France
Wide range survey of invasive plants, a hierarchical approach.

Tina Heger
Technical University Munich - Freising-Weihenstephan - Germany
Interpreting the process of invasion: crucial situations favouring special attributes of invasive species".

Lucia Viegi
University of Pisa - Pisa - Italy
Statistical analysis of some reproductive features of Italian Alien Flora.

13.30- 15.00 - Lunch

15.10-18.30 - II session - Chairman: Uwe Starfinger

Carey Suehs
Universite d'Aix-Marseille III - Marseille - France
Ecological and genetic features of the invasion by the alien *Carpobrotus (Aizoaceae)* **plants in Mediterranean island habitats.**

Ignazio Camarda
University of Sassari - Sassari - Italy
Exotic species landscape and biodiversity in Sardinia.

Sheng Qiang
Nanjing Agricultural University - Nanjing - PR China
The survey and analysis of exotic weeds in China.

Mashhor Mansor
University Sains Malaysia - Minden - Malaysia
A comparative study of invasive plants in Malaysian natural and disturbed habitats.

17:30 - 18:00 - Coffee break

Piotr Medrzycki
Uniwersytet Warszawski - Bialowieza - Poland
The invading plant and man - an interspecific relation Functional and evolutionary approach.

Barbara Tokarska-Guzik
University of Silesia - Katowice - Poland
History of studies of invasive alien plants in Poland.

László Udvardy
University of Horticulture and Food Industry - Budapest Hungary
Some remarkable instances of invasion of *Ailanthus altissim.* **in Hungary.**

Ewald Weber
Swiss Federal Research Station for Fruitgrowing, Viticulture an Horticulture - Wädenswil - Switzerland
Risk assessment of future weed invasion into Switzerland.

THURSDAY, 14TH OCTOBER 1999

8.00-13.30 - III session - Chairman: Sandro Pignatti

Carol Horvitz
University of Miami - Coral Gables - U.S.A.
Effects of exotic vines on forest regeneration: A post-hurrican restoration experiment in Florida's subtropical hardwoo forests.

Fugo Takasu
Nara Women's University - Nara - Japan
Modeling the range expansion of pine wilt desease in Japan.

Eric Tabacchi
Centre d'Ecologie des Systèmes Aquatiques Continentaux Toulouse - France
Invasions of riparian ecosystems by exotic plants species patterns and causes.

David Tickner
University of Birmingham - Birmingham - United Kingdom
Hydrology as an influence on Invasion: Experimenta investigations into competition between the Alien *Impatien glandulifera* **and the Native** *Urtica dioica* **in the UK.**

Francisca Aguiar
Instituto Superior de Agronomia - Lisboa - Portugal
Alien perennial plants in an Iberian regulated river.

James P. Bennett
University of Wisconsin - Madison - U.S.A.
Type Characters of Non-Native Plant Species in Great Lake National Parks, USA.

Susan Donaldson
University of Nevada - Reno - U.S.A.
Community-based efforts to control early invasion of tal whitetop (*Lepidium latifolium*) in the Lake Tahoe Basin.

Raj Prasad
Canadian Forest Service - Victoria - Canada
The Ecology of Invasive Alien Plants: Mechanisms o invasiveness of the exotic weed, Scotch broom *Cytisus scopariu* (L.) Link, **in British Columbia.**

11.30 - 12:00 - Coffee break

Betsy Hickey
University College Dublin - Dublin - Ireland
Natural seedbanks, seedling growth and survival in areas invaded by *Gunnera tinctoria*.

Harold Avery
University of California - Riverside - U.S.A.
Effects of exotic vegetation on the nutrition and ecology of a model herbivore, the threatened desert tortoise (*Gopherus agassizii*) in the Mojave National Preserve, USA.

David Bass
Flinders University - Adelaide - Australia
The ecological interactions between weeds and animals in Australia.

Maria Zajac
Jagiellonian University - Cracow - Poland
Success factors of mountain massifs penetration by kenophytes: an example from the northern part of the Polish Carpathians and the Sudetes.

13.30- 15.00 - Lunch

15.10-19.30 - IV session - Chairman: Petr Pysek

Montserrat Vila
Centre de Recerca Ecologica i Aplicacions Forestals - Bellaterra - Spain
Post-dispersal seed predation controlling *Opuntia* spp. invasion in Mediterranean communities.

Laura Celesti Grapow
Università La Sapienza - Roma - Italy
The importance of Alien and Native Species in the Urban Flora of Italy

Carl E. Bell
University of California Cooperative Extension - Holtville - U.S.A.
California Exotic Pest Plant Council; the role of the NGO in the problem of invasive plants.

Katerina Bimova
Czech University of Agriculture - Kostelec - Czech Republic
Comparative study of *Renoutria* taxa control.

Lois Child
Loughborough University - Loughborough - United Kingdom
Strategic invasive plant management, linking policy and practice: a case study of *Fallopia japonica* in Swansea, South Wales, UK.

Giulia Ceccherelli
Università degli Studi di Sassari - Sassari - Italy
The Effect of the two Invasive Tropical Algae *Caulerpa taxifolia* and *Caulerpa racemosa* on the Native Seagrass *Cymodocea nodosa* in the Mediterranenan.

Diane Larson
US Geological Survey - St. Paul - U.S.A.
Relative effects of native vegetation type, anthropogenic disturbance, and stochasticity in alien plant invasion of a mixed-grass prairie preserve.

17:30 - 18:00 - Coffee break

Maria A. Colasante
Università La Sapienza - Roma - Italy
Annual papavers: taxonomically complex weeds.

Anne C. Cully
Kansas State University - Manhattan - U.S.A.
The effects of size and fragmentation on invasion of tall-grass prairie fragments by non-native plant species

Livio Poldini Livio
University of Trieste - Trieste - Italy
Relationships between neophytes and disturbance factors in th North-Adriatic Karst.

FRIDAY, 15TH OCTOBER 1999

9:00 - 13:30 - V session - Chairman: Fugo Takasu

Erika Zavaleta
Stanford University - Stanford - U.S.A.
Valuing ecosystem services lost to *Tamarix* invasion in th United States.

Heinke Jaeger
Oldenburg University - Oldenburg - Germany
Impact of the introduced tree *Cinchona pubescens* on the nativ flora of Santa Cruz Island, Galapagos.

Don Mattheus
Heathdon Agricultural Services - Wodonga - Australia
Australia's 13 most unwanted.

Bohdan Prots
University of Sheffield - Sheffield - United Kingdom
Growth responses of *Impatiens glandulifera* Royle to CO enrichment.

Alicia Prowse
Bolton Institute - Bolton - United Kingdom.
Ecological impact of the invasive alien *Impatiens glandulifer* (Himalayan Balsam) on native vegetation in north wes England.

11:00 - 11:30 - Discussion
11.30 - 12:00 - Coffee break

Baki Bin Bakar
University of Malaya - Kuala Lumpur - Malaysia
Spatio-temporal dynamics of *Mimosa quadrivalvis* L. va *leptocarpa* (DC.) syn. *Shrankia leptocarpa* populations i Peninsular Malaysia.

Gérard Balent
INRA-SAD - Toulouse - France
Landscape level to assess *Acacia mearnsii* invasion in th Réunion Island (Indian Ocean).

John H. Brock
Arizona State University - Tempe - U.S.A.
Seed banks of *Elaeagnus angustifolia* (Russian olive) i northeastern Arizona.

GabrielaWozniak
University of Silesia - Katowice - Poland
Invasive plants in course of primary succession on coal-min sedimentation pools Upper Silesia (Poland).

13.30- 15.00 - Lunch

15:30 - 19:30 - VI session: Posters

Ore 21.00 - Social Dinner

SATURDAY, 16TH OCTOBER 1999

Excursion

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ORCHIDS AS INVASIVE PLANTS

Wojciech Adamowski

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Extinction or endangerment of many orchid species is well known fact. However, also in this group one can find invasive species. The paper include list of more than twenty taxons, spreading in new countries and even invading natural plant communities.
European *Epipactis helleborine* occurs in a variety of anthropogenic habitats and broad-leaved forests in Eastern part of Northern America. In western Europe, on pine and spruce plantations, boreal orchids *Goodyera repens* and *Listera cordata* are spreading. In tropical zone most successful invaders are African species: *Oeceoclades maculata* in Southern and Central America and *Monadenia bracteata* in Western and Southern Australia. Some orchids, commonly cultivated, escape in two geographical regions, e.g. *Epidendrum o'brienianum* in Eastern Australia and Hawaii Islands. Most rich in naturalised orchids are Central America and Hawaii Islands.
Common characters of many invading orchids are:
- quick development (*Oeceoclades maculata* 1 year from seed to flower in favourable conditions!)
- autogamy
- apomixis
- wide ecological amplitudes
- broad natural distribution

In most cases, intentional human activity (cultivation) was very important factor for further successful spreading. Unintentional activity (transformation of habitats, accidental introductions) seems to be of similar importance.
This phenomenon can be more common, particularly in tropical countries, where orchid flora is rich, and conditions for cultivation more favourable.

THE MANOR PARK IN BIALOWIEZA AS A NASCENT FOCUS OF PLANT INVASIONS IN BIALOWIEZA FOREST (NE POLAND)

Wojciech Adamowski and Piotr Medrzycki

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English landscape parks, botanical gardens and *arboreta* are widely known to be sources of propagules of alien plants being cultivated there and the susceptible habitat for first invasion steps. This is an effect of the high number of cultivated *taxa* and the diversity of habitats, including these almost natural.
These processes occurs also in all landscape parks in Bialowieza Forest. This is the especially the case with the Manor Park (ca. 50 ha). When it was established in the end of XIX century around the Russian tsar's hunting palace, several species of non-indigenous trees and shrubs have been planted. Many of them perfectly regenerated, created self-sustainable populations and spread widely around the park, including the most valuable in the all Bialowieza Forest primeval stands of the Strict Preserve.
The paper contains the complete list of the woody species being considered non-native in the Bialowieza Forest, that occur in the Manor Park and colonise natural or semi-natural plant communities. Data on the time and the range of their invasion are provided, together with maps of distribution for selected *taxa*. Most widespread woody alien *taxa* are *Sambucus racemosa*, *Acer negundo, A. pseudoplatanus* and *Quercus rubra* (Adamowski, Medrzycki and Luczaj, 1998). However, juvenile individuals of some woody cultivars are also observed, e.g.: *Quercus robur* 'Fastigiata', *Fraxinus excelsior* 'Pendula'.
The special meaning of the Manor Park as the nascent focus of invasions is additionally determined by following factors:
- the localisation in the centre of forest complex;
- the presence of abandoned farmlands in the close vicinity of the Park;
- the intensity of the tourism within the park (hotels, restaurants).

Taking into consideration all these facts makes it possible to treat the landscape mosaic of 100-year-old English park as model object for studying alien species' invasions and predicting their further behaviour.

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SUCCESS OF EARLY ERADICATION: THE CASE OF *IMPATIENS PARVIFLORA* IN BIALOWIEZA NATIONAL PARK (NE POLAND)

Wojciech Adamowski (1) and Andrzej Keczynski (2)

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Impatiens parviflora, one of the most common invaders in Europe (Trepl 1984) has been spreading in the Bialowieza Forest for about 25 years. Having encountered a site of its occurrence in the Strict Reserve of Bialowieza National Park, attempts were made to stop its expansion (Adamowski and Keczynski, 1998). Every year (1991 - 1998; one to four surveys in summer months) the individuals of this species found in the National Park were carefully removed; plant material was dried in 105 °C, to prevent dissemination of viable seeds. This led to almost complete extirpation of *Impatiens parviflora* population. Surveys will be continued several years after extirpation to prevent reappearance of the species from seed bank.

The wide spread of the species in the western part of the Bialowieza Forest makes impossible its total elimination. However, every effort is undertaken to prevent the expansion of the species at least in the close vicinity of the Strict Reserve, e.g. at the Bialowieza Clearing, to build a buffer zone. A significant delay of spread of *Impatiens parviflora* into forest communities of the Bialowieza National Park is expected.

The success of this action is an example, that early start is a warranty of efficient eradication, achieved with simple, non-destructive and non-expensive methods.

ALIEN PERENNIAL PLANTS IN AN IBERIAN REGULATED RIVER

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The River Mondego (CW of Portugal) has been subjected to regularisation of its lowlands on the late seventies, for flood defence, irrigation and land drainage purposes. The alluvial flood plain, Baixo Mondego, has about 15,000 hectares occupied mainly by rice and other highly water-consuming Mediterranean crops (INE, 1993), crossed by drainage and irrigation channels and ditches, and by the resectioned river ('New Mondego') in a extension of about 40 km. This segment was subjected to mechanical reprofiling by dredging, straightening and to a two-stage bank reinforcement. Some promoted stone areas were positioned on the riverbed.

A detailed survey of aquatic and riparian plants was performed in May-June 1999, on six reaches along the New Mondego. On each site, three longitudinal transepts (A, B and C) were studied, with five 5 x 25 m plots. The first transept was positioned on the water and the in-stream side of the bank and the others on the two-stage terraces of the bank.

All species were identified. Its cover was visually estimated, as well as the total tree cover and herbaceous cover. Distance and height above the water were measured for each plot, and substrate composition was visually estimated. For each site, the following variables were considered: distance to the sea, water conductivity, type of land use, average depth and average bank width.

A canonical correspondence analysis using Program CANOCO ver. 4.0 1998 (Ter Braak, 1995) was used to analyse the relations between species and environmental variables and NTSYSpc ver. 2.0 1997 (Numerical Taxonomy System) was used for the hierarchical classification of the data.

Alien cover was dominant in many plots, though alien plant richness was only about 10% of the total flora. Dominant alien species were *Acacia dealbata* Link and *Eryngium pandanifolium* Cham. and Schlecht., however *Paspalum paspalodes* (Michx) Scribner and *Tradescantia fluminensis* Velloso were also largely disseminated.

Results of multivariate analysis are displayed in Figure 1: eight variables explained 40.3% of the total species variation. The first axis shows a clear transversal variation, with a high correlation with the transept height and distance to the water (0.93 and 0.97 of inter set correlation, respectively), showing the effects of river regularisation on the species composition. The second axis illustrates the longitudinal variation, opposing conductivity, depth and bedrock substrate to distance to the sea.

The invasiveness of the South American alien *E. pandanifolium* was clearly defined on the two reaches closer to the sea (transepts A and B) and was progressively substituted by *P. paspalodes*, corresponding to a promoted area. *T. fluminensis* was dominant on transept B along all the studied area. *A. dealbata* invades specially the transepts more distant from the water, and on reaches with more intensive agricultural use and further away from the sea.

Figure 1: Axis I and Axis II of the canonical correspondence analysis, showing the position of the environmental variables, species and plots (ordered by increasing distance to the sea); only dominant alien species are indicated. DSEA-distance to the sea; COND-water conductivity; LAND USE-land use; DEPTH-average depth; BWIDTH- average bank width; SAND/CLAY-fine substract elements;BEDROCK-bedrock; HEIGTHW-height above water; DISTW- distance to the water

References

INE (Instituto Nacional de Estatística). 1993. *Portugal Agrícola*. Instituto Nacional de Estatística, Lisboa, 258 p.

Ter Braak, C.J.F. (1995). Ordination. In Jongman, R.H.G., Ter Braak, C.J.F. and Van Tongeren, O.F.R. (eds.) *Data analysis in Community and Landscape Ecology*. Cambridge University Press, Cambridge, UK: 91-173.

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THE EXOTIC AND INVASIVE FLORA OF PORTUGAL

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This survey of the introduction of exotic plants in Portugal in the last two centuries showed an important increment during the last decades, reaching now a preoccupying figure of more than 14 % of the Portuguese flora. In this paper we present a report of the actual situation in Portugal, based on a large amount of bibliography, *herbarium* specimens and field studies. We have also considered the distribution of these species according to the Portuguese administrative regions (provinces), and the effect of their different demographic and social patterns.

ACACIA INVASION ON PENA PARK (CENTRE OF PORTUGAL)

J. Alves (1), Ilídio Moreira (2), Maria Cristina Duarte (3) and J. Monjardino (4)

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The "Parque da Pena" is a historical park situated in the stony slopes of Serra de Sintra, a coastal granitic mountain at west from Lisbon. It was founded by the king D. Fernando II at the middle of the XIX century. This park is included in the "Parque Natural de Sintra-Cascais", a natural park under the administration of the Instituto da Conservação da Natureza, a state department for nature conservation. The topography and the mild climate of this region allowed the successfully establishment of species from all over the world. The diversity and the notability of the introduced flora turned this park not only a space for leisure but also a field laboratory for research studies. In the last years the floristic richness of the Parque da Pena has been reduced. The naturalisation of some of the cultivated species and the lack of control measures are some of the main causes for the present situation. In the sixties Azevedo Gomes published a monograph about the flora of this park. This work is noteworthy for the accuracy of the descriptions. Gomes (1960) pointed out the most notable trees and made some remarks about invading alien species, such as *Acacia melanoxylon*, *Acacia dealbata*, *Hakea salicifolia* and *Pittosporum undulatum*. The comparative analysis of the data published by Gomes in 1960 and those acquired in field work in 1999 will allow to study the evolution of the invading woody flora in the last forty years. In 1967 a fire caused severe damages in some areas of the park. The consequences of this fire in the spread of alien species would also be evaluated. Finally the field survey will allow the recognition of the presently naturalised woody species and the assessment of its invading potential. A better knowledge of these topics would be very useful to establish priorities for the control of alien species and to prevent the spread of new invaders throughout the area.

OSSERVAZIONI SUL COMPORTAMENTO DELL'AILANTO NEGLI SPAZI VERDI DI SIRACUSA

A. Attardo (1) and A. Trigilia

(1) Assessorato Agricoltura e Foreste
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Italia

La presenza di una vegetazione infestante nei monumenti, sui manufatti d'interesse storico-artistico, nelle zone archeologiche, nelle riserve naturali e nei girdini storici, pone per le trasformazioni che può indurre sui materiali e negli organismi viventi, degli evidenti problemi di gestione.
Oggi in Sicilia, sopìrattutto *Ailanthus altissima*, *Robinia pseudoacacia*, ma anche *Broussonetia papyrifera* e *Nicotiana glauca*, favorite dalle condizioni di illuminazione, si diffondono rapidamente per la loro capacità di emettere polloni radicali e per il loro potere di disseminazione.
La lotta a queste specie pone problemi assai delicati perché anche da minuscoli frammenti di radice possono rigenerarsi nuove piante.
Gli autori hanno osservato da alcuni anni il comportamento dell'ailanto nel territorio provinciale di Siracusa. Formazioni recenti sono state riscontrate in territorio di Buscemi - Palzzo Acreide nell'Alta valle dell'Anapo, in zone agricole lungo il corso del fiume a breve distanza dalla riserva naturale di Pantalica.
Colonie ormai decennali si propagano in C.da Rinaura, a meno di 500 metri in linea d'aria dai resti del Tempio di Giove e della riserva naturale Ciane - Saline.
Interi complessi architettonici (masserie, frantoi, case rurali) ma anche semplici manufatti in pietra come stalle e ricoveri per animali, cisterne, "senie", "saie" e muri a secco sono gravemente danneggiati.
L'ailanto oltre che propagarsi nelle aree agricole e forestali ha conquistato grandi porzioni di territorio anche all'interno del perimetro cittadino di Siracusa, colonizzando alcuni vuoti urbani i più significativi giardini storici pubblici e privati, nonché le più interessanti e suggestive aree archeologiche della antica polis di Siracusa, Akradina.
L'acquisizione di maggiori conoscenze sulle relazioni che intercorrono tra le componenti biologiche vegetali, i substrati ed i fattori ambientali, potrà permettere l'individuazione, non solo della capacità della specie di arrecare danno, ma anche delle potenzialità di propagarsi e diffondersi.
Tali conoscenze scientifiche potranno adeguatamente tradursi in benefici per la società soltanto a condizione che siano supportati da idonei interventi legislativi e politici.

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IPOMOEA MUTABILIS LINDL. (*CONVOLVULACEAE*) COLTIVATA SPONTANEIZZATA A SASSARI (SARDEGNA, ITALIA)

Aldo Domenico Atzei

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Università degli Studi di Sassari
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Viene segnalata come coltivata spontaneizzata a Sassari (Sardegna, Italia) *Ipomoea mutabilis* Lindl. (=*I. dealbata* Hemsl. = *I. leàrii* Meiss. non Paxt. = *Pharbitis mutabilis* Bojer) (*Convolvulaceae*), dell'America tropicale, che non ci risulta segnalata come spontaneizzata in Italia nè nel bacino del Mediterraneo. La stazione è ubicata alla periferia della città, in zona Baldedda, su un terreno comprendente la siepe stradale, una zona incolta degradante in un ampio fossato in parte adibita a discarica abusiva, e un piccolo tratto confinante coltivato ad oliveto, su una superificie di circa 1200 m2, nonché dal lato opposto della strada e confinante con la ferrovia, un giardino abbandonato, anche questo parzialmente utilizzato come discarica, su una superficie minore diu circa 150 m2, per un totale di circa 1350 m2. Nel periodo vegetativo (fine primavera - inizio autunno) la specie ricopre interamente il terreno e le piante spontanee presenti, raggiungendo la chioma degli alberi di olivo coltivato.
La specie presente è perenne, munita di rizoma lungo e grosso da cui si dipartono lunghissimi esili fusti rampicanti fioriferi, afoglia in prevalenza profondamente 3-loba ma anche intera o con lobi accennati, fiori in grappoli di (1-)3-5(-7), corolla lunga 6,5-7,5 cm e larga 8-9 cm, azzurra, a tubo e 5 costolature rosee, diventante rosea con l'essicamento. Per alcuni caratteri (lunghezza della foglia e del calice, costole rosee rispetto al resto azzurro della corolla) si avvicina a *I. indica* (Burm.) Murr. (= *I. acuminata* (Vahl) Roemer and Schultes = *I. leàrii* Paxton = *Pharbitis cathartica* (Poiret) Choisy = *Convolvolus indicus* Burm.), naturalizzata alle Azzorre, Baleari, Portogallo, Francia, Malta e Sicilia, ma presenta la pagina superiore della foglia minutamente peloso-sericea (e non glabra), quella inferiore canescente argentina. D'altra parte i campioni non rientrano in nessuna delle altre specie perenni trattate dalla Letteratura consultata.
Attualmente sono in corso lavori di riempimento del fossato interssato e la specie è rimasta accantonata su una superficie residua, ma ancora rappresentativa della spontaneizzazione.

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NATIVE PLANT SPECIES RICHNESS AND INVASIBILITY OF ECOSYSTEMS

Harald Auge, Uwe Amarell, Roland Brandl, Stefan Klotz, Jutta Stadler

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Invasive species are not randomly distributed over biological communities. Thus, one major question concerning success or failure of invasions is: What characteristics make a community invasible by alien species? Theoretical considerations predict a higher chance of establishment of alien species in species-poor communities compared to communities of a high diversity of native species. We tested this prediction for invasive plants using (1) species lists of 20 political districts in south-western Kenya, (2) the flora of 17 cities in central and e*Aster*n Germany, and (3) a gradient of floristic diversity across 400 pine forest sites in central Germany.
Compiling the three data sets, we found a consistent pattern despite the different spatial scales and biogeographic regions considered: In each case, species richness of alien plants was positively correlated with species richness of native plants. Moreover, the proportion of alien plant species increased significantly with increasing diversity of native plants. Thus, in contrast to our prediction, the species-rich communities or regions investigated are not more resistant against biological invasions than the species-poor ones.

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SPATIO-TEMPORAL DYNAMICS OF *MIMOSA QUADRIVALVIS* L. VAR. *LEPTOCARPA* (DC.) BARNEBY SYN. *SHRANKIA LEPTOCARPA* POPULATIONS IN PENINSULAR MALAYSIA

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Mimosa quadrivalvis L. var. *leptocarpa* (DC.) Barneby was first detected in Peninsular Malaysia in by Baki *et al.* (1993). It was a new species record for Malaysia and Malaesia. Subsequent field surveys conducted in 1994 and 1998 recorded increased infestation of the weed from small localised pockets in Penang to areas hitherto uncolonised in Perlis, Kedah and Penang states in northern Peninsular Malaysia, usually on inseptisol, vertisol, ultisol and entisol soils. The weed populations were highly clustered with Ip (Lloydís patchiness index) values ranging from 64.89 to 121.84. The Lloydís mean crowding (m*)-to-Lloydís mean density (m) ratios of fruit-bearing populations registered values ranging from 31.08 to 57.86. Field populations displayed erratic oscillations and this apparently was due to high mortality of seedlings. Each plant produced ca. 11,550 seeds/year with 98.23% viability. Only about 5.75% of the seeds produced emerged as seedlings out of which only 24.85% became successful colonisers of open space. There is a slight increase in fruit-bearing adult populations of 2.54%/year over the 1994-1998 period. This was translated as an increase of seed bank populations in soils (5.95%/year) over the same period. The seeds display both primary and secondary dormancy. The plant exhibited robust clonal growth producing many primary and higher order stolons, which in turn act as fruit- and seed-bearing entities and resource-capture. Arguably, high seed production capacity coupled with robust and aggressive clonal growth identify *M. quadrivalvis* as an invasive weed to watch in Peninsular Malaysia.

Key words: *Mimosa quadrivalvis* var. *leptocarpa*, *Shrankia leptocarpa*, spatio-temporal dynamics, seed banks

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LANDSCAPE LEVEL TO ASSESS *ACACIA MEARNSII* INVASION IN THE REUNION ISLAND (INDIAN OCEAN)

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Hierarchy theory, which suggests that higher levels of organization incorporate and constrain the behaviour of lower levels, highlights the interest to assess plant invasions at different levels of organization, including landscape level. The paper presents the integration of landscape level in order to assess the process and the impact of *Acacia mearnsii* in the western and southern slopes of Reunion Island (French Overseas Territory, Indian ocean).

In Reunion Island, the patterns of *A. mearnsii* invasion are highly correlated to landscape changes and landscape structure. Introduced in 1887, this exotic species was planted in the 1950s by forestry services, mainly on high slopes above the pelargonium cropping zones. In 1962, an important crisis of pelargonium production provided many safe sites, lands relinquished by farmers, where the invasion began. The colonisation of landscape was then spatially correlated to the organisation of ravines, riparian corridors and gullies. Today, *A. mearnsii* is observed in ravines at a very low altitude, probably with the help of hurricanes (as Firinga in 1989) which facilitate the transport of pods. Mainly from these corridors, this plant has then colonised new safe sites in rural areas. There, main invasion patches consist of long and narrow bands limited by the boundaries of abandoned land ownerships.

In return, landscape attributes are modified by *A. mearnsii* invasion. Species richness of birds is lower in areas with *A. mearnsii* stands. Total plant cover at the ground level is lower, though aboveground phytomass is higher. On the other hand, this invasion doesn't seem to have incidence on fire propagation.

Both process and impact of *A. mearnsii* are still very linked to the evolution of agriculture. Some economic opportunities can favourish *A. mearnsii* clearing in order to produce new crops, but *A. mearnsii* woods can recover very quickly from seed-banks if land is abandoned again.

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INVASIVE ALIEN PLANTS THREATENED THE NATURAL VEGETATION OF ÖRSÉG LANDSCAPE PROTECTION AREA (WESTERN HUNGARY)

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Örség Landscape Protection Area (ÖLPA) (380 km^2) is situated in Western Hungary, along the Austrian-Slovenian border (h. a.s.l. 194-386 m). The landscape is characterised by deep valleys and flat-ridged hills. The northern part lowers to the flood plain of Rába, which is the greatest river in Western Hungary. Its natural conditions are determined by the transitional situation between the Alps and Transdanubia. Rivers and streams belong to the drainage area of Rába, Lake Balaton and of the Mura-Drava river-system. The original flora can be characterised as a mixture of Atlantic, Submediterranean and Central European floristic elements. Great number of dealpine-montane elements, postglacial relicts and more than a hundred protected or endangered species make it one of the most valuable and beautiful area in Hungary. The most typical plant associations, according to Kovács (1999), are as follows: *Genisto-Pinetum, Galio rotundifolio-Fagetum, Luzulo-Querco-Carpinetum* in the woody vegetation; *Carici brizoidis-Alnetum, Molinion, Filipendulo-Petasition* in valleys; *Leucojo aestivi-Salicetum albae* along the rivers and *Caricion fuscae, Deschampsion, Arrhenatherion, Nardetalia* in herbaceous vegetation. Our examinations were carried out between 1993 and 1998. The main aim was to investigate the role these adventive invasive plants play in the transformation of the original vegetation. Recent distribution of adventive invasive species was illustrated on UTM maps. There are also registered those associations that are invaded by these *taxa* entered into the various units of natural vegetation. On the basis of the coverage degree, these plant *taxa* can be ordered as follows: *Solidago gigantea* Ait. has the largest distribution, often forming (sub)monodominant stands; mainly in the flood areas of rivers and streams, mostly endangering the associations that belong to *Phragmitetea australis* R. Tx. *et* Preising 1942 and *Molinio-Arrhenatheretea* R. Tx. 1937, and secondly along the roadsides by the sides of abandoned fields. *Fallopia* x *bohemica* (Chrtek and Chrtková) J. Bailey frequently forms monodominant stands, mainly in the flood area of Rába, often invading the lower layers of *Leucojo aestivi-Salicetum albae* Kevey in Borhidi *et* Kevey 1996. (The hybrid's parent species *F. japonica* and *F. sachalinensis* are unknown from the area.) *Helianthus tuberosus* L. agg. and *Impatiens glandulifera* Royle often form (sub)monodominant stands mainly in the flood areas of Rába and Zala, endangering mostly the associations that belong to *Phragmitetea australis* and *Salicetea purpureae* Moor 1958. Similar habitats are colonised by the following species, but less frequently than the previous ones: *Aster lanceolatus* Willd., *Echinocystis lobata* (Michx.) Torr. *et* Gray and *Rudbeckia laciniata* L. Only a few localities of *Asclepias syriaca* L., *Amorpha fruticosa* L., *Heracleum mantegazzianum* Somm. and Lev. are recently known. It became clear that there is a slight difference only between the degree of invasion of natural / seminatural habits of Ölpa and other parts of Western Hungary. The *exsiccata* are deposited in the *herbarium* of the Savaria Museum (Szombathely).

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THE ECOLOGICAL INTERACTIONS BETWEEN WEEDS AND ANIMALS IN AUSTRALIA

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Environmental weeds are almost universally regarded as detrimental. These weeds modify ecosystems, alter natural biodiversity, and promote landscape degradation. In many disturbed ecosystems, especially those that have suffered significant native plant clearance, weeds may provide significant habitat resources. Data from camphor laurel (*Cinnamomum camphora*) invaded sub tropical NE NSW, and olive (*Olea europaea*) invaded woodland in SA reveal that these environmental weeds provide shelter, feeding substrates, sites for social interaction and vegetation corridors for a range of bird species. These resources are in addition to fruit, which may be very significant for native birds that have lost significant habitat from widespread clearance for agriculture. The implications for weed management and landscape rehabilitation are profound. Where weeds are to be removed there should be an assessment of the ecological role they play. There is a significant spatial and temporal scale to this issue. The lag between weed removal and establishment of mature native vegetation may exert significant stress on local fauna, which may already be suffering stress from the previous clearance of native vegetation. A program of weed removal should plan the location of its activities not just to take advantage of access but provide a level of continuity of vegetation for use by birds. The lesson to be learned from this approach is to realise that animals are more likely to recognise a weed as a plant rather than some noxious entity. The rate of vegetation change from a native to more weedy state has been detrimental; the rate of change from weedy to rehabilitated vegetation may be the last nail in the coffin for some threatened species.

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THE IMPORTANCE OF POPULATION GROWTH AND SEED DISPERSAL ECOLOGY IN DETERMINING INVASIVENESS OF FRUITING WOODY PLANTS IN AUSTRALIA

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This paper examines the relative invasiveness of two woody species, *Crataegus monogyna* and *Prunus mahaleb* and highlights implications for assessing invasion risk. The species are closely related and have similar habits and overlapping home ranges in Europe. The species have fleshy fruits and vertebrate dispersed seeds characteristic of many ornamental escapes. *C. monogyna* was introduced to Australia mainly as an ornamental and hedge plant with extensive plantings throughout southeastern Australia. *P. mahaleb* was introduced as rootstock for orchard trees and has only one recorded infestation in Australia. The project was focused on the Northern Tablelands of New South Wales. *C. monogyna* is very invasive in the region, having spread rapidly and conspicuously throughout northern New South Wales and elsewhere in southern Australia at rates of 80 - 120 m yr^{-1}. *P. mahaleb* is far less invasive, being restricted to a small population near Armidale, which is expanding at 20 m yr^{-1}. Demographic analysis utilising modified Leslie matrices showed that potential growth rates (expressed as the dominant latent root of transition matrix) of *P. mahaleb* (1.713 - 1.490) are greater than those for *C. monogyna* (1.138 - 1.103). Assessment of the seed dispersal ecology of both species revealed that *C. monogyna*, an autumn-winter fruiting species, had seeds dispersed by one bird and three mammals over many kilometres. *P. mahaleb*, a summer fruiting species, had seeds dispersed by six birds and four mammals over distances generally less than 100 m.

The main factors determining the difference in invasiveness between the two species relate directly to the changing nature of human management of each species and the ecological interactions between the plants and the invaded environment. *C. monogyna* was widely and extensively planted in hedges and gardens that provided many foci for further and accelerated spread facilitated by vertebrate seed dispersal. *P. mahaleb* was not planted widely and as result spread relatively slowly from a single focus. Despite a more rapid population growth rate *P. mahaleb* had seeds dispersed only relatively short distances compared to *C. monogyna* that has seed dispersed over many kilometres. This research has implications for the prediction and management of biological invasions; emphasising the importance of seed dispersal and human activities in determining the course of invasions: both of which cannot be readily predicted.

THE 1st INTERNATIONAL WORKSHOP ON WEED RISK ASSESSMENT

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The '1st International Workshop on Weed Risk Assessment' was held in Adelaide, Australia in February 1999. Weed risk assessment (WRA) is the use of a standard, scientifically-based, decision making process to determine the relative weed threats posed by various plant species. The Workshop brought together 55 scientific and policy experts from eight countries to discuss best practice techniques to predict weediness and to prioritise weed species for control. The Workshop first considered three major criteria of WRA systems; invasiveness, impacts and potential distribution.
Important factors identified for invasiveness were weed history, reproductive ability, dispersal ability, habitat invasibility, native latitude range and introduction pressure. Types of impacts needing assessment were competition with desired vegetation, changes to ecosystem structure and functioning, effects on animal and human health, reductions in biodiversity, restrictions on movement, hosts for pests and diseases, loss of markets, cost of control measures and beneficial uses. The potential distribution session reviewed climate-based models to predict weed distribution, with CLIMEX and CLIMATE being most useful. Discussion on predicting weediness examined the strengths and weaknesses of the system recently implemented by Australia. The final session compared USA, New Zealand and Australian WRA systems to prioritise weeds for control, recognising many similarities. Issues frequently raised were the need to share weed data for WRA decisions (e.g.. weed lists, distributions, biology, impacts), to develop standard approaches between States and Countries, to ensure research meets the needs of policy makers, and to keep WRA decisions transparent to the community. Working groups were formed with actions beyond the Workshop to develop international standards for WRA, improve global sharing of weed data and develop a protocol for early action against new weed incursions. The proceedings of the Workshop are to be published, with details on the Workshop's website (*http://www.hear.org/iwraw/index.html*).

CALIFORNIA EXOTIC PEST PLANT COUNCIL; THE ROLE OF THE NGO IN THE PROBLEM OF INVASIVE PLANTS

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The natural landscape of California, with more than 5,800 native species, 24% of whom are endemic, is one of the most biologically rich in the temperate climate zones in the world. Human settlement has disrupted much of this landscape, principally by physical alteration, but also by the widespread introduction of non-native plants. At present, over 1,000 non-native species have become established in California. In response to this impact on biological diversity, particularly in natural areas, a group of concerned citizens, scientists, and land managers came together in 1992 to create the California Exotic Pest Plant Council (CalEPPC). The objectives of CalEPPC are to facilitate communication about invasive pest plants, to educate professionals and the lay public on this issue, and to facilitate and help coordinate detection, research, and control efforts. Important activities of CalEPPC include hosting an annual Symposium, co-hosting symposia and workshops with other groups, publishing an educational newsletter and other documents, maintaining a website, managing and soliciting grant funds for control projects, and providing expert testimony for political entities on public policy issues relating to exotic pest plants. The diversity of CalEPPC's membership, currently at 800, which includes academics, public agency professionals, private environmental consultants, members of environmental organisations, and many private citizens, strengthens the CalEPPC's ability to educate and to influence public policy. The problem of invasive species is larger than the ability and resources of public agencies to solve alone. CalEPPC, by providing a forum for common interests and action, has assumed a vital role in the management of exotic plants in California.

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WHY IS *BIDENS FRONDOSA* MORE SUCCESSFUL THAN NATIVE *BIDENS* SPECIES ?
I. HABITAT PREFERENCES

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Bidens frondosa is an annual species of *Asteraceae*, of the North American origin. It occurs from the north Canada to the south of U.S.A., where it growths mainly on riversides, at the shores of water reservoirs, in pastures, along roads, in gardens, in fields and in various waste places, all with higher soil moisture. The *genus Bidens* has three native representatives in Czech Republic, namely *B. tripartita*, *B. cernua* and *B. radiata*, but alien *B. frondosa* is more successful in competition with them. It expands to the detriment of the native species. In comparison with the native species, typically occurring only on wet sites, *B. frondosa* is able to grow also in relatively dry, mostly ruderal sites. Two species - *B. frondosa* and *B. tripartita* - were experimentally grown in a greenhouse, in mixture and separately. Two substrate types, differing in the amount of nutrients, were used and two types of moisture regime were applied: the variant receiving 0.5 litre of water three times a week and the variant with water level permanently at the soil surface. *B. frondosa* grew better under lower water table, on the other hand *B. tripartita* needed permanently wet soil to be able to grow successfully. Phytosociological data were collected in the field and elaborated by the PCA (Principal Components Analysis) ordination method. The results also illustrate that *B. tripartita*, *B. cernua* and *B. radiata* require higher site moisture than *B. frondosa*, occurring together with species such as *Lemna minor*, *Glyceria maxima* and *Polygonum hydropiper*. Based on the results of the experiments and the analysis of the phytosociological data it can be concluded that *B. frondosa* grows well and occurs in a broader variety of site moisture conditions than the native *Bidens* species, which are restricted to stands with high water level. Thus the occurrence of native species seems to be more limited by site conditions in comparison to *B. frondosa*.

WHY IS *BIDENS FRONDOSA* MORE SUCCESSFUL THAN NATIVE *BIDENS* SPECIES?
II. SEED PRODUCTION AND SEED DISPERSAL

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In its secondary range, *B. frondosa* invades natural stands of native species *Bidens cernua*, *Bidens radiata* and *Bidens tripartita*, and often outcompetes them. Seed production and dispersibility were suspected to contribute to its success. Together 30 individuals of each species were randomly selected in the field at the time of ripening. Plant height, number of heads and number of seeds in 30 randomly selected heads in the particular order were determined. There were differences within species and among the species in the number of seeds in heads of different order. The highest number of seeds was found in the heads of *B. radiata* followed by *B. cernua* and the last was *Bidens frondosa*. *B. frondosa* was found to be the highest among the all *Bidens* species and possessed the highest number of heads. It resulted into the highest average seed production per plant of this alien species among the all *Bidens* species. The potential for epizoochory was evaluated by an experiment in which we threw seeds from the height of 65 cm on the piece of cloth: fleece, and 100% PAD, which differed in their surface structure. The cloth was then lifted to the vertical position and seeds that remained on the cloth were counted. The seeds of *Bidens cernua* with four "teeth", were found to be the best attached to fleece, a cloth with long hair. *B. frondosa* was most successful on the 100% PAD, which is a completely smooth cloth. The two species seem to be the best adapted to epizoochoric dispersal. As our results suggest, high reproductive capacity of *B. frondosa* and the good ability to spread by epizoochory can play important role in invasive success of this alien species.

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TYPE CHARACTERS OF NON-NATIVE PLANT SPECIES IN GREAT LAKES NATIONAL PARKS, USA

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Non-native plant species are increasing in frequency and abundance in many natural areas. In Midwestern National Parks, as much as one third of a park flora may be non-native. It was hypothesised that botanical characters of these species could be used to typify them and improve the methods of predicting invasions. Data on 20 characters of 341 non-native species from the four Great Lakes national lake shores (Apostle Islands, Indiana Dunes, Pictured Rocks, and Sleeping Bear Dunes) and invasive non-native species for the State of Wisconsin were collected and studied. For many of the species, little data could be collected, but for 139 of them, data were collected for at least 80% of the characters. The frequencies of classes of the characters were tabulated and ranked in order to typify the most common non-native species. This type species will be described in the presentation. Three species of *Cirsium*, including Canada (*C. arvense*), marsh (*C. palustre*), and bull thistle (*C. vulgare*), matched the type species better than other species. *Cirsium vulgare* occurs in more national parks than the other thistles.

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ROBINIA PSEUDOACACIA L. IN THE FORESTED AGRICULTURAL LANDSCAPE OF THE PISAN HILLS (TUSCANY - ITALY)

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Introduction

This study is part of a larger research project on transformations in the forested agricultural landscape of the Pisan Hills in the course of the last 50 years. Over time, both soil utilisation for agricultural purposes and spontaneous ground cover have undergone substantial change and fluctuation in terms of the area occupied (Bertacchi *et* Onnis, 1995). One major aspect concerns *Robinia pseudoacacia* L, an exotic species of North American origin naturalised in Tuscany. Although its presence in Tuscany was reported as early as the beginning of the 1800's (Savi, 1801), it has spread extensively over vast stretches of formerly agricultural but now abandoned land, often giving rise to monophytic populations. These may at times be found within native phytocenoses but in many cases the *Robinia pseudoacacia* populations have fully replaced the original phytocenoses.

Area of study and methodology already adopted

A close investigation of the expansion dynamics of *Robinia pseudoacacia* within the agroforest environment was undertaken on a limited area measuring roughly 900 ha, located along the western ridge of the Pisan Hills (43° 33' 36" Lat. N, 10° 28' 32" Long. E Greenwich). This sector, which reaches a maximum elevation of 97 m. above sea level, is geopedologically characterised by sands and predominantly calcareous pleistocenic conglomerates (AAVV, 1965). Its climate belongs to the Sub-Humid type (C2 B'2 sb'4) (Vittorini, 1971).

Roughly 2/3 of the area studied presents mixed agricultural soil utilisation, although large expanses of agricultural land are in effect abandoned and/or converted to other uses (e.g.. riding stables, agritourism). Roughly 30% of the area is covered by woodland, represented at the higher elevations by mixed deciduous stands dominated by *Quercus cerris* L. These stands are generally managed as coppice, often with low density conifer plantations with *Pinus pinAster* Aiton, according to the Tuscan tradition. The valley floors present hygrophilous phytocenoses of *Populus* sppl., *Salix* sppl. and *Alnus glutinosa* (L.) Gaetner interspersed with the species that also cloak the hillsides, together with microcommunities composed of *Carpinus betulus* L., *Ulmus minor* Miller and *Corylus avellana* L. In addition, *R. pseudoacacia* is present throughout, although to various extents.

During the preliminary stage of research, the historical Land Registry and a comparison between 1954 and 1997 aerial photographs were used to determine past and present vegetational typologies, and a surface mapping was drawn up. Field trips were then undertaken to verify the correspondence between the mapping and actual conditions. A floristic-vegetational investigation was also conducted, with 30 phytosociological samplings using the Braun-Blanquet method. Of these, 8 were carried out on mixed deciduous stands with predominance of *Q. cerris*; 1 on a community with predominance of *C. betulus*; 1 on a hygrophilous valley-floor stand; 1 on a *P. pinAster* pine forest and the

remaining 19 in *R. pseudoacacia* communities at different stages of maturity and degree of ground cover. In addition, several forest transects were carried out on ecotonal portions among the *Robinia* thickets and the adjacent phytocenoses.

Results and Discussion

Out of an increase, over the last 50 years, of roughly 93 ha in the area occupied by woodland (271 ha in 1954, 364 ha currently), approximately 50 ha are represented by stands of *Robinia*, which has completely invaded abandoned agricultural lands. Furthermore, in an additional total of about 25 ha, *Robinia* cenoses have almost completely replaced the previous *Q. cerris*-dominated deciduous stands.Vegetational and floristic analysis of *Robinia* stands reveals different aspects according to the age of the community. Overall, three different typologies can be identified:

(1) young stage - <5 years -: when maintained in this stage by extremely frequent cutting, *Robinia* gives rise to monophytic formations, which are virtually impenetrable and have extremely thorny suckers. No other phanerophytes or nanophanerophytes succeed in becoming established, except for *Rubus ulmifolius* Schott, *Sambucus nigra* L. and, among herbaceous plants, only a few species such as *Stellaria media* (L.) Will. and *Galium aparine* L.

(2) *Robinia* stands aged 10-15 years: *Robinia* is dominant, but other species are present, deriving from adjacent cenoses. Among arboreal species *Q. cerris* is found, but also *U. minor, C. betulus, Laurus nobilis* L., *Ilex aquilfolium* L. There is greater presence and development of *S. nigra*, and to a lesser extent *R. ulmifolius*. Among herbaceous plants *Muscari comosum* (L.) Miller, *Rubia peregrina* L., *Hedera elix* L are found. Seedlings of the above cited phanerophytes are also present.

3) "Mature" *Robinia* stands, aged 20-25 years: *Robinia* loses its structural and numerical dominance, with the resurgence of native formations.

Out of the cases investigated in this study, almost all - 17 - belonged to the first or second typology, in roughly equal quantities. In none of the cases studied were *Robinia* seedlings germinated from seed observed.

Conclusions

The rapid spread of *R. pseudoacacia* in the area studied has been caused predominantly by the direct or indirect action of man. It appears that in the 1930s and '40s, a limited number of *Robinia* trees were planted close to farmhouses for use as forage and for stake and pole production, but then they rapidly grew out of control as a result of bad management practices, or as surrounding land was left to go wild. The former case, corresponding to the first typology cited above, arose when *Robinia* was included in forest stands under assiduous coppice management (cut down at least every ten years), which allowed *Robinia* to penetrate agamously. Owing to its rapid growth habit, *Robinia* was thus able to compete successfully with the much slower suckering ability of the pre-existing coppice species. This phenomenon, together with repeated cuttings undertaken in the mistaken belief that such a procedure would control its growth, has led in many cases to the present situation in which *Robinia* has ousted the previous forest species. The second typology arose in cases where *Robinia* left on abandoned farms was cut down periodically as a marginal but continuous source of firewood or wood for stakes and poles. This favoured its rapid spread throughout uncultivated areas.

In agreement with findings from similar (Bertacchi *et* Onnis, in press; Arrigoni, 1997) or other geographic contexts (Mondino and Scotta, 1987; Corbetta and Pirone,1995; Gentile,

1995), *Robinia* communities show a floristic composition that is differentiated qualitatively and quantitatively according to the age and physiognomic structure of the community. In the mature stage, there is a preponderance of floristic-vegetational elements of native communities, suggesting that if *Robinia* stands are not constantly "rejuvenated" by human action, they are destined over time to lose their character of dominant communities and be replaced by the original cenoses.

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EXPERIMENTAL CONTROL OF *REYNOUTRIA*: A COMPARATIVE STUDY OF THREE CONGENERS

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The effects of various eradication methods were compared for three invasive *Reynoutria* species, *i.e. R. japonica* var. *japonica*, *R. sachalinensis* and their hybrid *R.* x *bohemica*. Five monospecific stands of each *taxon* were selected and subjected to the following treatments: (i) cutting, (ii) digging, (iii) combined cutting/spraying, and (iv) combined digging/spraying. Glyphosate was used for spraying. The trial was conducted over two growing seasons and the density of shoots, biomass production and performance of other species were used as measures of the control efficiency. Particular *taxa* responded in a different way to the treatments used.

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PROBLEM CAUSING WOODY ALIENS IN SOUTHERN GERMANY

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In Germany more than 150 hardwood alien species are noted up to now. Only a very few escaped in natural and seminatural areas and may be classified as agriophytes. Most of these species which are causing problems were introduced for forest purposes and got naturalised after extensive planting. Following species are selected due to their importance in different types of stands:
Acer negundo
Prunus serotina
Quercus rubra
Robinia pseudoacacia
Populus x *euamericana*
Pseudotsuga menziesii
They all are occupying large patches of land and are more or less frequent spotted in parts with low altitudes all over. Their strategies of concurrence in relation to native trees are different but in general successfully. Their specific abilities are presented in this poster.

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WIDE RANGE SURVEY OF INVASIVE PLANTS, A HIERARCHICAL APPROACH

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The French Mediterranean area is facing a large problem with invasive plants. The action undertaken by the botanical conservancy unit of Porquerolles is developing according three directions : fight, monitoring and survey, prospective.
As we have some hundred invasive or potentially invasive species, we have develop a set of criterias to classify the so call species in order to establish priorities for monitoring and action. The criterias take on board :
* the plant capacity to colonise a not disturbed habitat.
* The speed of wide spreading
* The adaptation to a wide range of ecological conditions
* The behaviour in term of space occupation * The reproductive modes
* The longevity of individuals
* *etc.*
These criteria are used according a numerical system leading to a ranking of the invasive species in term of potential threats for habitats.

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THE EFFECT OF WEATHER AND CUTTING ON THE GROWTH OF GIANT GOLDENROD (*SOLIDAGO GIGANTEA* AIT.)

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Giant goldenrod (*Solidago gigantea* Ait) has a North American origin. Its occurrence in Hungary was observed in the middle of the last century. Nowadays it has been regarded as one of the most important weed species. In agricultural point of view it causes problems first of all in perennial cultures, sapling gardens (erdészeti csemetekertekben), young forests, pastures, meadows. It establishes monodominant fields whose area may be a few hectares. In this way it occupies the habitats of natural species. The growth of *Solidago gigantea* was studied from 1993 to 1996. It can be found that the biomass production per shoot is determined by the rainfall in the firs part of growing season.
The temperature seems to be important only early spring, when it determines the date of the begin of intensive growth. In summer the drought causes decrease of leaf area. The plant defends itself against the water deficit. The leaf death rate correlates with the rainfall but the development of new leaf seems to be independent of it. There is no tendency in the number of leaf in the year. The decrease of leaf area in the second part of growing season is caused by the decrease of average size of leaf. After cutting the production of *Solidago* became significantly less and the putting out the shoots in the next spring was significantly weaker.

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SEED BANKS OF *ELAEAGNUS ANGUSTIFOLIA* (RUSSIAN OLIVE) IN NORTEASTERN ARIZONA.

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Elaeagnus angustifolia (Russian olive) was introduced to the United States as an ornamental and land conservation tree in the later half of the 19th century. It rapidly escaped and in the southwestern USA has become a major invader of riparian habitats. In addition to continued planting by humans, the plant readily spreads through wildlife ingestion of its relatively large fruits and by water along stream courses. The population of seeds in the soil was investigated along two streams in northeastern Arizona on the Navajo Indian Reservation. Soil, litter and seeds were collected to a depth of 1.0 cm depth from 0.5 m^2 quadrats. A total of twenty samples were taken from Chinle Creek and Ganado Wash. Seeds of *Elaeagnus angustifolia* were separated from the other materials and counted. Three sub-samples of seeds were placed in a germinator to determine the germination potential of the seed bank. There are numerous seeds in the seed bank and there are indications that those that are viable germinate readily.

INVASIVE SPECIES IN URBAN AND SUBURBAN COENOSIC IN CENTRAL ITALY

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A list is given of the species which for many years have been present in urban and suburban areas in Umbria, in particular in the area of Perugia and Lake Trasimeno. These species were introduced deliberately or naturally, and are currently cultivated in gardens, parks, avenues and walkways, and also in marginal urban and suburban areas. They often create problems because of their capacity to spread and invade. Sometimes very large specimens of some species damage sewer networks, boundary walls, and even ancient city walls. Roadside species can cause accidents linked to particular environmental situations such as heavy rain or wind. Moreover they often trigger allergic reactions, caused by the large quantity of specimens in a given area. Sometimes they are more vulnerable to attack by parasites, in that they have f*Aster* metabolisms than native species. There are also cases linked to the damaging effects of invasive species on cultivated crops.

List of species per area:
Robinia pseudoacacia L., *Senecio inaequidens* DC., *Hypericum calycinum* L., *Acer negundo* L., *Syringa vulgaris* L., *Prunus laurocerasus* L., *Amorpha fruticosa* L., *Parthenocissus quinquefolia* (L.) Planchon, *Helianthus tuberosus* L., *Portulaca oleracea* L., *Wisteria sinensis* (Sims) Sweet.
Some of the above species have reached a high degree of naturality, others are now beginning to reveal tendencies to occupy marginal ecological niches, while others have only recently been observed as spontaneous species, flowers in gardens and city parks. There are many remarkable cases of coevolutive adaptation in urban and suburban cenosic; some of them are adopting truly invasive characteristics due to their large numbers in a given area.

Perugia the city and the province: *Sophora japonica* L., *Paulownia tomentosa* Steud., *Broussonetia papyrifera* L'Hérit, *Ailanthus altissima* Swingle, *Cupressus arizonica* Greene, *Maclura pomifera* Schneid., *Gleditsia triacanthos* L., *Agave americana* L., *Salpichroa origanifolia* (Lam.) Baillon, *Dichondra micrantha* Urban, *Portulaca oleracea* L.
Most of the above species are arboreal and are ornamental plants for gardens, public and private parks in environments with a submediterranean climate, capable of resisting sudden climatic variations, either of excessive rainfall or periods of excessive hot or cold temperatures. They have adopted various survival strategies and almost all of them have naturalised, except *Cupressus arizonica* and *Sophora japonica*. They often show significant signs of coevolutive adaptation.

Trasimeno: *Abutilon theophrasti* Medicus, *Oenothera* L. sp., *Ceratostgima plumbaginioides* Bunge, *Elaeagnus angustifolia* L., *Datura stramonium* L., *Lantana camara* L., *Opuntia ficus-indica* L., *Yucca aloifolia* L.

These species are found in antropic areas, on the margins of agricultural crops, but some of them tend to have crop fields even if only on marginal strips of land. They prefer conditions good water availability, together with high temperatures, allowing them to survive and spread.

Middle Tiber valley: *Ambrosia gigantea*, *Sicyos angulatus* L., *Bambusa* Schreber. sp., *Arundinaria* Richard sp.

Plants belonging to these species take advantage of extremely favourable geopedological and bioclimatic conditions; they grow in sandy soils, with adequate water availability.

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EXOTIC SPECIES LANDSCAPE AND BIODIVERSITY IN SARDINIA

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The presence of exotic species in Sardinia goes back to the very old times and now many of them are very common in several different places as woods, coastal regions, cultivated areas, rice-fields, along the roads (Chiappini, 1963; Bocchieri 1978; 1990, Camarda, 1982, 1983, 1998; Viegi 1993; Lanza, Camarda and Natali, 1995). Their impact on the landscape, in spite of being quite low in the past, it's increasing more and more in the last time.
Pinus pinea, Castanea sativa, Corylus avellana, Prunus avium, Amygdalus communis, Olea europaea, Vitis vinifera, Juglans regia, and probably *Ceratonia siliqua* also, are introduced and characterise the countryside. It consists of entities diffused above all during roman period and they also represent an important source as food for human alimentation (Cherchi-Paba F., 1974-77; Perra, 1993). Only *Ceratonia siliqua* and *Olea europaea* spread spontaneously, as native species. The other ones, in general, are substituted by local flora and vegetation in a more or less long period of time.
After America discovery another group of exotic species made more abundant Sardinian flora, but only some of them as, e.g., *Opuntia ficus-indica, Agave americana* and *Nicotiana glauca* must been considered as fully part of the landscape.
Between ligneous species coming from other regions of the world *Acacia cyanophylla* s.l. and *Ailanthus altissima* are the only ones that seem able to propagate, contrary to *Alnus cordata, Casuarina equisetifolia, Cupressus sempervirens, C. arizonica, C. macrocarpa, Eucalyptus sp.pl., Fagus sylvatica, Pinus nigra, Pinus canariensis, Pinus radiata, Myoporum tetrandra, Pittospyrum tobira, Sarothamnus scoparius*, introduced for afforestation.
Pinus halepensis and *Pinus pinea*, are the conifers which show a low capacity of spreading. The exotic species more utilised for afforestation in Sardinia are *P. nigra, P. radiata, P. canariensis, Cedrus atlantica*, while broad-leaved are *Acacia cyanophylla, Eucalyptus camaldulensis* and *E. globulus*.
Conifers wood have a strong impact on local flora and spontaneous vegetation, both because the vegetation is totally destroyed during the soil tillage for the plantation, and because the high density of plants. The disappearance of native species on large surfaces impoverish the biodiversity. When the cover of tree is reduced it is possible the restoration of natural vegetation.
Eucalyptus camaldulensis is an heliofilous species, that constitutes clear woodlands, but the competition of imposing root-system and the accumulation of organic matter undecayed on the soil, in addition to the presence of *Acacia cyanophylla*, both developing by seeds and by suckers from roots, impedes the development of native flora. In every cases changes of landscape bring to an immediate influence on natural habitats, decreasing biodiversity of biocenosis.

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ECOLOGY AND POPULATION DYNAMICS OF THE INVASIVE EXOTIC SPECIES *CARPOBROTUS EDULIS* IN THE PORTUGUESE SANDY COAST

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Coastal areas are particularly vulnerable to natural and anthropogenic disturbances, especially dune systems. The fragmentation of natural vegetation, due to anthropogenic pressure, associated with biological invasion represents a serious threat to the conservation of native species in sand dunes.
Carpobrotus edulis (*Aizoaceae*) is native from South Africa. This perennial succulent was introduced in Portugal for dune stabilisation and erosion control. The fleshy fruits of *C. edulis* are edible and the native fauna may constitute a strong dispersion mean. Once stabilised this plant shows a high vegetative reproduction rate and growth is not affected by herbivory or competition. This exotic species was greatly dispersed throughout Portuguese sand dunes, affecting the natural succession and ecological processes by changing species composition.
It is our aim is to understand the extension of the invasion of *Carpobrotus edulis* in the sandy coast of Portugal, the way it competes with native species and how serious are the ecological consequences of this invasion.

Key words: plant invasion, *Carpobrotus edulis*, biodiversity, sand dunes.

THE EFFECT OF THE TWO INVASIVE TROPICAL ALGAE *CAULERPA TAXIFOLIA* AND *CAULERPA RACEMOSA* ON THE NATIVE SEAGRASS *CYMODOCEA NODOSA* IN THE MEDITERRANENAN

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The introduction of non-native plants has become an increasing problem in many different ecosystems. Introduced species have interested ecologists because of their effects which are often detrimental to the biodiversity of their new environment. Non-indigenous seaweed species, for instance, have been claimed to reduce the distribution of native seagrasses by competitively displacing them. Marine rhizophytic algae, such as *Caulerpae* species, show to be highly invasive especially where they are non-native.
The introduced green algae *Caulerpa racemosa* (Forsskål) J. Agardh and *Caulerpa taxifolia* (Vahl) J. Agardh have been shown to fast-spread and colonize many types of substrata in the Mediterranean. In fact they are found on sand, cobbles, on algal mats and seagrass habitats such as *Cymodocea nodosa* (Ucria) Aschers. and *Posidonia oceanica* (L.) Delile.
In this paper we present results obtained in two different experimental studies that have investigated separately the effect of the removal of *Caulerpa racemosa* and *Caulerpa taxifolia* on *Cymodocea nodosa.* Both experiments were carried out in the field, lasted for 18 months and had, as response variables, density, length of the seagrass canopy and density of flowers.
Results obtained indicated that in areas where *C. racemosa* and *C. taxifolia* were present the shoot density of *C. nodosa* was lower than in controls, suggesting a negative effect of both introduced algae on the native seagrass. However, the number of both male and female flowers in removal treatment are significantly higher where algae were present than in the removal areas.

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THE IMPORTANCE OF ALIEN AND NATIVE SPECIES IN THE URBAN FLORA OF ITALY

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Urban floras generally comprise a high proportion of alien species. In this study the flora of several Italian cities is analysed in order to evaluate the relative importance of alien and native species. Both experimental data and data gathered from literature are considered. The proportion of aliens in the Italian urban flora is generally lower than that found in Central European cities. This trend particularly characterises the Mediterranean Region where the apophytes (indigenous species expanding into man-made habitats) are the most successful group of spontaneous urban flora. Besides, in Mediterranean cities, alien plants are almost totally confined to man-made habitats and do not generally invade semi-natural vegetation. These results may be explained by the minor importance of the urban heath island effect in the distribution pattern of the species in the Mediterranean area. Another possible reason may be found in the pre-adaptation of many Mediterranean plant species to human disturbance which strongly characterises urban habitats.

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STRATEGIC INVASIVE PLANT MANAGEMENT, LINKING POLICY AND PRACTICE: A CASE STUDY OF *FALLOPIA JAPONICA* IN SWANSEA, SOUTH WALES, UK

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Since the export of *Fallopia japonica* (Houtt.) Ronse Decraene from Japan in the mid nineteenth century as an ornamental species, this rhizomatous perennial plant has rapidly extended its distribution in its introduced range. The control of the plant in both urban and rural environments is now a significant problem in Europe, the northern states of the USA, Canada and New Zealand. Human activity is mainly responsible for its spread, particularly in urban environments through movement of soil containing plant fragments.
The Planning Department of the City and County of Swansea, a local authority in South Wales, UK, has attempted to manage the invasion of *F. japonica* in the area of their jurisdiction by establishing a strategic management plan.
A comprehensive ground survey created an accurate picture of the distribution of the plant within an area of approximately 400 km^2. These data were transferred to a Geographical Information System (GIS) enabling rapid manipulation and the establishment of links between e.g. planning policy, land ownership and the presence of *F. japonica*. Three priorities have been identified in formulating a management strategy (i) to prevent further spread of the plant; (ii) to protect vulnerable areas from becoming infested; (iii) to target control at priority areas on the basis of, for example, high nature conservation value, aesthetics and nuisance. The opportunities and constraints involved in controlling *F. japonica* in an urban environment are explored from a local authority perspective. Some problems encountered in using GIS for this type of exercise are discussed.
Results of the survey show that the area covered by *F. japonica* is 100 ha which represents 0.25% of the total area surveyed. In relation to the strategic management of the plant within the city, the use of GIS has enabled the Council to identify alert areas where plans for re-development within the city affect infested sites and to place restrictions on the movement of infested soil. A Knotweed Officer has also been appointed.

COMPARATIVE VEGETATIVE REGENERATION POTENTIAL IN ASIATIC KNOTWEEDS: OBSERVATIONS FROM GREENHOUSE TRIALS

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The group of Asiatic knotweeds in the *genus* Fallopia, incuding *F. japonica*, F. *sachalinensis, F. japonica* var. *compacta* and the hybrid F. x *bohemica*, are now well distributed throughout their introduced ranges worldwide. The relative invasion potential of these Asiatic knotweeds was investigated by exploring their rates of vegetative regeneration from fresh stem and rhizome material in a series of greenhouse trials. Stems were subjected to two conditions, either buried in a soil medium or placed in water, rhizomes were buried in a soil medium. Stem material from *F. japonica* plants regenerated more rapidly than stems from hybrid plants under both aquatic and terrestrial conditions. Buried hybrid stems gave higher regeneration rates than hybrid stems in water treatments. For all treatments, *F. japonica* and *F.* x *bohemica* stem material gave higher regeneration success rates than either *F. sachalinensis* or *F. japonica* var *compacta*. The hybrid *F.* x *bohemica* showed a regeneration potential comparable to that of *F. japonica* with a greater than 50% rate of successful regeneration from 3.9 g of fresh rhizome material. Rhizome material taken from male-fertile hybrid plants showed a greater regeneration potential than material from female hybrid plants in terms of time to shoot emergence, shoot height and percentage success rate. The invasion potential of rhizome material from *F.* sachalinensis and *F. japonica* var. *compacta* plants was not as great with lower regeneration success rates and larger amounts of material being required for regeneration success. Assuming that the means of dispersal are similar for each of these species, the potential for a secondary invasion of *F.* x *bohemica* is indicated.

MYCELIS MURALIS (L.) DUMONT (WALL LETTUCE): INTRODUCED BUT NEVER INVASIVE IN IRELAND

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Attempts at understanding the key features that contributes to the success of introduced plants have focused on species that have a major impact on exixting communities. In the main, however, this approach has failed to identify those characteristics that make some plants successful invaders and others not. An alternative approach is the examination of plants that, although introduced, have not become invasive, although they may have potential to become invasive in the future. We have applied this latter approach to a study on *Mycelis muralis* (L.) Dumort, the wall lettuce. This species has almost certainly been introduced into Ireland and now occupies a number of predominantly shaded sites although, unusually, it reaches its greatest abundance in the Burren, an exposed limestone area. However, *M. muralis* is never a majorcomponent of the vegetation in any habitat in which it is present, consistent with its occurence throughout its range. Competition experiments with *Geum urbanum* have indicated that the performance of this species in shade may be poor at low calcium supply and this may limit its spread outside calcareous understory environments. The origin of the open pavement population is thought to be relatively recent (~ 60 years) and, based on RAPD analysis, is genetically distinct from the woodland populations. These differences are not, however, related to a number of physiological attributes. This indicates that increases in the range of habitats occupied by introduced species may not be simply predictable on the basis of their overall ecology or physiology.

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CYPERACEAE, IRIDACEAE AND COMMELINACEAE AS WEEDS

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Generally, the families *Cyperaceae*, *Iridaceae* and *Commelinaceae* are considered ornamental plants, but, when they interfere with man's activities, they become weeds. As all the plants can become weeds as function of time and place, in Italy, some species of *Cyperaceae*, *Iridaceae* and *Commelinaceae* are weeds among crop plants.
Here, are our preliminary observations on some species of these three mentioned families, their presence in Italian crops, their general strategy for dispersal.
The species of the *genus Cyperus* L., *C. esculentus* L. (Ter Borg *et al.*, 1998), *C. glomeratus* L., and *C. rotundus* L. that can be found wild in damp soils, but in the case of their spreading into monoculture crops, in vineyards, and even in asphalt in the city roads, they must be considered invasive.
In the family *Iridaceae*, even though we are used to observe the large diffusion of ornamental rhizomatous Irises out of the areas designed to them (this can be bothering sometime for the man's activities or desirable in soils subject to landslides), actually we can consider invasive the species of another *genus* of *Iridaceae*, the *genus Gladiolus* L. Indeed, *G. italicus* Miller and *G. byzantinus* Miller can become invasive of wheat crops.
In agronomy and agriculture practices, many species of these families show strong similarity in habit to that of the crops, especially wheat, in which they live.
The appearance of leaves, for example, of a lot of species of *Cyperus*, is very close to that of young plants of *Triticum* and other cultivated *Poaceae*. The same can be easily observed in the leaves of the *genus Gladiolus* L., at least before the blooming of the plant. So, for many farmers, it is very difficult promptly to distinguish these invasive plants from the crop.
Another important characteristics of these plants which underlines their strong potentiality of diffusion linked to their wide ecological adaptability, is represented by their life form. Many *Cyperaceae* (*Cyperus*, *Carex*) produce a hypogeous modified stem, often very long with usual spatial high development (Munzik, 1970).
Commelinaceae, such as *Murdannia* sp. pl., are the most cases perennial herbaceous creeping plants, growing in tropical places (in Italy, we can find *M. keisak* (Hassk.) Handel-Mazz. as invasive in rice monocultures, near Vercelli); they normally produce adventitious roots at the nodes of vegetative stems, at more or less regular distance one by one, so the population appears in thick tufts. This is very important for their diffusion, because when the same stem is broken by accident, it can easily give origin to another plant completely independent from the original, able to produce other plants in the same vegetative way.
In addition, as both *Cyperaceae* and *Commelinaceae* have sexual reproduction, the number of individuals in each population can increase rapidly in this way and can be well advantaged by their biological form in vegetative reproduction. On the contrary, *Gladiolus* species, because of their biological cycle and, consequently, for their reproductive strategy, cannot produce adventitious roots or stolons, having just a bulb-tuber (Mathew and

Swindells, 1996), so they use sexual reproduction as an invasive strategy and their distribution is less abundant that of the other mentioned genera.
The basal biosystematic investigation as from morphological characters and distribution data shows immediately that *G. italicus*, even if it is of doubtful origin, because it is over all Italy, becomes more noxious economically than *G. byzantinus*, that is characteristic only of the Central-Southern Italy.
Consequently, a systematic study of the above mentioned genera can help in the case of mechanical or biological control of cereal crops.
In this preliminary study, we show the importance of convergence of characters between the invasive with "autoctone" species, the relation between their life cycle and their strategy of diffusion and some systematic data that point out also the misidentification (Pignatti, 1982) of the above mentioned *Murdannia keisak* with *Commelina communis* L., even the colour of flower in the last species is pale blue and not white-pink, and rarely with *Tradescantia virginiana* L., often cultivated ornamental species that escape in fields near houses and gardens to become invasive.

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ANNUAL PAPAVERS: TAXONOMICALLY COMPLEX WEEDS

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In Italy, red annual papavers (poppies) are taxonomically complex weeds, which are widespread in different wild, cultivated and ruderal sites. Since they are very invasive it is difficult to eliminate them from crops. Several studies have been carried out to resolve the many problems linked to their high potentiality for diffusion in crops (Munzik 1970, Hanf 1980,Viggiani 1990), but the solution is difficult without a clear understanding of the characters related to their life forms, reproduction and ecological strategy.
A recent investigation assessed the systematics (Kadereit 1988) of the *genus Papaver* L. sect. *Rhoeadium* Spach and led to the separation of a new species "*Ïntrasection*" and eliminated others already instituted. However, this study was carried out mainly on *herbarium* specimens, not always taking relative populations into account, and with an arbitrary rejection of some samples.
We quote from Kadereit (1988) a paragraph which elucidates the difficult interpretation of *P. rhoeas*: " On the one hand, Elkan (1839) and Kunze (1887) accommodated all *taxa* known at their time in two (*P. rhoeas* L. and *P. dubium* L.) or one (*P. rhoeas*) species respectively. On the other hand, a large number of new species were described by Fedde (1909), often from single *herbarium* specimens only or including obvious monstrosities, and by Timbal-Lagrave (1870, 1892), Jordan (1861, 1864) and Wein (1911 a, 1911c), who worked on a regional scale. This approach has led to the acceptance of 16 species with 9 subspecies and three varieties. "
The systematics of the problematical species *P. rhoeas* and its allies is established mainly on morphological elements. Our approach to this "*Papaver* group" therefore involves a macro and micro-morphological investigation of natural populations to establish which one of the previous discordant revisions and systematic interpretations could be considered valid.
Our investigation started with examination of bibliographic data, then examination of *herbarium* specimens, collection of new samples (both living and dry), comparison of these with the Linnean samples, observations made in the field, and laboratory analysis. The results showed an inconsistency of the present systematic position of the poppies based only on morphological study of samples either of unknown origin or from different areas and mainly from *herbarium* specimens. The importance of a study of populations and their range of variation in delimiting the *P. rhoeas* entity, seems to have been often neglected. Our preliminary analysis has demonstrated high variability and provided new and interesting systematic data.
All the populations examined (mainly among crops, in abandoned fields and either near or within cities mainly from Lazio, Abruzzi and Campania) were highly polymorphic as well as rich in individuals; also they had a high diversity of individuals in a very small population (1m x 1m). They were polymorphic for the following characters: large or reduced lamina of leaves, branched or unbranched stem, solitary or many flowers, more or less elliptical to subspherical capsules, coloured or bicoloured spots on petals, number of

stigma rays, some heteromorphic pairs in the karyotypes (2n=14), new plants obtained from the seeds of poppies of known characters.
Investigation of seeds by S.E.M. revealed other characteristics: the seeds presented a low level of intra-individual (same capsule) variation, but some inter-individual variation in each population, mainly in distribution of testa cells and in the wall. On the basis of the available data we agree with Kadereit on the complexity of *P. rhoeas* and the difficulty of separation of the species by the seeds. However, we found in each population more or less the same range of seed variation referred by Kadereit to many of the species that this author instituted and recognized (1988), with the big difference that we could refer them only to each population of *P. rhoeas* s. l.. On the whole we remain perplexed both about some of the solutions adopted, and on the systematics of the section by Kadereit.
We conclude that, although we need more data to interpret the systematic entity of this *taxon* and consequently to address the biological problems, our opinion is closer to that of Kuntz (1887) than Kadereit (1988), but with two main differences. Our results from karyotype analysis also show evidence of high genetic potential and possible phenotypic plasticity linked to the constant possibility of annual recombination by meiosis that increases variation and consequently populational polymorphism. The hypothesis of a possible hybrid origin of this complex weed from autoctones and oriental species, is partly upheld by the introduction of poppies to many fields in Italy through crop seeds from different countries. Studies on experimental hybrids (Wein 1911a, 1911c) and cytogenetic, observations on natural hybrids have given some data (McNaughton and Harper 1960a 1960b), but the origin of the many different individuals of each population is still uncertain.

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THE INVASIVE *STELLARIA MEDIA* (L.) VILL. (*CARYOPHYLLACEAE*), A CRITICAL *TAXON* AT SPECIFIC AND SUBSPECIFIC LEVEL

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In Italy, *Stellaria media* (L.) Vill. can be found in every site, often also where it is unwelcome. The more or less procumbent arrangement of the first part of the stem, divided in nodes and internodes, makes easier the diffusion in wild areas, inside the cities, in abandoned fields, but also in crops. During the year, the long flowering time of this *taxon* leads to the maturation of many seeds that increase the potentiality of diffusion of *S.m.* and the chromosome rearrangement, so it has been treated as invasive by many Authors (Mann and Barnes 1950, Hanf 1980, Viggiani 1990) and some attempts with chemical and biological control have been operated to eliminate it from crops, not always successfully.
S. media is a *taxon* yet in discussion because of its doubtful origin, high polymorphism, over a broad diffusion area and uncertain systematics (Colasante and Lucchese, 1995).
The main taxonomic problems concern: a) a lot of forms that have been described, b) the different denomination and systematic rank that have been assigned to these forms, c) the relation with the putative ancestors: S. neglecta Weihe and S. pallida (Dumort.) PirË. Actually, there is the interpretation of Beguinot (1910a, 1910b, 1920) that separated many species and forms, while that of Greuter *et al.* (1984) separates three species *S.pallida*, S. *neglecta* and *S. media* aggr., the last subdivided in the subspp. *media, cupaniana* and *postii*, the second subspecies synonymyzed with the third. We have investigated specimens of three European *herbaria*: Patras (UPA), Geneve (G), and Rome (RO) regarding the *taxa S. media* subsp. media, S. m. subsp. *cupaniana* (Jourd. and Four.) Nym., S. m. subsp. *postii* Holmb., but the specimens presented many misdeterminations. In addition, the *herbarium* data stray from the reality verified in the wild areas, because of the high polymorphism of this *taxon*. The analysis of some wild Italian populations (in Lazio, Molise and Sardinia) showed higher inter and intra-populational (rare intraindividual) polymorphism in relation to broader spread areas of the populations. In fact, we noted a correlation between the variations of the characters and the number of the individuals into each population.
We analysed macro and micromorphological characters of each individual within and between different populations to compare the *taxon* S. m. and the contiguous *taxa*, at different levels, also using scanning electron microscopy. The usual character of strip of hairs along the stem, to indentify the species and subspecies of the mentioned *taxa* (Whitehead and Sinha, 1967), appeared very variable within the populations in number, thickness and distribution, so that it did not appeare of valid diagnostic use in the species and in the subspecies. The form and the nature of the hairs (simple or glandular) have not been significant enough to separate in *taxa* specific and subspecific because of their irregular distribution. The comparison of the seeds, often a very conservative character, by S.E.M., showed testa cells arranged in an external denticulate group and the other cells with variable winding wall (Godeau 1973). The total arrangement presented intraspecific

variation in *S.m.*, but also pointed out some difficulty of separation between the seeds of *S.m.*. (and its subspecies media and cupaniana, syn.postii), S. pallida and S. neglecta because of the many intermediate seed forms found in *S.m.* (Colasante and Lucchese, 1995), supporting the hypothesis of allopolyploid origin of S. m. and the possible ancestors in the last two mentioned *Stellaria* (Peterson, 1933, 1935, 1936; Negodi, 1936). In addition, the many intermediate forms between these and the probable amphidiploid natural hybrid, put in evidence the difficulty of separation between the above mentioned critical *taxa* also at subspecific level. On the basis of the slight diagnostic characters, the institution of some subspecies geographically distinct, as *cupaniana* and *postii*, appears unjustifiable in accordance with other A. l.c., but also the same institution of the subspecies, in our opinion seems to be rejected as in our examination of some Italian populations we found together individuals that were referable to the subspp. media and cupaniana together with some intermediate forms.

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COMMUNITY CHARACTERISTICS IN A MOUNTAIN FOREST INVADED BY *GLEDITSIA TRIACANTHOS* L. (*FABACEAE*)

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Gleditsia triacanthos L. (*Fabaceae*) is original from the central-east E.E.U.U, and has invaded the mountain forest of San Lorenzo (Salta, Argentina) in association with anthropogenic disturbances. This work is part of a mayor research and is focused in some community features related to the invasion process as well as the impact of *G. triacanthos* on the local diversity. We analyzed species richness, relative abundance, similarity, DBH and diversity in three successional stages: colonized, mixed and climax. The three situations were different in the environmental and vegetational characteristics. The invasion of *G. triacanthos* was associated to the colonization of gaps formed for cattle grazing. We didn't found individuals of the introduced species in the climax stage. *G. triacanthos* is the most abundant species in the mixed stage but we also found abundant recruitment of native species. The diversity of trees was similar between mixed and climax stages. The diversity of the study area was higher due to the introduction of new species in the community and the disturbance regime. The results are discussed taken into account the importance of different successional stages in the invasion process, the regeneration of the native forest, the intrinsic features of the invasive species and the impact of the invasion on the local tree species diversity.

OSSERVAZIONI SULLE VARIAZIONI FITOSOCIOLOGICHE INDOTTE DA *ROBINIA*, AILANTO E AMORFA IN VARIE LOCALITÀ ITALIANE

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Vengono riportatio dati a diverso grado di approfondimento relativi alla invasività della *Robinia* nel bosco di Agognate (NO), nei boschi relitti in territorio di Parona e Clavegna (PV), nei boschi della valle di Aterno (AQ), nei boschi in Lomellina (PV); dell'ailanto nel bosco della Mesola (FE), nell'isola di Montecristo (LI) e nella valle dell'Aterno (AQ); di *Amorpha fruticosa* nella foresta Panfilia (FE) e nell'oasi di Campotto (FE).
Allo stato attuale delle conoscenze, peraltro ancora incomplete, si nota che il più significativo influsso sul sottobosco è esercitato dalla *Robinia*.

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THE EFFECTS OF SIZE AND FRAGMENTATION ON INVASION OF TALL-GRASS PRAIRIE FRAGMENTS BY NON-NATIVE PLANT SPECIES

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Since European agricultural practices began on the Great Plains, the tall-grass prairie hasœdeclined in area between 82-99%. In addition to decline in area, species numbers in the remainingœprairie may also have declined as a result of habitat fragmentation. Further species loss andœalteration of plant communities may result from the invasion of prairie fragments by non-nativeœplant species.

A study of 24 tall-grass prairie fragments ranging geographically from Minnesotaœand Wisconsin to Oklahoma and Missouri (and ranging in size from 0.5 ha to 12,000 ha) addresses these questions:

1) do numbers of non-native plant species increase as prairie unit sizeœdecreases;

2) do naturally fragmented units (in woodlands) have lower numbers of non-nativeœinvaders than human fragmented units (in agricultural settings) of the same size; and

3) will prairieœfragments clustered in space have more similar non-native species assemblages than like sizeœfragments from more distant locations?

Information from study plots indicates that most of theœprairie plant communities studied have a component of early, or cool season non-native plantœspecies. Non-native plants are a major part of community species composition and abundance inœmany prairie fragments, but the patterns of distribution and abundance of these plants appear toœhave little to do with size of the prairies. Prairies isolated in northern woodland margins had theœlowest numbers and abundance of non-native species, and the highest numbers and abundance of non-natives were found in the northern prairies isolated by agriculture.

THE ALIEN FLORA OF SOUTHEASTERN SPAIN. AN ADVANCE FOR THE EXOTIC PLANTS DATABASE NATIONAL RESEARCH PROJECT

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As a result of the increasing importance of exotic plants invasions, evaluation of alien flora in every country has became a necessary goal. In order to reach this aim, floristic lists, in wich other kind of information is recorded (as the extension degree in every territory or morphological and ecological characteristics of every species) should be a prioritary objetive.
For pushing this kind of research, the "Exotic Plants Database National Research Project" has been recently developed in Spain and its goal is to quantify and to study the alien flora of this country. Seventeen items allow us the recording of any information concerning any species. Our contribution here is based on this National Research Proyect and is an advance for the knowledgement concerning the exotic flora in the southeastern of Spain. The study area is Almerìa province (8,774 km^2), a territory with a high landscapes diversity, wich has a wide altitudinal variation range in only few km. We may consider Almerìa province as representative enough of other sea-side regions in southeastern Spain; the goal of this paper is to reduce the multiple factors involved in the differences among invassiveness characteristics of alien plant species in order to get a few parameters easier to use, and wich allow to improve prevention strategies for avoiding further plants invasions.
Our preliminary results show that about 300 exotic species (about the 10% of the total flora) may be found in this territory, although rather fewer show invassive behaviour. Paleo and Neotropical terophytic species showed the strongest invassive character and were the most numerous group. Hence, the prevention strategies should be focused on this group. The results also showed the high invading power of those southafrican species, mainly chamephytes and phanerophytes, and the lower invading power of the Chinese and Japanese species.
Finally, we remark the needing use of autochtonous flora, in sustitution of alien one.

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COMMUNITY-BASED EFFORTS TO CONTROL EARLY INVASION OF TALL WHITETOP (*LEPIDIUM LATIFOLIUM*) IN THE LAKE TAHOE BASIN

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Tall whitetop (*Lepidium latifolium*) is a non-native weed from Eurasia that has invaded sensitive wetland and riparian sites in the western United States. The plant was first positively identified in the Lake Tahoe Basin in 1997, with anecdotal reports of infestation dating back to the early 1990s. Lake Tahoe is a unique national treasure famed for its unusual water clarity and surrounding beauty. Pressures from development and urbanization have resulted in an accelerated rate of eutrophication and resultant algae growth. It has been estimated that during the last 30 years, clarity as measured by secchi disks has decreased at a rate of more than one foot per year. Current research suggests that the lake is phosphorus limited, with erosion and sediment transport increasing phosphorus loads to the lake. Efforts to control erosion include construction best management practices, limits on growth, and preservation of streamside environment zones.

Tall whitetop forms colonies that dominate entire fields or wetlands. The name "tall whitetop" comes from the clusters of small white flowers produced from June through September. This weed expands by creeping underground roots that send up shoots to form new plants.

The weed is spread in a number of ways. It commonly travels in rivers and irrigation systems over long distances as seeds and rhizomes from eroded banks. Seeds and rhizomes are also spread in contaminated fill dirt or topsoil during construction and landscaping. They may be picked up and distributed to uninfested areas on tires and all types of equipment. Contaminated straw used in erosion control projects also moves this weed.

Tall whitetop is difficult to control due to its competitive nature and rapidly spreading roots. Research is underway at the Agricultural Research Service in Reno, Nevada to determine optimal control methods. Mechanical methods, including digging, mowing, tilling, mulching or shading have proved ineffective for control of established stands. To date, no biological control agent has been identified for this weed. In most cases, chemical applications provide the only effective control. In most cases, controls must be practiced over several years, and competitive vegetation must become established if the weed is to be controlled. Since tall whitetop prefers to grow in wet areas, extreme care is needed to avoid contaminating waterways with pesticides. Because tall whitetop has the potential to destroy sensitive streamside environment zones that are essential to the protection of Lake Tahoe's clarity, an effort was begun immediately to locate and map the weed throughout the Basin.

During the summer of 1998, a public awareness campaign was mounted by the University of Nevada Cooperative Extension and M*Aster* Gardener intern Ellen Swensen. Local media ran stories on radio, television, and in local newspapers, and posters were placed in strategic locations. On August 15, 1998, the public was asked to call one of four locations, to report suspected locations of the weed. From these reports, 35 tall whitetop infested sites

were identified, confirmed and mapped in the Tahoe Basin. The size of these infestations ranges from one plant to one-half acre dominated by tall whitetop. While the weed is found throughout the Basin, the largest infestation sites involve riparian areas adjacent to Trout Creek in South Lake Tahoe, a tributary to Lake Tahoe. There are several other infestation sites in the South Shore area as well as a number of sites at North Shore's Incline Village. Many of these sites fall within priority 1 and 2 watersheds critical to preserving the Lake's water clarity. At many of these sites, there is a co-incidence of straw bale usage and tall whitetop infestation. It seems likely that seeds or plant parts are entering via these erosion-control bales. The bi-state Tahoe Regional Planning Agency is aware of this issue and has changed their policies to require use of certified weed-free straw.

The current phase involves the implementation of site-specific control recommendations developed with the assistance of USDA/ARS. Local residents will be urged to "Adopt-a-Spot" for long term monitoring of control efforts. As the Lahontan Regional Water Quality Control Board has set a zero tolerance standard for pesticides in Lake Tahoe water, any chemical applications will have to be carefully controlled and monitored. Tall whitetop is a designated noxious weed in the state of Nevada, but is currently "B" listed in California, placing it lower on the list of priorities. In order to have any chance of successfully eradicating tall whitetop in the Lake Tahoe Basin, it must become a #1 priority for all Basin residents and agencies.

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EFFECTS OF DISEASE AND DISTURBANCE ON A CULTIVATED GRASS INTRODUCED TO SEMI-NATURAL GRASSLANDS.

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Many crop species are able to grow and persist in non-cultivated habitats and this has given rise to a general concern about the effects of escaped crops. To improve properties favourable for cultivation, crop species are undergoing constant selection in breeding programs. Presumably, crops selected towards increased disease resistance may achieve an increased invasiveness as several researchers have argued that diseases are among the most important barriers to invasion.

To test this hypothesis, a manipulative field experiment set up as a full factorial block design was carried out to investigate the effects of fungal plant disease on artificially introduced and naturally occurring perennial ryegrass, *Lolium perenne*. Soil disturbance was included as a treatment in order to asses the importance of creating additional microsites suitable for establishment. Two cultivars of *L. perenne* differing in their susceptibility to crown rust, *Puccinia coronata*, were broadcast to experimental plots at four different types of grassland sites.

The preliminary results from the first year of measurement show that additional seeds did not increase the total cover of *L. perenne* at sites where *L. perenne* was already occurring. Contrary to expectations, the existing *L. perenne* populations responded to addition of disease by increasing in cover. *Lolium perenne* was successfully established at two sites with no existing population of the species. This establishment was dependent on neither the disease nor on the variety added. Disturbance had a significant effect on establishment only when biomass of the vegetation was high and the level of natural soil disturbance low. Data from the second year of measurements will also be presented.

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ECOLOGY OF *HAKEA SERICEA* SCHRADER AND *HAKEA SALICIFOLIA* (VENT.) B. L. BURTT IN PORTUGAL

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The *Hakea* Schrader *genus* is mainly represented by evergreen xerophytical trees or shrubs, being represented in Portugal by the species H. sericea Schrader and *H. salicifolia* (Vent.) B. L. Burtt. Both are originary from Australia and where introduced in Portugal to form fencelines or windbreaks. The second species is particularly well adapted to windy seashores. Both species have revealed a highly invasive character, having the authors often seen *H. sericea* infestating *Eucaliptus* woodlands. The expansion of these *taxa* populations is largely enhanced by forest fires, because fire facilitates the opening of the ligneous follicles, as well as seed sprouting. *H. salicifolia* is very similar to an *Acacia* schrub, differing from this one because of the redish tips of its leaves, especcially at young ages. It constitutes one of the main problems nowadays, in Serra de Sintra, where it is especially abundant (mostly on the South slope).
The authors present the general distribition of the two *taxa* and their relation the ecological characteristics in wich they occour.

Key-words: *Hakea sericea*, *Hakea salicifolia*, ligneous weeds, ecology, Portugal.

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CONTRIBUTION TO THE INVASIVE ECOLOGY OF *RUDBECKIA LACINIATA* L. IN THE CZECH REPUBLIC

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Rudbeckia laciniata belongs to the North American species first introduced to Europe as an ornamental plant. It became spreading outside gardens in the 1850s and 1860s. The species occurs as a characteristic component of the vegetation along rivers and brooks. Outside Europe, the species is invasive in Japan. The aim of this work was to clarify mechanisms leading to the incorporation of this invasive alien into natural communities, considering both vegetative and generative reproduction. Possibility of restriction of already established R. laciniata populations was experimentally tested.

As for generative reproduction, seed germination was tested in a greenhouse experiment with respect to the type of winter storage of seeds. In all types of storage, the germination was about 40 %. Seed germination was also tested under field conditions. Germination and seedling survivorship in differently treated plots (control, mowing and plots with sod turned upside down) was checked during 1997 and 1998 (and will be checked in 1999 as well). Phenological observations were made during 1998. The changing numbers of leaves in rosettes and on stems are correlated to the shoot mortality during vegetation season. Two peaks of mortality were observed - the first one responding to self-thinning during shoot sprouting from rosettes, and the second one corresponding to senescence in the end of vegetation season. Established populations of R. laciniata were subjected to mowing of different intensities. After two vegetation seasons, there were no significant changes in community structure, implying the necessity of long-term management.

Low germination and incapability of recruitment in undisturbed sites indicate that generative reproduction doesn't provide the species with enough possibilities to incorporate into natural communities. The relatively small role of generative reproduction is apparently compensated by vegetative spread.

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IMPACTE OF *CARPOBROTUS EDULIS* (L.) N. E. BR. ON THE AUTOCHTHON VEGETATION OF THE PROTECTED AREA RESERVA NATURAL DAS BERLENGAS (PORTUGAL)

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The aim of this work is to evaluate the alteration in floristic diversity caused by *Carpobrotus edulis* (L.) N. E. BR. growth on the autochthone vegetation of the protected area, the arquipelago "Reserva Natural das Berlengas". This protected area is located on the portuguese Estremadura littoral (39° 24' 49" N e 9° 30' 29" W) and is formed by rocky islands. The height of the islands is under 100 m and Berlenga, the largest island has an area of 76 ha. A seasonally occuped fishermen village is located in this island and the others are uninhabited.

In the 50's *Carpobrotus edulis* as been introducted in order to avoid the overthrow of rocks in the leasure areas of the island, it as been planted in two islands, Berlenga and Farilho Grande and has successfully established. Presently *Carpobrotus edulis* as spread out over the cliffs and hillsides mainly in those with south exposition. Spontaneous occurences of this specie have been observed in three other islands of the arquipelago. *Carpobrotus edulis* establishes a monospecific cover that obstructs the occurrence of the autochthone vegetation. The Flora of this protected area consists of around a hundred species mainly annuals and few perennials, three species are endemics from the arquipelago.

Linear transepts were done in order to collect the data, they were made inside and outside the area covered with *Carpobrotus edulis*, in both islands Berlenga and Farilho Grande.

The results allow to obtain a quantitative appreciation of the frequency reduction and covering area of the native Flora. They also indicate that *Carpobrotus edulis* presents a different soil occupation pattern on the differents islands.

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SEEDLING AND SAPLING GROWTH OF THE ALIEN INVASIVE SPECIES *PINUS STROBUS* IN *PINUS SYLVESTRIS* FORESTS IN THE ELBE RIVER SANDSTONE MOUNTAINS, THE CZECH REPUBLIC

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The North American pine species *Pinus strobus* L. became a pest in different sandstone areas in the Czech Republic. It invades into forests of *Pinus sylvestris* L., both native and cultivated. The study was hold in the Elbe River Sandstone Mountains where the invasion is the most advanced.
As the favourable reproduction strategy of *P. strobus* is supposed to be responsible for its great success, the seedling and sapling growth of both pine species was compared in different habitats in the field and in the common garden. Localities were not far from a seed source of both pine species.

Field study
More *Pinus sylvestris* saplings survived and grew better only at the sunny and extremely dry localities represented by the ass. *Dicrano-Pinetum.* A lot of saplings of *P. strobus* survived at not so extremely dry and sunny localities and in cultivated pine forests and they grew faster there. At the humid and shady localities hardly any saplings of *Pinus sylvestris* survived.

Common garden study
Seedlings and saplings were cultivated in the soil taken from the field with both *P.sylvestris* and *P. strobus* litter on the soil surface, under optimum light and soil humidity conditions. *P. sylvestris* grew better in comparison with *P. strobus*: more seeds germinated, the seedlings developed higher biomass, trunks were taller, cotyledons were longer. Saplings were taller and produced more branches and terminal buds.
The kind of the litter on the soil surface influenced significantly more parameters of *Pinus sylvestris* then *P. strobus*: All of *P. sylvestris* seedling parameters exhibited lower values when cultivated in *P. strobus* litter. *P. strobus* was negatively influenced by its own litter only in the number of seedlings.
It could be concluded: *Pinus sylvestris* would grow better at more favourable stands then are those at which it prevails in the field - windy, dry and sunny rock tops and rock plateau edges. But at not so exposed localities a lot of *Pinus strobus* saplings appear making a dense undercanopy layer and causing the habitat is shady. Such environment suppress *P. sylvestris* sapling growth and survival.

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DIFFERENCES BETWEEN NATIVE AND NON-NATIVE POPULATIONS OF *LYTHRUM SALICARIA*

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Lythrum salicaria, native to Eurasia, has successfully colonized and established in temperate North American wetlands. The success of *L. salicaria* in North America may be the result of the rapid evolution of non-native populations into a more competitive genotype, compared to native Eurasian populations.
Based on the results of a field study, a three year long (1996-1998) common garden experiment, using a full factorial design, was devised to test the possibility that the native and non-native populations used in the initial study are different genotypes. Plants from one non-native U.S. (Indiana Dunes) and two native European (Opatovicky, Czech Republic; Gbelce, Slovak Republic) populations were subjected to one of three nutrient (nutrient-poor, intermediate, nutrient-rich) and one of two water level (saturated, unsaturated) treatments. Plants were grown in sand in tubs at the Institute of Botany in Trebon, Czech Republic, with plants in a particular tub subjected to similar treatment conditions. Measurements included flower phenology, susceptibility to herbivory, shoot height, stem number per plant, and dry weight biomass allocation. We hypothesized that non-native U.S. plants should be taller, flower later, have lower reproductive effort, and more biomass allocated to growth, than plants from native European populations.
Native European plants flowered earlier in the growing season than the U.S. plants, especially when growing in nutrient-rich conditions. There was a much greater difference between plants from Slovakia and the U.S. plants, than between the Opatovicky and U.S. plants. Insect herbivores, which attacked the plants naturally, did not have a preference for native or non-native plants. Also, there were no significant differences in shoot height or stem number between the U.S. and European populations, when subjected to similar treatment conditions. Reproductive effort was greater for European plants, but the differences were significant only between the U.S. and Slovakian populations. Similarly, U.S. plants allocated more biomass to roots, but, again, differences were significant only when comparing the U.S. and Slovakian populations.

The results of this experiment are counter to what is predicted by theory. While there are significant differences in some life history and growth traits between native and non-native populations of *L. salicaria*, mainly the populations tested grew in a similar manner. Any conclusions also appear to depend on which populations are being compared and in the conditions in which they are grown.

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COMPARISON OF POPULATION CHARACTERISTICS AND SITE AND PLANT COMMUNITY RELATIONSHIPS IN NATIVE AND INVASIVE *LYTHRUM SALICARIA L.*

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Lythrum salicaria L., an herbaceous perennial native to Europe and Asia, is recognized as an aggressive invasive species of North America wetlands. In the present paper, 26 invasive and 32 native populations of *L. salicaria* were compared in conditions of their growing habitats (native populations in Tøeboò Biosphere reserve – South Bohemia, Czech Republic and invasive populations in Indiana Dunes National Lakeshore – Indiana, USA). Basic population characteristics (shoot density, fertility *etc.*), plant life history traits (average height, plant architecture *etc.*) and stand characteristics (water level, irradiance) were quantified in native and invasive locations. Additionally, phytocoenological releves were taken to evaluate the frequency of co-occurring species in the primary and secondary regions.

Shoot density and fertility were significantly greater in invasive populations than in native ones. Invasive plants grew taller with more lateral branches, supporting the idea of increased competitive ability of those plants in plant communities.

Lythrum salicaria occurs in a wide variety of habitat conditions in both native and invaded areas; from very dry locations along railroads to deep water in lakes or ponds. Statistically, invasive plants occurred more often on stands with deep water and very scattered vegetation.

Invasive *L. salicaria* populations were more often monocultural (often connected with deep water), which is very rare in native populations, as the native plants seem to prefer more disturbed stands in ditches along roads. Native stands in the Czech Republic had higher species diversity than invasive stands in the U.S. On the other hand, plants in native populations were apparently more negatively affected by herbivores than plants in invasive populations. Other differences and facts found in plant, population and stand characteristics are discussed in the paper.

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U.S. ROADSIDE VEGETATION POLICY

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Past and Present Highway rights-of-way on interstate and State highways covers more than 10 million acres of land in the United States. When invasive plant species are found on those rights-of-way, the plants threaten our and our neighbors land. Non-native invasive plants do not respect political boundaries; and so we cannot limit ourselves to boundary solutions. We need to work together. Over the years, how we care for roadside right-of-way (ROW) has been similar from State to State. Our history goes something like this:

1930's - unwritten front yard policy. The development of roadsides was a natural goal following road construction, improved automobiles and public demand. Jesse M. Bennett wrote a book, *Roadsides, the Front Yard of the Nation* in response. He wrote *what is really desired, however, is attractive and useful roadsides which can be obtained by preserving or creating a natural or an approach to a natural condition in keeping with the adjacent or surrounding country. And the significant thing about this is that to follow a natural development is outright economy in road maintenance.* Unfortunately it was the title of his book, not his words that were unofficially adopted as policy. Mowing to a *front yard* look occurred nationwide.

1950's - agricultural approach. With the development of herbicides came another tool.

The mow-spray combination continued to achieve that front yard look. The State highway agencies had concluded by this time that *the look* was what the public wanted.

1970's - ecological approach. The energy crunch of this era halted this labor-intensive, fossil-fuel eating, maintenance approach. Yes, economic restraints led to ecological solutions during this decade. Less mowing and spraying had positive effects: increased wildlife habitat, enhanced natural beauty, saved maintenance dollars...and the public did not complain.

1990's - ecological approach and IRVM unite! Not all States embraced this common sense maintenance method. Because safety will always be the number one priority for transportation*s decision-making, many States did maintenance 50's style. The 90's fiscal constraints pressured those traditional approaches. Roadside managers sought affordable solutions that were environmentally responsible. The result was an idea that emerged from Iowa, Integrated Roadside Vegetation Management (IRVM). IRVM meant being site specific with methods and tools that fit each segment of roadside. When IRVM was explained to the public, the public embraced it.

Into 2000 - Pulling Together. But problems of vegetation management have been complicated by State and Federal Laws or absence of them, as well as weed population explosions. Often it is the highway agency that is blamed for the transport and planting of invasive species. This paper will explain current policy changes that have resulted from the signing of an Executive Order on February 3, 1999 by President Clinton to address invasive species across all agencies across the country, including highway ROW.

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WEEDING THE GRAND CANYON! NON-NATIVE PLANT MANAGEMENT AT GRAND CANYON NATIONAL PARK

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Did I here you correctly? You are asking park visitors to give up vacation time to hack at "non-native invasive" plants? Although the idea seems a bit far-fetched on paper, using volunteers to complete habitat restoration projects is an idea whose time has come. It is obvious that many people are truly interested in giving something back to their national parks.

Grand Canyon National Park's Habitat Restoration Team (HRT) program is an innovative approach to introducing the public to the joy of eradicating non-native species. Grand Canyon's "ground-breaking" technique was developed to involve park visitors in the effort to control some of the park's 140 known alien plant species. The program also provides a medium for educating the public about natural ecosystems, native and alien species, and ecological diversity.

The program is designed to take advantage of as many volunteers as possible. Scheduled small-scale projects are available for park visitors; organized groups are recruited and scheduled for larger projects; and participation by local schools is actively sought after and encouraged. Since its inception five years ago, the program has blossomed to over 14,000 volunteer hours in 1998.

Short-term projects are scheduled on a daily basis. During each 1.5-hour session, visitors are given a brief orientation to the issues on non-native plants and habitat restoration. After the orientation, the volunteers proceed to a work site to complete a restoration project. The projects generally involved removal of alien species and replacement with a native species.

The second component of the HRT program took advantage of organized groups to complete large-scale projects. These groups usually stayed at the park for several days and ranged in size from 10 to 100 people. The groups were scheduled several months in advance so that all necessary planning and environmental compliance requirements could be met.

Habitat restoration needs are not going to disappear. In these times of diminishing budgets, innovative approaches to solving problems need to be developed. Habitat Restoration Teams take advantage of a tremendous pool of talented and eager volunteers.

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INTERPRETING THE PROCESS OF INVASION: CRUCIAL SITUATIONS FAVOURING SPECIAL ATTRIBUTES OF INVASIVE SPECIES

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Analysing the causes and mechanisms of biological invasions, different approaches have been followed in the past. One of the most common approaches is the search for certain attributes, which make species invasive. Another approach is to look for abiotic or biotic conditions making a site or a community resistant (or especially prone) to invasions. A third approach is to consider the possibilities for an organism to get transported as being crucial for the process of an invasion.
It has already been stated that none of these approaches is appropriate to explain every single process of invasion. To get to an explanation of the causes and mechanisms of invasions, it is necessary to consider not just one of these decisive factors (attributes of the invading species, characteristics of the invaded ecosystems, modes of transportation), but all of them. Trying to combine the different approaches brings about the problem of handling the complexity of the invasion process.
A possibility to get over this problem will be presented in the paper. It will be demonstrated, that the interpretation of the invasion process as a sequence of barriers, which must be overcome for a successful invasion, is a helpful tool in understanding the invasion process. It is possible to find typical crucial situations within the invasion process, which may cause the failure of an invading species. For every one of these crucial situations there are special favourable attributes, which make it possible for a species to succeed in the crucial situation.

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THE SOUTHERN AFRICAN PLANT INVADERS ATLAS (SAPIA) AND ITS CONTRIBUTION TO BIOLOGICAL WEED CONTROL

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The Southern African Plant Invaders Atlas (SAPIA) is a mapping project, launched in 1994, to collate information on the distribution, abundance and habitat types of alien invasive plants in southern Africa. The SAPIA database is a computerised catalogue of some 40 000 locality records of more than 400 naturalised alien plant species. The database incorporates records gathered by about 180 participants between 1994 and 1998 and from roadside surveys conducted by the author between 1979 and 1993. Among its many uses, SAPIA can assist biological control programmes, in particular the more recent ones, in several ways. Information on the geographical distributions and ecological requirements of invasive plants in their introduced range can ensure that biological control agents are brought from comparable habitats in their country of origin so as to optimise the chances of establishment and efficacy. Early detection of new invaders and new foci of spread allows implementation of biological control at an early stage of invasion with the potential to pre-empt severe problems. In the long term, SAPIA will also provide an historical record of the spread of invaders and can thereby be used to monitor the effectiveness of introduced biological control agents. Although biological control programmes against weeds have been ongoing in South Africa for some 80 years prior to the advent of SAPIA, baseline data generated by this initiative should prove particularly useful in the case of new programmes.

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NATURAL SEED-BANKS, SEEDLING GROWTH AND SURVIVAL IN AREAS INVADED BY *GUNNERA TINCTORIA* (MOLINA) MIRBEL

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In the west of Ireland invasion by the N-fixing, alien species *Gunnera tinctoria* has lead to changes in community composition. This results in the formation of almost monospecific stands of *G. tinctoria*, with a fragmentary ground flora, comprising between ~ 22 and 40 higher plant species. Only 3 to 14 of the 22 to 40 species present were common to both colonised and uncolonised areas. Few surviving seedlings of *G. tinctoria* were found in either colonised or uncolonised areas even though individual plants of *G. tinctoria* are capable of producing ~760,000 seeds annually. Examination of colonised plots indicated that only ~ 0.1% of the potential seeds produced germinated and, of these, at most 3% (22 to 33 seedlings m-2) over wintered successfully (Fig. 1a). In contrast, significantly less seedlings of all the other species were present in the colonised plots, and few of these survived (Fig. 1b).

Fig.1. Total number of seedlings of *G. tinctoria* (a) and associated species (b) in colonised plots (● = well-drained site; = poorly drained site).

We investigated the reasons for the poor germination and survival of seedlings beneath the *G. tinctoria* canopy. Two assessments of the seed-bank of colonised plots were carried out over 2 consecutive years in the greenhouse, under exposed and shade conditions with differing watering regimes, using soil collected before (Feb-Mar) significant growth of *G. tinctoria* had occurred. Under these conditions only 1 to 4 additional species were found, indicating that few species fail to germinate under natural conditions. However the number of species were significantly reduced (9-18), suggesting significant recruitment into the

colonised plots prior to canopy closure. Of the seedlings present those of *G. tinctoria* dominated the population with peak values between May and June when the canopy is almost developed (Table 1).

Table 1. Numbers of seedlings of *G. tinctoria* grown under greenhouse conditions given optimal (+ H2O) and sub-optimal (– H2O) amounts of water.

	Numbers of *G. tinctoria* seedlings (m-2)			
Month	Shade + H2O	Shade - H2O	Open + H2O	Open - H2O
March	268 318	204 178	459 726	484 561
April	5873 3337	5770 4127	7515 4650	6828 4115
June	6471 3681	6140 4076	8547 3107	8217 6242

Although water supply and shading influence seedling germination, with the lowest germination under shade, this did not account for the approximately 90% reduction in germination, in the field beneath the *G. tinctoria* canopy. Seedling numbers of the other species were significantly less (120-140 m^2), with a seasonal pattern and magnitude comparable to the field results (Fig 1b). On the basis of these results there is little evidence for any additional factors inhibiting the germination of these species in the colonised plots.

INHIBITION OF FOREST SUCCESSION BY NON-INDIGENOUS VINES FOLLOWING A NATURAL DISTURBANCE

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After disturbances such as tree falls, fires and hurricanes, vines sometimes constitute an initial sere that temporarily provides cover. They may grow rapidly over the ground and ameliorate harsh heat and light as well as preventing erosion; they may create conditions favorable for the establishment of trees. On the other hand, vines may cover gap areas too intensively and for a prolonged period, shading out any potential sources of forest regeneration. We investigate the role of non-indigenous *vs* indigenous vines in forest succession with five years of experimental data on vine cover and forest regeneration from tropical hardwood forests of southern Florida after Hurricane Andrew. To facilitate the natural regeneration process, managers removed non-indigenous vines from some forest areas. Recruitment of native seedlings and saplings was higher in areas from which non-indigenous vines had been removed. Recruitment of non-indigenous vines was shade tolerant in contrast to native vine recruitment. Also, our results indicate that non-indigenous vines strangled gaps more often than native vines. A model incorporating these effects indicates that non-indigenous vines dramatically altered the spatiotemporal pattern of recruitment sites.

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IMPACT OF THE INTRODUCED TREE *CINCHONA PUBESCENS* VAHL. ON THE NATIVE FLORA OF SANTA CRUZ ISLAND (GALAPAGOS)

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This quantitative study evaluates the impact of *Cinchona pubescens* (syn. *C. succirubra*) (Red Quinine Tree) on the native vegetation in the Miconia- and Fern-Sedge zones in the highlands of Santa Cruz Island (Galapagos). Percentage cover of all species occurring in this area was measured in plots suffering from a range of invasion by *Cinchona* and by means of transects around individual *Cinchona* trees.

Though investigations in plots did not reveal significant differences between grades of invasion, measurements around individual *Cinchona* trees displayed drastic reductions in all species and especies groups' concerned when comparing the outer area with the area under the tree's canopy. In the *Miconia* zone, cover of the endemic shrub *Miconia robinsoniana* was reduced by almost half when these two areas were compared. In the Fern-Sedge zone the species especially affected included the native grasses and the endemic herbaceous species *Justicia galapagana* and *Pilea baurii*, which were significantly reduced in their cover. In general, vegetation of the Fern-Sedge zone was more adversely affected by the presence of *Cinchona pubescens* than that of the *Miconia* zone. This is probably due to the fact that species in the *Miconia* zone are already shade adapted to a certain degree as they are adapted to live under the relatively dense canopy of the *Miconia* population when in healthy condition. An analysis of historical records for the *Cinchona* invasion for the last 20 years, showed that the originally treeless highlands of Santa Cruz will be entirely covered with *Cinchona* if no control of the invader is implemented. It is recommended to keep the *Miconia* zone free of *Cinchona*, since this is a unique vegetation zone and the area is limited, so that an eradication is feasible. In the Fern-Sedge zone, prioritized areas should be established which will be intensively, since native and endemic species are adversely affected in this zone.

Furthermore the seed-producing trees should be controlled in the Fern-Sedge zone, since the light wind-born seeds are easily distributed and cause a continuous infestation with *Cinchona pubescens* in other areas or a reinfestation of areas already controlled.
By means of permanent vegetation quadrats, a long-term sustainable monitoring project was established to study the ecology of the invasion by *Cinchona* and the biological

characteristics that account for its invasive character (e.g. phenology, growth, vegetative reproduction).

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SOME ASPECTS OF GENERATIVE REPRODUCTION OF INVASIVE NORTH-AMERICAN ASTERS IN THE CZECH REPUBLIC (MIDDLE EUROPE)

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Perennial North-American members of the *genus Aster* L. have become very common in the Middle Europe, especially in the lowlands and disturbed sites such as urban abandoned areas, road and railway ditches. These invasive *Aster*s were tested on their seeds germination capacity, the main character of the generative reproduction.
Mature achenes were taken from wild growing *Aster*s in three macrolocalities in the Czech Republic. Ten samples of achenes were germinated after three differnt treatments: immediately after ripening in the autumn, after cool storage at 5 °C and storage at room temperature. The experiments shows that *Aster*s haven't a primary dormanci and can germinate immediately after ripening in the autumn. The percentage of germinating achenes is approximately correlated with the percentage of mature achenes and can reach a relatively high value (about 70% in three samples) after using all treatments. The relatively low value of germinating achenes (about 10% in two samples) can be due to different enviromental conditions, or the hybrid origin of sampling plants. Nevertheless the taxonomical origin of *Aster*s growing in the area of the Czech Republic (also in the Middle Europe) haven't been clarified.

AUTOTOXICITY IN *TITHONIA TUBAEFORMIS* AS A MECHANISM OF INVASION CONTROL

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In the last decades, the studies of biological invasions has increased, as one of the components of global change and biodiversity loss. The northwestern of Argentina is affected by *Tithonia tubaeformis* invasion, a plant from Mexico. It appeared in the Lerma Valley (Salta, Argentina) in 1978, and is found as weed in corn, sorghum and bean crops. The invasion success of this plant is related to its reproductive rate that produces more than 3,000 fruits by plant. The objective of this work is the study of autotoxic chemical compounds produced by this plant. Dry tissues of the inflorescence, leaf and stem were macerated separately in distilled water and the extraction of the compounds was conducted following Heisey (1996). Triplicates, following a randomized design in a germination chamber, using 20 seeds per container ran bioassays. Each container was moistened with the different extracts separately. There was a significant inhibition of germination with the chloroformic extracts from stems and leaves. From these extracts a TLC chromatography was conducted in silica gel and the presence of flavonoids was detected.

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INVASIVE PLANTS ON LAND RECOVERING FROM DESERTIFICATION ON ST HELENA ISLAND - POSITIVE AND NEGATIVE EFFECTS.

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Saint Helena Island, South Atlantic, has a long history of mis-management of natural resources. Loss and fragmentation of the natural vegetation began in the early 1500s with the release of feral goats and tree removal for firewood and timber. Today wastelands of bare soil and sparse, mostly exotic scrub, cover over 60% of the island. Indigenous semi-natural forest covers less than one per cent of the country, occurring only in isolated remnants and are given statutory protection as Crown Lands (Maunder *et* al, 1995).

The native flora of St Helena consisted of about 70 species of flowering plants and ferns, 60 of which are endemic in 10 endemic genera. This makes it one of the most important islands for biodiversity in the world. Many of the plants are relicts of a primitive flora that was once widespread and that colonised the island perhaps 10 million years ago (Cronk, 1989). Today approximately 50% of these natives are extinct from the island. In parallel with this decline, introductions of economically important plants have increased the number of species significantly together with an accidental increase in weeds and invertebrate pests. The flora now consists of about 320 species, of which 260 (86%) are naturalized aliens.

The last feral goats were culled in the 1960s (Cronk, 1986) and the regeneration of vegetation on the barren areas is now clearly progressing. Areas devoid of trees just twenty years ago now show a developing covering of sparse scrub. However the opportunities and trends now presented are complex. A careful analysis is required of whether the revegetation can be influenced by intervention, the nature of the species and communities that are developing, and the ways in which sustainable use can be made of the new land use opportunities.

The key colonists on the regenerating scrublands include several weeds of global importance such as *Opuntia* species, *Lantana camara* and *Schinus terebinthifolius*. Is it possible that the recovery from desertification is as big a threat to St Helena than the original degradation was? To be able to make a realistic assessment of the weed threat requires addressing the issue of what the concept of 'weed' really means in the heavily degraded environment of the St Helena Wastes. For a plant to be a real weed on the island there has to be a target for it to impact against, it needs to be expected to cause significant harm and it needs to be a species for which eradication or control is challenging. The challenge on St Helena is to predict these impacts or problems for ecosystems that are as yet unformed, and to identify which weeds will be likely to remain problems rather than representing a temporary successional stage.

The following threats may result on St Helena through the growth of undesirable shrubs: soil quality degradation; excessive water use; encouragement of spread of invertebrate pests (*Lantana* is a host for *Orthyzia insignis* that has threatened endemic relict woodlands); competitive threat to pasture land species; competitive threat to forestry land species; human health effects (*Schinus terebinthifolius* has been linked to respiratory diseases); livestock health effects (poisonous plants); honey spoiling; development of a fire risk; weed threat to endemic plant refuges (this has international as well as local significance).

In contrast many of the invading plants play an important role in substrate development and soil stabilisation. In the 1970s biological controls were introduced to attack *Opuntia* and *Lantana* and this has lead to an increase in erosion and the redevelopment of instability on slopes above housing (Kendle, 1995).

Amidst growing global concern about invasive species there is a great temptation to see the dominance of non-native species on St Helena as in itself a problem that needs to be tackled, but this would present the people of the island with an impossible challenge. The future ecology of St Helena will inevitably be based on a combination of natives and non-natives. Alien species can not be condemned just because of their non-native origin or even rate of spread, rather a functional classification of the effects and behaviour of each species is required.

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INSECT HERBIVORY ON INVASIVE ALIEN PLANTS - A COMPARISON OF 10 INVASIVE AND 10 INDIGENOUS SPECIES

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Success of alien plant invasions is often attributed to the release from natural enemies. In this study we examined whether invasive alien plants host fewer herbivorous species than indigenous plants. Furthermore we analyzed herbivorous pressure on both plant groups. Endophagous insects in leaves, stems, and fruits were examined in 10 invasive and 10 indigenous plant species. Indigenous plant species were chosen carefully in order to maximize similarity of the paired invasive and indigenous species considering distribution, plant architecture, taxonomy and ecology. Results showed that invasive alien plants hosted fewer species of herbivores than indigenous control plants. Difference in species diversity between both groups increased when parasitoids were taken into account. Moreover attack rate of herbivores was significantly lower on invasive plants and herbivorous insects reached significant higher abundances on indigenous control plants.

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COLONIZATION OF ALIEN TREES BY A NATIVE HEMI-PARASITIC PLANT

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One major component of biological invasions is the interaction of invasive species with native organisms, for instance the interaction between alien plants and native herbivores, pathogens and parasites. Because of the high diversity of alien plant species, parks and gardens may provide suitable model systems to evaluate possible effects of plant invasions across the food web. The aim of our case study is to identify factors determining the colonization of alien trees in the City Park of Mendoza (Argentina) by *Ligaria cuneifolia* (R. and P.) Tieghem (*Loranthaceae*), a widespread hemi-parasitic mistletoe of arid regions in Argentina. Using a multi-factorial approach, we test if the incidence of *L. cuneifolia* on alien park trees depends on (1) the taxonomic isolation of the tree species, (2) the abundance of the tree species in the park, and (3) the nitrogen concentration in the trees.

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INVASION POTENTIAL AND INVASION SUCCESS: ON THE RELEVANCE OF MAN-MADE INTERACTIONS

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Which traits of an alien species and which of the recipient ecosystems decide the success of an invasion? There is a still increasing knowledge on these classic questions of invasion biology. Save predictions on the performance of alien plant species are however still limited. This may be only partly due to incomplete knowledge on biological characteristics of species and habitats. This paper stresses the role of different types of man-made interactions on the performance of plant invasions. In addition to factors ascribed to species and to habitats, human interference should be recognised as a third set of factors that may determine the success or failure of invasions.

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THE ROLE OF *ACER NEGUNDO* L. IN THE STRUCTURE OF FLOODPLAIN FORESTS IN THE MIDDLE COURSE OF THE VISTULA RIVER

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Acer negundo (ash-leaved maple) has been recognized as a very agressive antropophyte in the Central Europe. It is a widespread and common tree in the floodplain zone of the Vistula River. The aim of this study was to determine the influence of ash-leaved maple on riparian scrub and forest plant cover. The species composition of scrub and forest communities was analysed along a hundred kilometre stretch of the Vistula course. The Braun-Blanquet method was used on 100 (400 square metre) sample plots. The detail structure analysis was conducted on twelve 1000 square metre plots.
Crown-projection, height and diameters of tree and shrub layers were studied on plots holding different cover of ash-leaved maple individuals. Although *A. negundo* forms communities dominated by itself two-way indicator species analysis showed that environmental factors were still mainly responsible for species distribution on the floodplain. In additon the presence of *A. negundo* was connected with geomorphological configuration which was a typical habitat of willow-poplar forests. The influence of ash-leaved maple on invaded communities is manifested in the reduction of species richness of shrub and herb layers. Compared to other woody native species it forms very asymmetric crowns.
This is caused by strong tendency of *A. negundo* to polycormonic growth that enables it to fill in empty spaces created by natural or anthropogenic disasters. Secondary communities dominated by ash-leaved maple are poor in species with lower shrub and tree densities and lower average height.

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RELATIVE EFFECTS OF NATIVE VEGETATION TYPE, ANTHROPOGENIC DISTURBANCE, AND STOCHASTICITY IN ALIEN PLANT INVASION OF A MIXED-GRASS PRAIRIE PRESERVE

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The ability of alien plant species to invade a region depends not only on attributes of the plant, but on characteristics of the habitat being invaded. Here, I examine characteristics that may influence the success of alien plant invasion in mixed-grass prairie at Theodore Roosevelt National Park, in western North Dakota, USA. The park consists of two geographically separate units with similar vegetation types and management history, which allowed examination of the effects of native vegetation type, anthropogenic disturbance (differences attributed to association with roads, trails, campgrounds, picnic areas, and seeded fields), and stochasticity (differences in colonization of each park unit) on the invasion of native plant communities by alien plant species common to counties surrounding both park units. If matters of chance related to availability of propagules and transient establishment opportunities determine the success of invasion, stochasticity and anthropogenic disturbance should better explain the variation in alien plant frequency; however, if invasibility is more strongly related to biotic or physical characteristics of the native plant communities, models of alien plant occurrence should contain vegetation type as an explanatory variable. Field crews examined more than 1,300 transects in all vegetation types for alien plants. We used Akaike's Information Criterion to select the best model for each species. Individual species generally fell into one of three groups: those with distributions best described by (1) the main effects or interaction between vegetation type and park unit (7 species), (2) main effects of park unit and/or disturbance (7 species), and (3) main effect of vegetation type (2 species). Despite well-documented associations between disturbance and alien plant invasion, five of the six most abundant alien species at the park had distributions unrelated to disturbance. Vegetation type should be explicitly taken into account when designing monitoring plans for alien species in natural areas.

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IRRIGATION AND EXOTIC SPECIES IN SARDINIA (ITALY)

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Sardinian agriculture is strictly dependent on irrigation. The summer drought make necessary the use of irrigation for many different crops, as well as for forages and fruit growing. Furthermore, the human demand for water arises in summer for the increase of population due to tourism. Therefore, the island is crossed by a network-system of water basins, channels, summer irrigated fields in the plains *etc*. We focused our attention on a study area in the Northern part of Sardinia (Coghinas water basin and irrigation catchment), with field surveys in the water basin and in the land served by the irrigation network, a plain land well suited for semi-intensive to intensive agriculture.
The aim is to verify the impact on the environment of this intervention, mostly concerning modification of flora and vegetation, with particular concern to the introduction, spread and establishment of exotic species.
In this first contribution, we mostly describe some changes in the landscape related to the change in the land use in the surroundings of the basin and the presence and behaviour of some exotic species such as: *Acacia* sp., *Agave americana, Ailanthus altissima, Amaranthus* sp pl., *Carpobrotus* sp., *Chrysanthemum coronarium, Conyza* sp., *Cupressus* sp., *Eucalyptus globolus, Ligustrum* sp., *Melilotus messanensis, Opuntia ficus-indica, Papaver sonniferum, Robinia pseudoacacia, Xanthium spinosum.*

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ALIEN WOODY INVADERS IN PORTUGAL - A BRIEF SURVEY

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Invasion by alien woody plants is becoming a serious problem in many places of Portugal. This phenomenon has considerably increased in the last few decades, not only in the continental territory, but also in Madeira and Azores Atlantic archipelagos. The main invasive plants recorded are *Acacia* spp. - notably *A. dealbata* Link - *Ailanthus altissima* (Miller) Swingle, *Hakea sericea* Schrad., *Clethra arborea* Ait. and *Pittosporum undulatum* Vent. A considerable area in forest ecosystems and rangelands has been invaded, and many natural and seminatural habitats are actually threatened.

Despite the dimensions that this problem is acquiring, the gravity of the situation is not yet fully recognised, neither by governmental agencies nor by non-governmental organisations. At the same time, much more information on the biology and ecology of the invasive species is needed in order to design effective species control programs. Thus, a proposal for action would include:

Survey of invaded areas;

Promotion of bioecological studies of the invasive species and assessment of its environmental impact;

Design and implementation of effective control strategies;

Rehabilitation of invaded areas, after controlling procedures.

Nevertheless, the possibility of finding a commercial value for some of the invasive species could enhance its control by financing, at least partially, the actions above mentioned. Investigation towards such valuation and the possibilities of lumbering is an important aspect that must be taken into account.

ANALYSIS OF PLANT INVASION IMPACTS AT THE GLOBAL SCALE: A GCTE INITIATIVE

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Recently, the impacts of no-indigenous species have become the focus of interest for such a wide range of scientists (from evolutionary biologists to global change researchers) as well as public interest groups (from aquaculturists to conservationists) that the variety of perspectives on how to measure these impacts is quite bewildering and important questions remain to be answered: What impact is, how we decide that the impact of one non-indigenous species exceeds that of another, or that the impact of a particular non-indigenous species is greater in one place than in another?

The Global Change and Terrestrial Ecosystems (GCTE*) project of the International Biosphere-Geosphere Program (IGBP) has launched an international initiative to quantify impacts of non-indigenous species. GCTE proposes a conceptual framework to measure impacts of non-indigenous plant species on a geographic scale. Three factors will determine the overall impact of an invasive non-indigenous species: the total area occupied, abundance, and some measure of the impact per individual that can be formally expressed with the equation: $I = R \times A \times E$ where overall impact, I, is defined as the product of the range size R (in km^2) of a species, its average abundance per unit area across that range (A, in numbers, biomass, or other relevant measure per m^2), and E, the effect per individual or per biomass unit of the invader.

For this purpose, over the next two years we propose to survey available data using the above mentioned conceptual framework to develop a common currency, or surrogate, for measuring E that will allow us to rank functional groups of invaders in order of per capita impact. Examples of potential surrogates or bioindicators might be yield losses for agricultural weeds and costs of herbicides for particular weeds.

* (*http://GCTE.org*)

CENTAUREA DILUTA AITON, POINTS ADDED AND CLARIFICATION ABOUT ITS DISTRIBUTION IN ITALY

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Centaurea diluta Aiton has been recently reported as a new exotic species for Italian flora, after being found in Abruzzo by Conti and Manzi; in the same period we had also found this species in Sicily (Plain of Catania) and Molise (Tavenna country).

We point out that in Sicily this species had already been collected by H. Ross in Marsala between 1887 and 1897, but had been wrongly identified by Lojacono as *C. urvillei* DC. In Marsala's territory this species is no longer found despite having searched for.

While for the Abruzzo and Molise stations it is evident that it is an alien plant not yet naturalised (fragmentary distribution in synanthropic habitats) in relation with a recent introduction, for what concerns Sicily we can think that, on the contrary, we are in the presence of fully naturalised populations and anyway totally integrated in local *Hedysarum coronarium* stands, so that the problem of the character of the species being native or not remains open to question. We could even argue that, at present, this species would be undergoing a new phase of re-expansion in the Italian peninsula.

A comparison can be made with *C. pullata*, which has been found recently by Lucchese in Lazio and whose area in great part corresponds to the one of *C. diluta* (Iberian-Maghrebinous element with distribution in Morocco, Algeria, Madeira and Canaries, SW and NE of Iberian Peninsula).
On this basis, the present expansion of such Iberian-Maghrebinous species towards our peninsula could be interpreted, even if favoured by man's activity, as a reoccupation of a territory which was already a part of an ancient area.

All this with the push of that progressive global warming registered in the last years (with very accentuated peaks in the Mediterranean), which could be interpreted as a new favourable factor.

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COMPARISON OF NATIVE AND INVASIVE PINE SPECIES (*PINUS SYLVESTRIS* AND *P. STROBUS*) USING TREE-RING ANALYSIS

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The research was conducted in Elbe Sandstone Landscape Protected Area in northern Bohemia, Czech Republic. Alien species white pine (*Pinus strobus*) from Northern America was brought here 200 years ago by foresters. Since 1970's we encounter massive spontaneous invasion of *P. strobus* into natural and seminatural coniferous forests. Of these, relict pine forests dominated by native Scots pine (*Pinus sylvestris*) (alliance *Dicrano-Pinion*, association *Dicrano-Pinetum*) which skirt the rock edges are the most endangered. In the light of this invasion we investigated relations between *P. sylvestris* and *P. strobus* by means of tree-ring analysis.

The first topic studied was the interspecific competition between *P. sylvestris* and *P. strobus*. Chronologies (mean increment curves) of *P. sylvestris* from mixed Scots pine - white pine forests were compared with chronologies of *P. sylvestris* from pure forests growing on similar stands. As for mixed stands, there were chosen localities with various age of trees of both species, different canopy and stand characteristics.
Chronologies of mixed stands with *P. strobus* trees distinctly younger and smaller than *P. sylvestris* trees didn't show any significant differences compared with chronologies for pure stands. The results were the same for open stands with old and grown white pines. Only on the closed stands, where white pines were higher than Scots pines (but they weren't always older than Scots pines), a decrease of *P. sylvestris* increments is seen. The beginning of the decrease shows the time, in which white pines outgrew and started to suppress Scots pines.
Response functions, which show influence of climatic factors (mean monthly temperatures and monthly rainfall totals) to tree-ring characteristics, were computed using the program PRECON (the calculation is based on stepwise multiple regression). Tree-ring width of both species and type of stand were positively affected by temperatures in February and precipitation in July in current year. March temperatures also positively influenced *P. sylvestris* increments, while *P. strobus* negatively reacted to temperatures in September in previous year. Total variability explained by climate was 0.53 for *P. sylvestris* from mixed stands, 0.57 for *P. sylvestris* from pure stands, 0.60 for *P. strobus* from mixed stands and 0.61 for *P. strobus* from pure stands. It means that *P.strobus* is slightly more sensitive to climate than *P. sylvestris*. Difference between stands can be explained by differences in microclimatic conditions in pure and mixed forests.

The second topic studied in effort to determine the resistance of *Pinus strobus* to climate extremes was comparison of *Pinus sylvestris* versus *Pinus strobus* reaction to climate (response function). To cover different ecological stands we sampled trees over an environmental gradient: from the sunny and dry edge of the sandstone plateau to the cold and shady bottom of a narrow river defile, both on southern and northern slope.
Surprisingly, there were no distinct differences between stands and species, ring widths of both species at all sites were significantly positively affected by temperature in February or March and precipitation in May, June and July of the current year. Total growth variability explained by climate was 0.56 for P. sylvestris from the rock edge with northern exposition, 0.52 for P. sylvestris from the rock edge with southern exposition, 0.57 for P. strobus from the rock edge with northern exposition and 0.63 for P. strobus from the slope near the bottom of the valley with southern exposition.

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INVASIVE BEHAVIOUR OF *MIMOSA PIGRA* L IN SRI LANKA

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Mimosa pigra L was first identified in Sri Lanka in 1997 (Amarasinghe and Marambe, 1997), growing luxuriantly and spreading along the riverbanks in the Central Province of Sri Lanka. The species has been recognised as a threat to the natural ecosystem of the country. Thus, studies were initiated to understand the growth and development, and distribution of *Mimosa pigra* in Sri Lanka. This was considered a pre-requisite to elucidate the invasive characteristics of the plant, to assess the threat of the invasive species to the natural ecosystem and to develop judicious control strategies.

The mature seeds of *M. pigra* (Table 1) were 100% viable after storage in room temperature (28 °C) and at 8 °C. About 99% of the seeds germinated only after sand scarification. In the Central Province of Sri Lanka (mid country wet zone, 28 °C, 480 m asl, 70-80% humidity), the onset of flowers was first observed at 12 weeks after planting (WAP). The initial growth of the weed was slow, but the height increased at 2.43 cm/day during the first 9-12 WAP. From 12 WAP, the stem dry weight of *M. pigra* increased at a rapid rate than the root dry weight. The growth analysis (Table 2) indicated that relative growth rate (RGR) increased until onset of flowers and then decreased. The soil-seed bank density within the canopy diameter of the naturally grown *M. pigra* plants varied from 2336 to 46,410 seeds/m".

Two years after the initial study conducted in 1997, *M. pigra* was mainly found in Kandy district (Central Province) and in three other districts in Western and North Western Provinces of Sri Lanka. The weed has formed a dense thicket along a 30-35 km strip along the Mahaweli riverbank, the longest and the major river in the country, which passes through the Central province. Water and river sand are the major carriers of *M. pigra* seeds. The weed has also invaded construction sites, non-agricultural lands, roadside, and paddy fields that have been abandoned for at least 2 cultivating seasons (approximately 1 year).

Table 1. Seed Germination Percentage of *Mimosa pigra*.

Seed Treatment	Seed Germination Percentage*		
At Harvest	Stored for	Stored for12 months at 8 °C	12 months at 28+-2 °C
Sand Scarification	99	98	100
Soaking in water (24 h)	3	2	3
Soaking in water (72 h)	3	3	2
Control	3	3	3

* Seed viability was 100% at 12 months after storage at both temperature regimes.

Table 2. Growth Analysis of *Mimosa pigra*.

Time (weeks)	L.W.R.* (g/g)	R.W.R. (g/g)	S.W.R. (g/g)	D.M.P. (g/plant)	R.G.R. (g/g/wk)	A.G.R. (g/wk)
8	0.59	0.23	0.19	0.59	-	0.07
12	0.41	0.29	0.29	2.79	0.44	0.69
14	0.38	0.29	0.31	2.19	0.25	1.09
16	0.32	0.30	0.38	2.58	0.29	1.29
18	0.29	0.42	0.30	1.88	0.10	0.94

* L.W.R.-Leaf Weight Ratio; R.W.R.-Root Weight Ratio; S.W.R.-Shoot Weight Ratio; D.M.P.-Dry Matter Production; R.G.R.-Relative Growth Rate; A.G.R.-Absolute Growth Rate

The results indicated that *M. pigra* seeds could be dormant for prolonged periods, and germinate readily after sand scarification. Under Sri Lankan conditions, the plant reaches the reproductive stage earlier than that observed in other countries (Lonsdale and Abrecht, 1989). *Mimosa pigra* has invaded a large extent of land within a relatively short period of time (2 years) and could cause a shift in the plant community in the natural ecosystems. This invasive plant spreads rapidly into surrounding environments mainly by seeds carried with water and river sand.

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IMPACT OF THE EXOTIC *GENUS ACACIA* SP. ON PLANT BIODIVERSITY OF THE PORTUGUESE SANDY COAST.

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Acacia species were originally introduced in the Portuguese dune system for stabilising sand dunes. Some of these introduced species have invasive properties and in several areas invasion has taken place, which represent an important threat to the native biodiversity, and it is endangering the natural succession of dune communities.

Some of the coastal invaded areas have conservation value and are therefore preserved areas. The scope of our research is to monitor the impact of *Acacia* in those areas in order to produce data for a better management and protection of coastal areas; preventing the loss of native biodiversity.

Acacia longifolia, the dominant species in the studied areas, can maintain numerous seed banks and regenerate vigorously after fire. These characteristics, associated to its exotic condition have been of great advantage in the invasion of the dune systems. Its uncontrolled growth in open areas (burnt areas) may result in *Acacia* forests that may change environmental conditions preventing the development of native species.

In this work we show the *Acacia* impact on plant biodiversity, comparing diversity in areas invaded by exotic species with biodiversity in natural, not invaded, areas. Disturbance factors that might make these habitats more susceptible to invasion by *Acacia* were also evaluated.

Sites along the Portuguese sandy coast were selected and every two-month inventory were made on fixed plots, and several parameters were registered as cover area of each invasive species; % of green branches/dead branches; diameter of *Acacia* stem; and *Acacia* species identification.

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AUSTRALIA'S 13 MOST UNWANTED

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Australia is an island continent, populated by primarily european stock. It has a land mass of 7.6 m / k2 and a population of only 19 m, this is only 2.3 people per km2. Europe has a density of 104 people per km2. In this large continent, with such a low concentration of people, the opportunity for weed invasion is open and once established, the cost of controlling invasive weeds is prohibitive. To overcome these obstacles, an effective quarantine service has been developed and a national weed strategy adopted.
Only 15% of Australia's population live in the rural areas. Agriculture, forestry and fishing only account for 3.8% of Australian GDP. Only 4.5% of the agricultural land is under crops, the largest of which is wheat. We have a small but flourishing wine industry. One of the unique characteristics of Australia is the ubiquitous native forests of *Eucalyptus* spp. There is a developing plantation of both *Pinus* spp. and *Eucalyptus* spp., the majority of which is used to produce paper. National Weed Strategy (NWS) and Weeds of National Significance (WoNS). NWS was launched in 1997 to co-ordinate weed control of exotic invasive weeds of primary production and the environment. All levels of Government and farming institutions were involved. As part of the strategy, it was decided to attempt something that we believe has not been undertaken anywhere else in the world, that was to undertake an assessment process to determine the 20 WoNS, with the 4 major criteria of invasiveness, impacts, potential for spread, socio-economic and environmental values. The process was developed by a Weed Risk Assessment Consultancy, including a literature review, a national workshop, and a national survey of Weed Managers and Researchers. We believe that the system developed is the first attempt to rank the importance of invasive weeds on a national scale for all ecosystems. I have used the following 13 plants as a good example of how these weeds were introduced into Australia.

Coastal Ecosystems
Lantana camara L., common Lantana, *Chrysanthemoides monilifera* ssp. *rotundata* (bitou bush).

Arid Zone
Acacia nilotica (L.) Delile (prickly Acacia), *Prosopis* spp. (mesquites).

Subtropical Zone
Parthenium hysterophorus L. (parthenium weed).

Tropical Zone
Cryptostegia grandiflora R.Br.(rubber vine), *Mimosa pigra* L.

Aquatics

Alternanthera philoxeraoides (Mart.) Griseb. (alligator weed), *Salvinia molesta* D.S. Mitchell (salvinia).

Temperate Zone
Rubus fruticosus L. agg. (blackberry), *Ulex europeaeus* L.(furze - gorse), *Echium plantagineum* L. (Paterson's curse) *Nassella trichotoma* (Nees) Hack. (serrated tussock).

All of the above species are highly invasive, therefore effective management of these weeds involves a much wider interpretation than the traditional spray/and burn techniques. Most of Australia's invasive weeds were deliberately imported as "it seemed like a good idea at the time". No thought was given to future weed status, as most of these weeds were not significant invaders in their home environment. Australia now has an effective quarantine system to ensure that any plants imported are evaluated for their potential weediness prior to approval for release.

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THE INVADING PLANT AND MAN - AN INTERSPECIFIC RELATION? FUNCTIONAL AND EVOLUTIONARY APPROACH

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The success of invasion is affected by numerous traits of the species and the invaded site. Among the traits of invaded ecosystem, the presence of mutualists and lack of predators are seen as most important factors. On the other hand, the activity of man is thought to impact significantly modern plant invasions. In my paper I show advantage of application of interspecific relationships theory for the man-invading plant interactions. It can be described functionally. The ability to be favoured intentionally or unintentionally by man (useful economically or aesthetically for man or simply unrecognisable from the preferred species) may help in the process of dispersal, colonisation and persistence in the human-influenced environments. On the other hand the presence of man as the mutualist (agent of disturbance or provider of effective ways of dispersal) and its absence as the predator (e.g. invasion control) are important properties of invasion-prone habitat. An evolutionary approach can be applied too. Being an important and powerful base of modern ecology of interspecific it deals with the process of selection acting on the level of population, community and ecosystem. Because the most of human variability is determined culturally. we have to analyse the culture evolutionarily too, e.g. as proposed by Dawkins (1977). When compare properties of these two kinds evolution: genetic *vs* cultural, conservative *vs* non conservative, non-cumulative *vs* cumulative, we can explain many patterns of invasions, related to difference in selection patterns. E.g. If positive and negative forces of human-related selection are very strong and very unstable, then the best invader profits of cultural trends and quickly spread independently, like cultivated wild plant species, when compared with highly transformed cultivars.
An implementation of the functional and evolutionary theory of interspecific relations may help to describe uniformly all realm of interactions between man and the bioshpere.

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CULTURE, NATURE AND THE PLANT INVASION

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Plant invasions are widely thought to be determined both by natural site conditions and human disturbances. Also the important role of positive interactions were noted. These simple relations are, however, hardly diversified and difficult to be studied together. It is indispensable to engage specialist in anthropology and the invasion ecology. The study area plays an important role too. This study was done with partial use of data on *Acer negundo* . invasion at Bialowieza, of the clearings of Bialowieza Forest (ca. 15 km^2, 2,500 habitants). For the present moment the invasion is limited to disturbed sites within the village, e.g. neglected courtyards, roadsides, riverbanks and fences. The only invaded forests are the most disturbed pine plantations close to the clearing border. The aim of this study is to analyse influence of habitants number, patterns of human behaviour, local customs, mode of life, richness, and direct relations to the species on population dynamics of the species within and around the village. One of the authors (P. Mêdrzycki - a plant invasion ecologist) has performed a detailed study of *Acer negundo* L. population in the Bialowieza Clearing, including direct mapping, measuring height and dbh, and dendrochronological study. The second (E. Keczyñska - an ethnologist, a specialist on Bialowieza culture) has done local sociological and ethnological researches. Results of the study shows among the others the relation between the elements of mode of maintaining of the houses, courtyards or fences and parameters of an invading population. Also the direct attitude plays an important role - the negative relation to *A. negundo*, modify tree architecture and the local population density.
Our study is a proof, that invasions may be effectively studied in the mixed, natural-cultural environment, as they occurs anywhere in the world.

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COMPARATIVE STUDY OF *OENOTHERA* SPECIES IN CENTRAL EUROPE: ECOLOGICAL CHARACTERISTICS AND DISTRIBUTIONS

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Evening primroses (*Oenothera* spp., *Onagraceae*) are usually considered as entirely invasive in the Central European flora. There are reported about twenty five species-level *taxa*. Most of them are assigned to the *biennis* group (*Oenothera* sect. *Oenothera* subsect. *Oenothera*) with a specific cytogenetic status responsible for their complicated taxonomic character. Among them, *O. biennis sensu stricto* seems to be the most successful invader in the Central Europe with the highest number of recorded localities.

This study attempts to analyse factors responsible for invasive ability of the particular *Oenothera* species with a special attention to success of *O. biennis s.s.* The distribution of *Oenothera* species in selected countries and dynamics of spreading in the historical perspective were analysed from various floristic data. The role of environmental factors including climate, landscape structure and anthropogenic impact was considered. Comparison of distribution of the *Oenothera* species distributions was performed considering the particular countries of native and secondary range.

Laboratory experiments were performed for 21 populations of about ten *Oenothera* species. Selected autecological characteristics from the set of attributes supposed to be responsible to invasive success were analysed, including experimental germination under various conditions (three temperature levels and light *vs* dark) and set of relative growth rate measurements.

Results of distribution analyses and experimental tests confirmed the eminent position of *O. biennis s.s.* among alien *Oenothera* species. This *taxon* shows highest number of recorded localities and high rate of spreading in time together with specific autecological characteristics (including relatively large seeds, high germination rate, high RGR) supporting the invasive success.

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THE GIS-INTEGRATED MODEL FOR THE INVASIVE TREE IN A DEFINED LANDSCAPE UNIT

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Our paper presents a GIS-Integrated model of demographic process and dispersal of the invasive tree in the defined landscape unit. The general idea is to create easy-to-use model that can give good predictions with the minimum of information given. The information taken into consideration is the possible to collect in relatively short time. The aim of the model is to help the process of land management, nature conservancy and preventing spread of alien plant.
the model is based on the data on the *Acer negundo* L. invasion in the clearing within Bialowieza Forest (approx. 15 km^2). The main management goal within the Bialowieza clearing is to reconcile the sustainable development of the Bialowieza village being an important forestry and research centre with maximal possible protection of surrounding forest, especially the Bialowieza National Park. For the present moment the invasion of *Acer negundo* L. is generally limited to disturbed sites within the village, e.g. neglected countryards, roadsides; riverbanks and fences. The only invaded forest are the most disturbed pine plantations close to the clearing border.
Informational layers of the model are gathered in two groups. The first one describes site parameters: land use patterns defined with the use of aerial photography, potential vegetation units *etc.* The second one contains detailed parameters of all individuals of *A. negundo* within the Bialowieza clearing obtained by direct mapping, measuring tree size and dbh, seed crop estimation and dendrochronological analysis.
The example of the *Acer negundo* invasion at Bialowieza clearing shows, that our model may be a useful tool for definition the invasion foci that are most dangerous in the present and in the future.

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MAPPING TO MONITOR THE SPREAD OF INTRODUCED GREEN ALGA *CAULERPA RACEMOSA* IN THE NORTH-WEST MEDITERRANEAN.

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The tropical green alga *Caulerpa racemosa* (Forsskal) J. Agardh was probably introduced in the Mediterranean sea, after the opening of the Suez Canal.
In the last few years it spread towards the western part of the basin, up to colonise several areas along the Italian coast. *C. racemosa* was found for the first time in Tuscany in 1993 and now it covers wide areas along 60 km of coast-line.
Two different areas south of Leghorn have been mapped by direct methods to evaluate the spreading capacity of *C. racemosa*. The increasing of surface occupied by this green alga was studied during one year period.
In the same period the cover of *C. racemosa*, in the above mentioned areas, was estimated using photographic methods.
After one year, the surface colonised by *C. racemosa* was increased in both the studied areas (approx. ten times) and coverage reached values of 80+ACU- at the end of the growth period (November). The increasing of *C. racemosa* was due both to growth of original patches and to new patches originated by turnoff fragments.
C. racemosa colonises easily on rocky or sandy substratum, dead matter of *Posidonia oceanica* and *Cymodocea nodosa* beds, while it's present only on the edge of *Posidonia oceanica* meadows.

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RELATIONSHIPS BETWEEN NEOPHYTES AND DISTURBANCE FACTORS IN THE NORTH-ADRIATIC KARST

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A wide basis of floristic knowledge is available for the region Friuli-Venezia Giulia (NE-Italy). It derives both from historical floras and from detailed field researches, conducted over the last decades. All data are now organised in a Data-Base, connected to a G.I.S.
This framework allows to draw interesting comparisons between the modern and the ancient status of the flora. A number of analyses regarding the neophytic component of the flora (including neoterophytes or "invasive species", *sensu* Barthlott *et al.* 1999, Acta Bot. Fenn. 162:105, such as *Senecio inaequidens*, *Ambrosia artemisiifolia*, *Bidens* spp.) have been carried out both from a qualitative and from a quantitative point of view.
It has been also possible to quantify the regression of the archeophytic elements (*i.e. Bifora radians*, *Consolida regalis*, *Caucalis platycarpos*).
All these aspects can be put in correlation with the modern landscape asset.
The study, which is part of a larger project regarding the whole Friuli-Venezia Giulia region, focussed on a sample area (North-Adriatic Karst), which is particularly well known in terms of flora, environmental parameters and anthropogenic pressure. It has thus been possible to verify the correlation between the neophytic flora and the anthropogenic pressure at a satisfactory scale of analyses. The percentage of neophytes in each OGU (Operational Geographic Units of about 9 km^2 in accordance with the project of Mapping the Flora of Central Europe) varies from 1.91 to 13.33 with a mean of 5.83; these values have been correlated with the surface area occupied by diffused and/or concentrated urbanisation, with linear measurements of roads -which have been subdivided in three categories: highways, main roads and secondary roads - and with the diffusion of some significant land-use categories such as vineyards.
This knowledge should provide a useful starting point for the monitoring of the neophytic component of the flora.

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THE ECOLOGY OF INVASIVE ALIEN PLANTS: MECHANISMS OF INVASIVENESS OF THE EXOTIC WEED, *CYTISUS SCOPARIUS* (L.) LINK (SCOTCH BROOM) IN BRITISH COLUMBIA.

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Scotch broom and gorse (*Ulex europeaus* L.) are exotic weeds which pose a serious threat to forested and other landscapes in southwestern British Columbia. These exotic weeds have several characteristics which promote their invasiveness and displacement of native plant species, e.g. reduced leaves, active stem photosynthesis, nitrogen fixation, profuse seed production, longevity of seed banks, rapid vertical growth, adaptability to various ecological niches, and lack of natural enemies. There is little data on the impact of Scotch broom and gorse on conifers in British Columbia. Therefore, two experimental sites were established on southern Vancouver Island to determine the nature and extent of invasiveness of Scotch broom in forested areas, and its impact on conifer crop trees and other plant communities.
Accordingly, field experiments were carried out to measure light infiltration (PAR, photosynthetically active radiation) and effects of competition of Scotch broom on Douglas-fir (*Pseudotsuga menziesii* Mirb.) seedling growth. Results demonstrated that Scotch broom not only reduces the input of PAR but also retards the height-volume growth of conifer seedlings. Details and future prospects for control are discussed.

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ANALYSIS OF THE MODERN PHYTOINVASIONS IN UKRAINE

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The Ukrainian flora consists of more than 5,000 species of vascular plants; its adventive fraction is represented by 755 species (ca. 18 % of the total number of the flora species).
Our analysis of plant invasions in Ukraine for the period from 1850 to 1999 shows a trend of the increasing number of alien plant species. The indices of synanthropization (S), modernization (M), and instability (I) considerably changed: the second half of the XIX c. - S (archaeophytes and kenophytes) = 196, M (archaeophytes/kenophytes) = 0.29, I (ephemerophytes and ergasiophytes) = 28; the first half of the XX c. - S = 531, M = 2.51, I = 195; the second half of the XX c. - S = 755, M = 4.0, I = 291. The degree of naturalisation of the majority of species was stable during this time. The species with a high degree of naturalisation prevailed during this period.
Most of the species (43 %) were naturalised in man-made habitats. Some species (ca. 1 %), agriophytes, are the components of both semi-natural and natural ecotopes. At present, ergasiophytes and ephemerophytes are the main source of "enrichment" of the adventive flora of Ukraine.
For the period analysed, the expansion of 29 species was observed; now the expansion of 22 species is continuing, and it is characterised by different chronological, arealogical, ecological and coenotic amplitudes. *Taxa* of the North American origin comprise the most numerous group among expansive species.
The shortest period of expansion, ca. 30 years, has been observed for *Amaranthus albus* L., *Solanum cornutum* Lam. (*S. rostratum* Dunal.), *Lepidotheca suaveolens* (Pursh) Nutt. The majority of species participating in the expansion have distributed in the territory of Ukraine. The longest period, more than 100 years, is observed for *Cyclachaena xanthiifolia* (Nutt.) Fresen, and is characterised by the wave character. The active distribution of 13 species at present is restricted to some of the botanical and geographical regions: *Cenchrus longispinus* (Hack.) Fern. in the steppe zone; *Helianthus* spp., *Reynoutria japonica* Hout., in Transcarpathia; *Ailanthus altissima* (Mill.) Swingle in the Crimea *etc.*
Of the species participating in the expansion, the following achieved the highest level of adaptation, or "biocoenotic success", according to J. Falinski; the species which participate in the natural coenoses with disturbed structure (17 species). Among these species, there are 13 North American species, 4 are the Asian species, and 1 Caucasian species. Despite of the fact that the most numerous group of species in Ukraine are those of Mediterranean origin, the most of them were not the members of the expansion process. However, this group contains the species with the highest level of adaptation. They are characterised by differentiation of their peripheral populations with separation of marginal sympathric races (e.g. *Ballota nigra* L., *Lamium amplexicaule* L., and *Carduus nutans* L.).
The most vulnerable plant communities are the riverside ones; their components in different regions are *Acer negundo* L., *Amorpha fruticosa* L., *Bidens frondosa* L., *Echinocystis lobata* (Michx) Torr. *et* Gray, *Helianthus tuberosus* L., *H. decapetalus* L., *H. subcanescens*

(A. Gray) E.E. Wats., *Impatiens glandulifera* Royle, *Phalacroloma annua* (L.) Dumort., *Reynoutria japonica, Xanthium albinum* (Widd.) H. Scholz *etc.*
Serious changes in the structure of semi-natural steppe communities are caused by *Grindelia squarrosa* (Pursh) Dunal.; the herbaceous layer of the forest communities is transformed by *Geranium sibiricum* L., *Impatiens parviflora* DC.; meadows are disturbed by *Ambrosia artemisiifolia* L., *Bidens frondosa, Phalacroloma annua etc.*

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ECOLOGICAL IMPACT OF THE INVASIVE ALIEN *IMPATIENS GLANDULIFERA* (HIMALAYAN BALSAM) ON NATIVE VEGETATION IN NORTH WEST ENGLAND.

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The impact of invasive alien plants is often assumed but more seldom measured. Sampling of plant communities in three habitats was carried out using randomly located quadrats in an area where *Impatiens glandulifera* is frequent. Percentage cover of all species including bryophytes was measured and diversity indices calculated and compared across habitats and at a range of abundance levels of *I. glandulifera*. Exploratory multivariate analysis of this data was carried out. Results indicate that in open riparian habitat, bare ground is apparently essential to the successful establishment of *I. glandulifera*: the presence of grasses, particularly *Holcus lanatus* and *Poa trivialis* help to prevent invasion. In woodland areas, bare ground does not necessarily allow for invasion by *I. glandulifera* and the presence of *Hyacinthoides non-scripta* may suppress growth of *I. glandulifera* seedlings.

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PERSISTENCE OF STOUT CLONAL HERBS AS INVADERS IN THE LANDSCAPE

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The persistence of clonal invasive herbs in the landscape was assessed in historical terms using *Rudbeckia laciniata* (*Compositae*) and species of the *genus* Reynoutria (*Polygonaceae*) as model *taxa*. Floristic records dating back to the 19th century were collated and the historical distribution of the *taxa* under study was obtained. Particular localities were then revisited to record the presence/absence of the species and character of the population. Majority of localities have been persisting in the Czech landscape for decades and the proportion of localities that do not exist any longer is rather low (about 15% in Rudbeckia). Reasons for persistence/retreat of populations of invasive species are discussed.

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THE SURVEY AND ANALYSIS OF EXOTIC WEEDS IN CHINA

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107species exotic weeds, belonging to 23 families, were established with the origin of foreign regions in China according to the definition of natural persistence of exotic plant population in man-made habitat after surveys and index of the related literatures were made. The origin regions, spread ways and time, and distribution and harmfulness of those weeds in China were thoroughly analysed. The methods and strategies of integrated management of the exotic weeds were proposed in China.

Key words: exotic weed; China; harmfulness; integrated management.

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INVADERS COMPUTER SYSTEM AND DATABASE ON THE DISTRIBUTION AND SPREAD OF INVASIVE ALIEN PLANTS IN THE NORTHWESTERN U.S.A.

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The INVADERS Database *http://invader.dbs.umt.edu* is an interactive web site that tracks the historic spread of approximately 900 exotic plants that have invaded the five Pacific Northwest states of United States since 1875. Core data include 80,000 distribution records from *herbaria*, weed identification laboratories, agency survey and other various sources. All distribution records have at least county level spatial resolution. Data can be verified as to source, and most have voucher specimens or originate from experienced weed taxonomists. Online outputs include county level distribution maps, time lapse spread maps, spread rate curve graphics, lists of exotics by user-specified state or county groupings, and a database engine with live links to other URL's with species specific descriptions. Point location records can be extracted and imported to GIS for climate matching, determination of habitats at risk to invasion, and other forms of spatial analyses. The site also includes examples of how regulatory agencies, weed program, and land managers have been using INVADERS data for risk assessment, environmental impact statements, selection of target weeds, legal noxious designations, and various on-the-ground projects. Taxonomically qualified users can submit new weed findings directly to the INVADERS web site. The new distribution records are immediately available for inclusion in output graphics and lists. Users can request automatic next morning e-mail notification of new reports of specific weeds. *http://invader.dbs.umt.edu* is a Java driven web site. It was designed to work best with the Microsoft Internet Explorer 4.01 browser, which allows full delivery of INVADERS web site graphics. The INVADERS team hopes to expand geographic coverage from the current 5 northwestern US states to at least the 50 US states or continental North America. if not the entire western hemisphere.

Keywords: database, web site, weed distribution, spread, mapping, GIS, risk assessment, invasions, exotics, strategy, climate matching

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EXPLANATIONS FOR THE SPREAD OF *PAULOWNIA TOMENTOSA* (THUNB. EX MURR.) STEUD. IN GERMANY

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Paulownia tomentosa is a tree species originating from East-Asia and has already been used as a solitary specimen in parks during the last century. The popularity of this species in Germany has risen especially in the last 10 years. This period covers the time during which most of the specimens in Stuttgart were planted. *Paulownia tomentosa* was chosen as a study object since this tree is found in cities lying at relatively northern latitudes with respect to the distribution in Europe: The spread and rejuvenation of tree growth in city-associated "warm islands" like in Stuttgart is, of course, in the initial stages. Spontaneous occurrences of *Paulownia tomentosa* have been observed in Germany, e.g. in Freiburg, Heidelberg and Stuttgart. These natural and spontaneous occurrences can be observed to extend along the Upper Rhine Valley and Neckar River and up to the Stuttgart Basin, *i.e.* in climatically favourable areas (macroclimatic level). It is known that young buds of *Paulownia*, which comprise immature wood, die back under severe frost.
The areas in Stuttgart with planted and naturally occurring *Paulownia* were investigated and charted onto a distribution map. This allowed the occurrence of rejuvenation to be related to mesoclimatic factors. The warmest climatic areas in Stuttgart, indicated via infra-red photography, were shown to be favoured sites for rejuvenation (Bad Cannstatt, bottom of the valley in Stuttgart-City).
The scale of the infra-red photographs used (1:10 000) does not, however, allow an adequate resolution of local temperature differences between land utilisation units. Local land utilisation units such as gravel areas, building perimeters, turf, hedges, bushes, small forested areas *etc.*, were climatically characterised by making over 1000 measurements during the warmest days of the year. The average maximum temperature of the soil surface was shown to be for example, only ca. 25 °C for small forested areas but ca. 45 °C for gravel areas or the perimeters of buildings. It was interesting to observe that the spontaneous rejuvenation of *Paulownia tomentosa* occurred exclusively in the warmest of the above mentioned land utilisation units (microclimatic level).
Apart from temperature dependency, the presence of a seed-bearing mother plant is also necessary. A spatial relationship between the mother plant and spontaneous rejuvenation could be demonstrated in many cases. Certain examples are represented graphically, whereby the dependence on land utilisation types was especially obvious. The morphological and germination biological relations are investigated.
The spontaneous occurrence of the investigated species was shown to be dependent on high temperatures at various spatial levels (micro-, meso- and macroclimatic levels). In a few decades, it is likely that *Paulownia tomentosa* will, similar to *Ailanthus altissima*, become an integral part of the city identity where spontaneously occurring specimens may not be clearly differentiated from planted specimens.

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EFFECT OF THE REMOVAL OF INDIVIDUALS OF THE EXOTIC SPECIE *EUCALYPTUS* AFF. *RESINIFERA* IN THE FLORISTIC COMPOSITION OF A PROTECTED XEROPHYTIC SHRUBLAND IN SOUTHERN MEXICO CITY.

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In 1951 a few juvenile individuals of the exotic species *Eucalyptus* aff. *resinifera* were introduced in a successional xerophytic community developing on a lava field of approximately 2,200 years of age. Individual trees were planted as a single row bordering the two largest remaining fragments of natural vegetation along road edges. These two areas were declared as ecological reserve in 1983. This initially linear and peripheral distribution facilitated the spreading of the eucalypts further into the fragments interior through the natural establishment of consecutive rows of eucalypts; by 1990 the eucalypt-dominated strip reached a maximum width of 225 m. The high rate of this spreading makes it possible to regard this phenomenon as an invasion. Eucalypts alter the natural conditions and the resource availability at the sites because of their fast growth rate and efficient water and nutrient uptake. These attributes make this species a successful competitor in this low-stature (< 7m), heliophyte dominated community. Considering the light interception of the eucalypts' canopies and the litter layer interference on the seeds, we designed an experiment to test if any, or both factors acting synergically have an effect in the natural composition. We defined four treatments with eight 20-m^2 circular replicates, each centred in an individual eucalypt: 1) with tree (shade) and with litter, 2) with tree and without litter (removed), 3) without tree (cut) and with litter, 4) without tree and without litter. Four reference samples in the native vegetation were also located 50 m beyond the last eucalypt line. All these sites were censused in 1996 (rainy season, prior to treatments), 1997 (dry and rainy seasons) and 1998 (dry and rainy seasons). The initial results on diversity showed that the natural community samples were richer than the sites with eucalypts in terms of species number, except in one case before the treatments were applied. The Shannon diversity index for individuals produced a similar result, except in one case. Both variables presented more seasonality-related variations in the sites with eucalypts than in those without them. Analysis in progress are considering other factors of the plants analysed, like biogeographical affinity (native *vs* non native) and crown cover changes through time.

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ECOLOGICAL AND OTHER PRAGMATIC MANAGEMENT TO COMBAT INVASIVE FLORA PROVING NOXIOUS WEEDS, WAYS TO UTILISE AS USEFUL CROPS WITH SUITABLE MANAGEMENT

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Some hardy vigorous growth wide adaptive flora escape from cultivation in nearby wilderness areas, come over less hardy and vigorous growing flora there. Then that useful flora groove invasive weed if not properly controlled. *Prosopis juliflora* was introduced in arid barren tanks of western Rajasthan and in northern Guyrat for afforestation. In these decades it has became over dominated flora around villages and towns outskirts.
Eichhomia crassipes was introduced in some tanks of towns but it spread wide to cover most of tanks suppressing native flora and fauna and caused many other lizards. I studied various ecological and human aspects of rise and control of invasive vigorous flora, often growing noxious weeds. How the vigorous weeds may be utilised as useful crop was also studied. I continued my study for last 25 years in Rajasthan and other neighbour states of India. My inferences and recommendations topics wise are as follows.

How particular flora groove invasive weed: it was observed that hardy, adaptive, vigorous growth profuse seedling flora often escape wide from the cultivation area, grow vigorously and empowers less vigorous and hardy flora thereby, soon from thicket, than may prove noxious weed to local men.

Adverse ecological and economic effects and their control: when particular flora grows excessive vigorous, suppresses nearby plants, then it proves noxious weed. This may be properly controlled with proper pruning and screting unwanted growths and plants. Proper regular management is required for satisfactory results. It was observed that regular vigilant supervision to check unwanted growth of flora in an area need not much labour, effort and expenses. On considerable growing negligence to control weed's growth, the weed may cause mortality to delicate flora nearby.

Control management: as weeds plants are very hardy and adaptive can grow vigorously anywhere, alternative change in the cultivations are may not prove much useful. Pruning, harvesting and weeding are necessary to control flora proving weed. Early routing of weed flora definitely check nuisance of weeds in the area. Considerable delay to route the weed flora, may avail weed to flower and disperse seeds widens, then it becomes difficult to control wide spread weed.

Prominent invasive flora proving noxious weeds if not properly managed for control and utilisation.
Prosopis juliflora: it is very hardy and vigorous growing flora, grows vigorously even in saline, lime alkaline, rocky barren areas and water-logged areas, hence now dominating flora around towns and villages, get widely distributed with droppings of cattle, particularly

the goat. Cattle relishes its legumes. Parsanty dwellers cut it indiscriminately for firewood, hence the flora remains as compact bush, by constant indiscriminate cuttings, where properly pruned, it grows well as shade thick tree. Where it is not wanted, it may be easily uprooted at early stage but people neglect so then the flora establishes firmly then very difficult to uproot it as its roots grow very deep and wide. With proper pruning the tree grows as fine shade tree, provide nectar to honey-bees and edible palatable legumes to herbivores, they relish that. Its tickets raises forest areas, increases rainfall and forest cover to wide range of wild fauna. There is anti juliflora lobby largely comprises of charlatan naturalists and some charlatan foresters. They condemn juliflora as noxious weed, plead to destroy it. (*abstract*)

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INVASIVE PLANTS IN UKRAINA URBAN PARKS

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Different types of parks existed in the territory of the town of Uzhgorod (Transcarpathia, Ukraina): in the XVII-XVIII c.c. there were forest parks, in the XIX-XX c.c. - arboreta, in the second half of the XX c. - recreation parks. In the present-day Uzhgorod, there are several parks differing in their age, size, location, principles of formation, mode of use *etc.* Synanthropization of the plant cover of urban parks is mostly neglectable.
In arboreta, the herbaceous plant cover is poorly developed, and consists of anthropophilous plants (*Dactylis glomerata, Aegopodium podagraria* L., *Glechoma hederaceae* L., *Stellaria media* (L.) Vill., *Ranunculus repens* L., *Lamium album* L. *etc*). In the forest parks the aboriginal species prevail; synanthropization is considerably higher, especially on ruderal plots (roads, alleys and riversides). Abundance of synanthropic species, especially adventive ones (*Impatiens parviflora* DC., *Reynoutria japonica* Houtt., *Helianthus tuberosus* L.), depends on the age of the park (it is much higher in modern parks), management and use.

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CLETHRA ARBOREA AN INVADER WITHIN MACARONESIA

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Clethra arborea Aiton (*Clethraceae*), a tree endemic to Madeira Island, is naturalised in São Miguel Island (Azores). In Madeira this tree is found in the *Clethro-Laurion*, and in São Miguel in the *Juniperion brevifolii*, two similar communities. The shrub and tree species associated with *C. arborea* in Madeira are: *Vaccinium maderense*, *Laurus azorica*, *Erica scoparia* ssp. *platycodon*, *Erica arborea* and *Myrica faya*. In São Miguel the more frequent species are: *L. azorica*, *C. arborea*, *Erica scoparia* ssp. *azorica*, I*lex perado* ssp. *azorica*, *Viburnum tinus* ssp. *subcordatum*, *Vaccinium cylindraceum*, *Myrsine africana* and *Juniperus brevifolia*. Three other important alien species are also found associated with *C. arborea* in São Miguel: *Leycesteria formosa*, *Gunnera tinctoria* and *Hedychium gardneranum*. Vegetation higher and lower canopy limits and basal diameter are higher in Madeira than in São Miguel. Those parameters are also higher for *C. arborea* and *L. azorica* in Madeira than in São Miguel. In São Miguel *C. arborea* is more often the tallest tree. Flowers are visited by several insect species and, contrary to native shrubs, *C. arborea* presents a copious production of small, readily germinating seeds. Germination is light dependent and seeds survive for more than one year in the forest soil. Seedlings are mainly found in vertical surfaces covered by bryophytes, but not in the litter covered forest soil. Saplings present a high survival rate. While in Madeira two species of insects feeding on leaves were found, in São Miguel an endemic bird and a native insect feed on the seeds. A phypathogenic fungus, causing a foliar disease might be specific and present in both islands. *C. arborea* may be controlled with low herbicide rates, namely with tryclopir, which stimulates the development of fungi and wood decay. Young plants might be controlled by uprooting.

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RECEPTION CAPACITY OF THE WEST MEDITERRANEAN COAST TO ALLOCTHONOUS PLANTS

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Actually, both the soil and vegetation of the Mediterranean coast of the Iberian Peninsula are degraded strongly from the effects of many centuries of agricultural activity and the more recent problems of excessive tourism and construction. As a consequence, many allocthonous plants have invaded the different ecological niches of the area in a process that has accelerated over the last two decades.

Using as a model a 60 km long by 10 km wide coastal strip in the Baix Camp (Tarragona, Spain) (UTM quadrants 31TCF45, 31TCF46, 32TCF45, 32TCF46, 32TCF47, 33TCF46, 33TCF47, 34TCF46, 34TCF47, 35TCF47, 35TCF48, 36TCF47, 36TCF48, 37TCF47, 37TCF48, 38TCF47 and 38TCF48), an area under maritime influence, a study was made of the reception capacity of allocthonous species and the ecological factors that facilitate their invasion. A detailed inventory of the area showed that 20% of the plant species were allocthonous, and that 40% of these were from tropical areas. A large number of these species were recent arrivals, with some showing strong invasive behaviour (*Araujia sericifera* Brot., *Gomphocarpus fruticosus* (L.) Ait. f. in Ait., *Chloris gayana* Kunth, *Ipomoea purpurea* Roth, *Bidens subalternus* DC., *Bidens pilosa* L., *Bidens frondosa* L., *Arctotheca calendula* (L.) Levyns). For all the allocthonous species found, the relationship between origin and new ecological niche colonized is discussed, so as the cause of their introduction and effects on the environment. Finally, a comparison is made of the reception capacity of this coastal land more strongly affected by man with areas of more continental climate and with a largely unaltered maritime area. In all the cases a greater ratio of xenophytes was found in the altered coastal area.

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ECOLOGICAL AND GENETIC FEATURES OF THE INVASION BY THE ALIEN *CARPOBROTUS* (*AIZOACEAE*) PLANTS IN MEDITERRANEAN ISLAND HABITATS

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Invasion by the introduced and invasive succulent *Carpobrotus* (*Aizoaceae*) constitutes one of the most severe threats to numerous terrestrial plant communities in coastal and island habitats of the Mediterranean Basin. Two South African *taxa*, *C. edulis* and *C.* aff. *acinaciformis*, have been introduced in Mediterranean France during the middle of the XIXth century. They have invaded the backdunes, coastal rocky slopes and cliffs, and even coastal scrubs, mainly in siliceous continental parts of Provence and on the island of Corsica. These alien *taxa* may induce severe local extinctions of native plants with a high patrimonial value (endemic, rare and/or protected plant species).
After a historical and biogeographical background about the invasion in the Mediterranean Basin, the present study is focused on the islands of Hyeres (Provence), mainly in the Port-Cros National Park. The two *taxa* show a combination of sexual and asexual strategies for reproduction. Asexual reproduction occurs both by vegetative propagation and facultative agamospermy (*i.e.* the formation of unreduced seeds by asexual processes). The relative frequencies of sexual *versus* asexual reproduction has a significant impact on the spatial genetic structure of natural populations. The purpose of this paper is (i) to determine the reproductive ecology and genetics of natural populations of the two invasive *taxa* (and their potential hybrids) in island habitats, and (ii) to examine how the dynamics of the two invasive *taxa* can influence the integrity of the local natural environment and native plant communities. First, we have quantified (i) the ability to autonomously self-fertilise, (ii) the relative performance of selfing and outcrossing, (iii) the level of agamospermy, (iv) the variation of floral traits related to the mating system, and (v) the rate of pollinator visitation. The level of genetic variability allows us to assess the clonal mosaic of genotypes. We could then compare between the two invasive *taxa* the reproductive success and the capacities of competition in these island habitats. Second, we have examined edaphic and floristic consequences of the presence of these two *Carpobrotus taxa*, particularly when important dense mats occur.
Finally, the clonal genetic structure is discussed in relation to the patterns of introduction of the two exotic *taxa*.

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ATTRIBUTES OF *ARCTOTHECA CALENDULA* (CAPEWEED) A POTENTIAL WEED IN NEW AREAS OF MEDITERRANEAN BASIN

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Arctotheca calendula (L.) Levyns, herbaceous annual, (*Asteraceae*) is a native species of South Africa and it has become naturalised in other countries. In Western Australia *A. calendula* has become a pest, the major weed of crops and pastures in all habitats. The content of Capeweed was estimated from 37% of pasture dry matter in high-rainfall grazing areas to 50% in lower-rainfall wheat belt areas. Due to the wide diffusion, it is investigated by Australian researchers as a potential forage source.
After its accidental introduction this species has been also recognised in Sardinia where it has shown a strong competition against sowed and native pasture species and invasive capacity. Some biological and agronomic traits of *A. calendula* in relation to the management of local forage farming systems are discussed in this paper. The very high seed production per plant, the easy seed dispersion by wind and animal, the high level of seed dormancy, the rapid growth of seedling after late summer rain, the extension of the root system, the vigour and prostrate habit of the plant are the key factors in the success of Capeweed. Moreover its earliness of flowering, low palatability for sheep and the undirect effect of agronomic techniques (e.g. ploughing, hay harvest) in maintaining the seed bank in the soil contribute to increase its persistence. On the basis of the available data and observations a prudential and integrated control of this exotic species is recommended for Sardinia.

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GROWTH AND RESOURCE ALLOCATION STRATEGY OF *PARTHENIUM HYSTEROPHORUS* L. AN EXOTIC WEED IN THE SEMI-ARID ENVIRONMENT AT MADURAI, SOUTH INDIA

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Invasion by exotic species can alter the population and community structure of a native ecosystem is well documented, but information from the tropics is limited. *Parthenium hysterophorus* L. a ruderal exotic perennial weed has become a menace to agriculture, forestry plantations and disturbance regimes and wastelands. Growth, resource allocation, nutrient uptake and use efficiencies and reproductive effort of *P. hysterophorus* a ruderal weed current year seedlings and populations various in (1, 3, 5 and 8 mm basal diameter class) were evaluated under open and shade habitat in the semi-arid environment of Madurai, India. It was found that the variability in the environment altered growth, resource allocation patterns and reproductive efforts. More resources were allocated to growth and reproduction under open habitat. Increased leaf area and slower growth rates under shade may be due to reduced light availability (Chapin, 1980). Decline of growth rate in older and previous year (2, 5 and 8 mm basal diameter class) populations caused by the reduction of leaf area due to high irradiance under open habitat. Older or previous year populations showed little or no variation in growth, resource allocation patterns and reproductive efforts in shade habitat. This was attributed to physiological adjustment or phenological plasticity of the populations adapted to survive under shade (Grime, 1974). Intraspecific variations could be related to differences in microhabitat and other intrinsic factors. Thus, it is concluded that the species has an exploitative growth strategy characteristic of a ruderal species and it may be controlled by light curtailment under a canopy cover. (*abstract*)

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EXOTIC PLANT INVASIONS IN DISTURBED AND MAN-MODIFIED ECOSYSTEMS AT VEERAPULI AND KALAMALAI RESERVE FORESTS IN THE WESTERN GHATS, SOUTH INDIA

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In the recent past the Western Ghats of Tamil Nadu has undergone heavy environmental transformation for various reasons, such as changes in land use pattern, monoculture, forestry operation and developmental activities. The intentional and unintentional use of fire result in both arrival of new species to the site and also death of existing plant species, besides a change in edaphic environment for better plant growth. These and other associated perturbations to different ecosystems have resulted in the invasion of exotic noxious weeds and unpalatable grasses like *Imperata cylindrica* causing profound structural changes in the plant communities. *Lantana camara* and *Chromolaena odorata*, natives of Latin America, have rapidly invaded deforested hill slopes, wastelands and abandoned croplands in the region. In this context, an understanding of their distribution in different ecosystems becomes important. Exotic plants contributed about 17 and 35% of the total importance value indices to the plant community structure in natural and man-modified ecosystems respectively. *L. camara* and *C. odorata* were found to be the dominant exotic perennial weeds in both kinds of ecosystems studied. The high IVI of exotics in the man-modified ecosystems could be attributed to frequent disturbance and resource rich transient open environment here. The disturbance regime and the type of exotic plant invasions were analysed and found that frequent fires to the ecosystem resulted in monotypic savannah grasslands. *C. odorata* and *L. camara* invaded the sites where mechanical disturbance and occasional fires occurred. The density and weed composition varied considerably in different agroecosystems and agroforestry systems practised by "Kani" tribes in the region. This may be due to variation in the number of weedings and light availability to the ground floor through the crop canopy cover (Ramakrishnan, 1991; Chandrasekaran and Swamy, 1995). During the secondary succession suppression of exotic weeds in 8 and 20 year old fallow could be attributed to decreased light availability by the larger shrubs and trees. (*abstract*)

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INVASIONS OF RIPARIAN ECOSYSTEMS BY EXOTIC PLANT SPECIES: PATTERNS AND CAUSES

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Patterns of plant species richness and community composition were studied along several riparian zones belonging to river systems from SW France and NW USA. Our findings suggest that riparian zones are among the most invasible ecosystems under oceanic climate influences. In SW France, 420 exotic species were found on 245 sites distributed along 7 rivers. Very few of them were pre-adapted with respect to the specificities of riparian ecosystems. At the scale of the entire corridor, exotics accounted between 25 to 30 % of the total number of species. This overall proportion as well as the patterns of longitudinal trends were consistent between the Adour River (France) and the MacKenzie River (Oregon), where the percentage of exotics at the local scale could respectively reach up to 40% and 60%. Due to intermediate levels of disturbance, spatial patterns at the local scale of a stretch of the middle Adour River showed a very complex mosaic of 45 different plant communities. As a result, the species richness was high (702 species on 200 ha). The highest species richness was found along the main channel in fragmented and disturbed patches, which were also the most invasible. Regional and local patterns of invasion by exotic plants are analysed and possible causes and consequences are discussed.

MODELLING THE RANGE EXPANSION OF PINE WILT DISEASE IN JAPAN

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Pine wilt disease is caused by the pinewood nematode, *Bursaphelenchus xylophilus*, that is vectored by a pine sawyer beetle, *Monochamus alternatus*.
Japanese native pinewood, black pine (*Pinus thunbergii* Parl.) and red pine (*P. densiflora* Sieb. *et* Zucc.) are extremely sensitive to the nematode infection and the disease damage has been expanding nation-wide in the last several decades despite the intensive effort to control the disease. To gain insight into the range expansion of the disease in Japan, we modeled the dynamics of the pinewoods and the vector beetles that carry the nematode using integro-difference equation in one dimensional space. We focused on the speed of the range expansion of the disease and investigated the dependence of the expanding speed on the eradication rate of the beetles, the initial pinewood density, and the beetle's ability to disperse, based on detailed data set collected in Japan. From the model analyses, we obtained the following results.
(1) The Allee effect operates on the beetle reproduction and hence the disease cannot invade a pinewood stand, once the beetle density decreases below a certain threshold.
(2) The distribution of the travel distance of the beetles critically affects the expanding speed of the disease. As the fraction of the beetles that travel over long distance (long range dispersal) is increased from zero, the expanding speed is sharply amplified, *i.e.*, occasional long distance dispersal greatly accelerates the disease range expansion.
(3) However, too much long range dispersals results in a failure of the disease invasion due to the Allee effect, suggesting the importance of correct assessment of the beetle's mobility to predict the disease expanding speed. Based on the model analyses, we discuss the effective control of the disease.

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IMPACTE OF *CARPOBROTUS EDULIS* (L.) N. E. BR. ON THE VEGETATION OF THE AUTOCHTON VEGETATION OF THE PROTECTED AREA RESERVA NATURAL DAS BERLENGAS (PORTUGAL)

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The aim of this work is to evaluate the alteration of the floristic diversity caused by *Carpobrotus edulis* (L.) N. E. Br. growth on the autochtone vegetation of the protected area, the archipelago Reserva Natural das Berlengas. This protected area is located along the portuguese Estremadura littoral (39° 24' 49"" N - 9° 30' 29" W) and is formed by rocky islands. The height of the islands is under 100 m and Berlenga, the largest one, has an area of 76 ha. A seasonally occuped fishermen village is located in this island and the others are uninhabited.

In the 50th *Carpobrotus edulis* (L.) N. E. Br. as been introducted in order to avoid the overthrow of rocks in the leasure areas of the island, it as been planted in two islands, Berlenga and Farilho Grande and has successfully established. Presently *Carpobrotus edulis* as spread out over the cliffs and hillsides mainly in those with south exposition. Spontaneous occurences of this specie have been observed in three other islands of the archipelago. *Carpobrotus edulis* establishes a monospecific cover that obstructs the occurence of the autochtone vegetation. The Flora of this protected area consists of around a hundred species mainly annuals and few perennials, three species are endemic from the archipelago.

Linear transepts were done in order to collect the data, they were made inside and outside the area covered with *Carpobrotus edulis*, in both islands Berlenga and Farilho Grande. The results allow to obtain a quantitative assessment of the reduction in frequency and covering area of the native Flora. They also indicate that *Carpobrotus edulis* presents a different soil occupation pattern on the different islands.

CITRUS AURANTIUM AS INVADER IN SUBTROPICAL MONTANE FORESTS OF ARGENTINA

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Citrus aurantium is a common exotic treelet in NW Argentina subtropical montane forests, native from SE Asia. It was introduced in the area as for orchard plantations and as a urban tree. Is the only exotic tree species frequently found in the understory of mature forests, including long lasting National Parks. We examined the size distribution of *C. aurantium* populations in two types of forest at El Rey National Park of NW Argentina: mature (MF) and second growth forest (SGF) with about 40 years of abandonement, in order to make inferences about population trends. We censused a total of 9.2 ha of forests (1.9 and 2.2 ha in two sites of MF; 2 and 3 ha in two sites in SGF) using 20 x 100 meters transects. We registered a total of 1011 individuals in the four areas sampled. Densities were significantly very different among sites (385 and 107ind/ha for MF; 19 and 3.6 ind/ha in SGF). The number of individuals of less than 1.5 m represented from about 92 to 58 % of the total at each site. The size distribution suggest that population is increasing, particularly in the mature forests. We found only 17 plants with fruits, 16 of those in one of the mature forest sites. According to its demographic patterns, *C. aurantium* can be characterised as a mature-forest species, which makes it particularly difficult to control in natural areas. High densities of *C. aurantium* juveniles in the mature forest may be attributed to the shade tolerance of this species and to the effective dispersal by native animals. The results emphasise the importance of prevention as a way to avoid invasion of this species. Future research should aim to quantify large scale patterns of distribution of the species and to identify natural pathogens and predators that could potentially reduce the expansion into more areas.

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HYDROLOGY AS AN INFLUENCE ON INVASION: EXPERIMENTAL INVESTIGATIONS INTO COMPETITION BETWEEN THE ALIEN *IMPATIENS GLANDULIFERA* AND THE NATIVE *URTICA DIOICA* IN THE UNITED KINGDOM

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Hydrogeomorphological processes are key influences on the structure of riparian plant communities. Research has pointed to disturbance regimes and the availability of vacant habitat niches as factors which make river margins prone to invasion by alien species.
However, most European research on invasive riparian plants has focused on their biology, autecology and biogeography. The interactions between invasion and factors such as flood frequency and duration, sediment transport processes and water-table regime requires further exploration.

Himalayan balsam (*Impatiens glandulifera*) is an alien annual herb which has colonised lowland riverbanks across much of the UK. Because it forms dense monospecific stands it is considered a threat to riparian biodiversity. Previous research and informal observations on riverbanks have tentatively suggested that Impatiens may even be able to out-compete native perennial species such as the common nettle (*Urtica dioica*).

The aim of this study was to assess competition between *Impatiens* and *Urtica* under a variety of hydrogeomorphological situations. Two separate mesocosm experiments were undertaken to investigate the influence on growth of the two species of depth to water-table and occurrence and timing of inundation. In the first experiment, three species-mixes were subjected to four different water-table regimes ranging from near-surface to beneath rooting zone. In the second experiment, treatments using the same species mixes were subjected to a number of different flood events. Data from these experiments indicated, *inter alia*, that once established, presence of *Impatiens* could have a significant negative impact on growth of *Urtica*. This impact was especially important when the water-table was low. These results were then related to field investigations.

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THE ROLE OF FLOODING IN RIPARIAN INVASIONS - A NOVEL APPROACH TO ASSESSMENT OF PROPAGULE TRANSPORT

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In several regions of the world it has been shown that riparian habitats are especially prone to invasion. It is often asserted that this vulnerability is, in part, due to the role of rivers in transporting propagules of alien species from upstream sources and depositing them during flood events. However, evidence of this process is difficult to find in the literature.

As part of a wider study on the influence of hydrogeomorphology on competition between native and alien riparian plant species, field investigations were undertaken of the importance of the deposition of alien seeds during flooding. Artificial turf mats were placed on the banks of two UK rivers (the River Severn and the River Trent) such that they would trap sediment and plant propagules during flood events. Following inundation the mats were collected and cleaned and their contents analysed for particle size distribution, nutrient content and presence/absence of key species, notably the invasive alien Himalayan balsam (*Impatiens glandulifera*). These data were then related to data from botanical surveys along the same riverbanks. Initial results have suggested that there is considerable small-scale variation in the deposition of propagules and that the artificial turf mats are a useful tool for the study of deposited riparian seed banks.

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HISTORY OF STUDIES OF INVASIVE ALIEN PLANTS IN POLAND

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The subject of the paper is a concise review of history, research trends and main methods used in studies of invasive alien plants in Poland. Some problems pertaining to methodological and nomenclatural classifications applied in Polish botanical literature against to the European ones are discussed.
Special attention is paid to the present studies which are intended to fill the gap in recognise recent distribution of about 250 species of invasive alien plants (kenophytes-neophytes) in Poland. The aims of these studies are: to present up-today distribution of kenophytes in Poland (the stations of species are plotted on the ATPOL grid - Atlas of distribution of vascular plants in Poland - 10 km square), to compare historical and recent spread of kenophytes, to give the general characteristic of this group of plants, to analyse of plant distribution data against historical, geographical, phytogeographical, man's activity factors.
The result of these studies have not only pure scientific value but can also serve as a basis to work out effective methods of management of the most invasive plants.

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TRENDS OF DISTRIBUTION AND INTERACTION OF ALIEN PLANT SPECIES AND LOWER FUNGI IN UKRAINE

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Since the process of plants migration acquired global scales, microorganisms developing on plants spread with them in many regions. It is known that in some cases alien plants invasion may be even determined by them (Tokhtar, Burda, Kolomoets, 1998).

Practically complete absence of data on conjugated migrations of alien species and parasitic or saprophytic mycobiotic organisms made us study this problem. 305 alien species of plants from 103 genera and 52 families have been reported by us from the south-east of Ukraine. Most representatives of alien species belong to the families *Asteraceae* (50 species), *Brassicaceae* (40), *Poaceae* (33), *Chenopodiaceae* and *Fabaceae* (both have 17). However the majority of fungous pathogenes are found in cultivated representatives of the families *Chenopodiaceae* (63 injuries of species), *Vitaceae* (63), *Fabaceae* (61), *Aceraceae* (30), *Poaceae* (25), *Juglandaceae* (23), *Grossulariaceae* (22), *Asteraceae* and *Brassicaceae* (21).

If to analyze alien species according to the time of their emergence in the region, it should be noted that mycobiotic species parasitize chiefly on species-archeophytes which were brought here in the 17th century (67 species). Lower fungi have been also observed on 23 species-neophytes, 16 euneophytes and on 7 new species which have been recently found.

In species which are at different stages of invasion vegetative organs are injured most of all. An average number of injury by fungi per 1 plant species decreases during invasion: 9,5 damages were observed in 1 species-ephemerophyte (an unstable element of flora); 4,3 - were in 1 species-epecophyte (the species is at an intermediate stage) and 4 were in 1 species-agriophyte (this species occurs already in local communities). It is highly probable that processes of coevolution and selection of alien species brought to the fact that species which got naturalised were less injured by fungi and adopted to the new conditions of the Ukrainian south-east best of all.

It is necessary to note that lower fungi are mainly observed on Mediterranean-Iranian-Turanian species of plants. This once again confirms correctness of ideas on common florogenetic roots of biotic complexes of the Ukrainian steppe zone and ancient Mediterranean region. Among alien species xero-and-hydrophytes are the least injured and xeromeso-and-mesophytes are the most damaged. It is explained by the fact that the fungi development cycle depends in many respects on moistening conditions. Some mycobiotic organisms brought into our region with alien plants occur only on these species and are narrowly specialised. Other species in the process of conjugated migration spread both on alien and local species of plants which is a certain menace for native ecosystems and has to be investigated in more detail.

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PRODUCTIVITY AND DYNAMICS OF *IMPATIENS PARVIFLORA* POPULATIONS IN HARDWOOD FORESTS IN SOUTH WESTERN GERMANY

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Over a three years period 20 populations of *Impatiens parviflora* has been investigated. Monthly measured site specific factors as soil water content, light regime and nutrients are included in a model which describes the self thinning mortality of meta populations of *Impatiens parviflora* by a naturally given starting density of seedlings.
Relationships between productivity, self thinning mortality and seed production give hints about the strategy of survival of meta-populations of this species in a landscape section.
The investigation tries an integration of the species hierarchical features as germination properties, physiology, morphology, growth and distribution patterns to select the most responsible for the species success.

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SOME REMARKABLE INSTANCES OF INVASION OF *AILANTHUS ALTISSIMA* IN HUNGARY

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Ailanthus altissima (Mill.) Swingle is native to China in the lower Yangtze and Korea, but its synanthropic area in China is much wider. Its global distribution has begun in the 1740's (HU 1979). The first data of tree of heaven in Hungary are were published by Bartosságh (1841, 1843), who planted young trees on his own estate in Villány to the southern foot of Szársomlyó hill of Nagyharsány, which were damaged by frost. Soó Jávorka (1951) indicates it already as an established plant on the Great Hungarian Plain (Alföld). For its widespread in Hungary old and more recent suggestions of its planting "with many uses" (Danszky 1964) could contribute to a great extent. Soó Kárpáti (1968), Simon (1992) and Bartha Mátyás (1995) indicates its frequent naturalisation, and that it is planted in plantations on the Great Plain. Invasion of *Ailanthus altissima* in Hungary is conspicuous in the following instances: in the Aggtelek National Park on one of the natural habitats of *Onosma tornense* JÁV., which is a strictly protected, endemic plant of limestone rock grasslands of the Northern Carpathians, and which has been taken on the list of Red Data Book of Europe; in the Villányi Mountains on Szársomlyó, on the *locus classicus* of *Colchicum hungaricum* Janka, a strictly protected preglacial relic, endemic in the Balkans; on the Balaton Highlands near Salföld on a protected rock-land area with junipers and acidophilous grasslands; in Fót-Somlyó Protected Area in steppe grasslands; in Budapest in the Sas-hegy Nature Conservation Area in warm, south facing slopes of limestone rock grasslands.

In the above mentioned areas tree of heaven has penetrated into natural habitats (in more cases first ones were planted there by man) and changes the composition of the local vegetation, endangering the survival of numerous rare, protected species. Among artificial environments *Ailanthus altissima* appears subspontaneously in botanical gardens and in almost all parks in Budapest due to insufficient horticultural work. Tree of heaven on the other hand is a characteristic plant of disturbed urban and country habitats, *i.e.* in the city in gaps between walls and the pavement and other artificial objects, in industrial areas, by railways, and by country ways.

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HEDERA HIBERNICA (KIRCHNER) BEAN (IRISH IVY) AS A WOODY EVERGREEN WEED

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Hedera helix L., native to Hungary, is native to all over Europe, and is an ornamental plant since the beginning of formation of garden cultivation. Primarily its handsome, more lobed, white veined and variegated leaf types are popular. Besides the native ivy, *Hedera hibernica* (Kirchner) Bean is planted since already 1815, which had been offered in the catalogues as Irish or English ivy primarily for its quick growth and handsome, big leaves. The origin of this tetraploid species (2n:96) is still unclear, by Koch (1869) "*it was born in England in cultivation, but is originated from Ireland*". In the Hungarian trade it has been surely existed in the 1870's, and was planted mainly in cemeteries, city gardens and parks.
In the late some years the weed effect of Irish ivy appears, especially in arboreta, collection gardens and their surroundings. In natural, and more or less disturbed seminatural vegetation, in flood areas and islands it appears, where *H. helix* is not native. Because the young leaves of *H. hibernica* are similar to that of *H. helix*, especially its form, named f. *sagittifolia*, it is easy to confuse with that. Distinguishing the two species can be made by the followings: Leaves of vegetative shoots of H. hibernica are about one and a half times as big as that of *H. helix*, broad, three lobed, the central lobe is broad, ending in a domy tip. Their surface is glossy, the venation is bright green, inconspicuous. Leaves of the generative shoot are broad ovate, the inflorescence axis is short (3-5 cm), its special and characteristic feature is a single flower under the main umbel. *H. hibernica* brings generative shoots often in the ground level, and becoming spontaneously a bush. Berries on short, 1 cm peduncles, become fertile only in the terminal umbels of the inflorescence. In spite of *H. helix* - where in most cases only 2-3 ovules become fertile - mostly 5 seeds develop, which can contribute to its propagation of greater extent. The fruity umbels of Irish ivy form brilliant, glaucous, deep blue balls, which mature in February, from which time the fruits of it are spread by birds (endozoochoria). Due to our observations about habitat preference of Irish ivy the followings can be stated: it appears in places of relatively even water supply, deep shade, slightly protected from frosts, e. g. under shrub-groups, hedges, and as a gap-inhabitant in the base of house walls, leaks of concrete, asphalt, stone and other artificial objects. Within the classification of adventive plants it belongs to the group of cultivation escapers (ergasiophygophyta).

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STATISTICAL INVESTIGATIONS ON SOME REPRODUCTIVE FEATURES OF INVASIVE ALIENS IN ITALY

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Since 1974 the Italian alien Flora has been revised and discussed from floristic, ecological and distributional points of view. More recently (Viegi, 1992/93) the attention has been focused on the invasive alien species in Sardinia. As previously reported (Viegi, 1998) the presence of aliens and in particular of invasive ones, in Italy is noticeable. An investigation on the type of their reproductive structures and on their mode of dispersal is extremely interesting in order to evaluate possible removal strategies.
In this paper we study from the statistical point of view: sex expression, life forms, blooming period, type of pollination, types of fruits and fruit dispersal and vegetative reproduction of alien invasive species in Italy. We used as data sources mainly Floras by Pignatti, (1982), Viegi (1974, 1992/93), Viegi *et al.* (1974, 1981, 1990, 1991, 1995).
A total of 210 species were analysed, which are distinguished in: escaped from cultivation, naturalised, casual and doubtful. The most represented families are *Asteraceae*, *Amaranthaceae*, *Poaceae*, *Fabaceae* and *Brassicaceae*. As regards sex expression, hermaphrodite are over 80 %, monoecious and dioecious 2%. T life form result the most represented (over 50%), followed by H (17%) and G (9%); the others are in low percentages (7%-2%). July, August and September are the months when a higher percentage of species blooms. Entomophilous species are more than the anemophilous ones. There are more dry fruits than fleshy ones, which are only 5%. Passive dispersal of seeds is predominant, followed by anemochorous and zoochorus. The most frequent type of dry fruits is the capsule in dicots and the caryopsis in the mono; the most frequent fleshy fruit is the berry.
The results are discussed on the base of a quantitative/qualitative comparison with data reported for native species (*i.e.* in general in Italy (Pignatti and Pignatti, 1990-91), in Mediterranean region (Pacini and Franchi, 1984), Apuan Alps (Viegi and Pacini, 1998)) and with data from other countries (Brock *et al.*, 1997).

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POST-DISPERSAL SEED PREDATION CONTROLLING *OPUNTIA* SPP. INVASION IN MEDITERRANEAN COMMUNITIES

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There is a great effort in determining factors controlling establishment of exotic species in natural communities in order to assess which communities are more prone to invasion. The lack of natural enemies has been claimed as one of the main causes of the invasion success of alien plants. However, few studies have investigated the role seed predation in the spatial patterns and population dynamics of alien plants.

Prickly-pear cacti (*Opuntia* spp) were introduced from Central America to Europe by the Spanish conquerors between the end of the 15th century and the beginning of the 16th century. Pricky-pear cacti have been used for fruit consumption, livestock foraging, fencing, the production of a red dye which is obtained from a cochineal insect host, and as ornamental. However, economic and land use changes have driven the naturalization of the species in natural areas of the Mediterranean region and now *Opuntia* can be considered a weed. Although, vegetative spread by cladodes is important for its population persistence, seedling establishment is also important for the extension of the geographical range and the initial establishment in new sites.

We studied post-dispersal seed predation of *Opuntia maxima* and *O. stricta* in old olive orchards, pine woodlands and shrublands in Cap de Creus (northeastern Spain). In average 2/3 of seeds from fruits were predated. Cage exclusion experiments demonstrated that fruits and seeds were mainly consumed by small rodents. Seeds placed in olive orchards were less predated than the ones placed in pine woodlands and shrublands. In olive orchards seed predation was lower under olive trees than beneath adult *Opuntia* plants and clearings. Our results demonstrate that seed-predation is acting differently among communities and also within a community matching differences in establishment patterns of *Opuntia* seedlings among and within communities.

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EVALUATION OF FUTURE WEED PROBLEMS IN SWITZERLAND

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Land use change and the continuing introduction of new species may lead to new weed problems in European countries. In order to evaluate species that might become future plant invaders in arable fields of Switzerland, we conducted an European wide survey of weed species by sending questionnaires to weed scientists. Recipients were asked to list species that are spreading and cause problems in agroecosystems, and to rate these according to the degree of weediness. We identified those species that currently are not present in Switzerland or do not pose weed problems (potential new weeds). In total, 299 weed species were reported from European countries.
Among these, 73 species (24%) could be identified as potential new weeds.
Source regions of these species were mainly southern and e*Aster*n parts of Europe. We ranked the species according to number of countries and habitats in which they occur in order to find species that are likely to become weed problems in Switzerland. The five species with the highest rankings were *Abutilon theophrasti*, Iva xanthifolia, Phalaris paradoxa, Avena sterilis and Matricaria perforata. Weed scores as given by recipients varied considerably and showed no relationship to distribution of the species.

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CAN THE IMPACTS OF INVASIVE SPECIES BE PREDICTED?

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In the 4th International symposium (4th ICEIAP), I discussed the measurement of the impact of invasive plants. Here I want to extend that both to explaining the impacts, explaining the measurements, by relating them statistically to other measures and also to see to what extent explanation can be expanded to prediction. There are many people who think that invasions can be predicted climatically, and in other ways. Examples will be given of such predictions and examined critically. Good explanations of the success of invaders have often depended on very detailed biology of the species. There are at least ten reasons why even good explanations may lead to unsatisfactory predictions. The question then is, under what circumstances will it be possible to get useful predictions ? The examples in the paper will mostly be drawn from the distribution of British and Australian plants, but other impacts will also be considered.

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INVASIVE PLANTS IN COURSE OF PRIMARY SUCCESSION ON COAL-MINE SEDIMENTATION POOLS, UPPER SILESIA (POLAND)

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One of the results of industrial activity is the existence of expansive areas being post-industrial west lands, without plant cover and its surface is covered by specific substratum (e.g. coal dust) On the background of the surrounding vegetation these areas consists a kind of habitat islands. It has been stated that plant expansion on such places is carried out in different ways. By means of transect system it has been investigated which species and how fast do they manage to establish on those habitats. New data for species observed by such method have been obtained. The investigation on primary succession on coal-mine sedimentation pools has been carried out for seven years on 137 objects (few hectares each).
The presented paper contains:

* the list of kenophyte (new comers) species observed on (all 137) objects;
* ecological characteristics of stated species;
* the frequency of the plants occurrence (on particular objects);
* the participation of kenophytes among species which establish first on the bare coal dust substratum;
* the participation of the kenophytes in the floras of particular objects;
* the role of the described species in course of quality and quantity changes in plant composition during the plant cover development;
* the kenophyte participation in plant communities of different internal structure complicity dependent on the development stage of vegetation.

SUCCESS FACTORS ENABLING THE PENETRATION OF MOUNTAIN MASSIFS BY KENOPHYTES: AN EXAMPLE FROM THE NORTHERN PART OF THE CARPATHIANS AND THE SUDETES

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Studies of the horizontal distribution of kenophytes (meaning neophytes according to Thellung) in the Polish Carpathians (Zajac M, Zajac A., 1998) and the data on their vertical ranges, communities where they occur, native range of distribution and the manner of their introduction into the area concerned, permit and underpins some hypotheses about their success in penetration.

The proximity of the native range and often the mountain characteristics of a *taxon* in its homeland can be identified as two of the most important success factors. The species once cultivated by humans and later returned to the wild have a decisive advantage over those species which incidentally become kenophytes. This is probably associated with the fact that a large number of diaspores with the appropriate ecotopic variability reach the colonised area. Another factor ensuring the success is the ability to penetrate extrazonal communities (e.g. associated with river valleys). Also important is the method of dissemination (anemochores prevailing greatly among them).

The altitudinal spectra show, however, that in their vertical distribution, with only some exceptions (even the species which have characteristics of mountain plants in their homelands) they mostly occupy the habitats within the foreland and lower coniferous forest zones. In higher locations, the climate and the competition in natural (or primary) communities are the principal limiting factors. In principle, only a major intervention by humans (erecting major technical structures or buildings) can enable them to penetrate higher locations.

The issue of the factors enabling kenophytes to penetrate the mountains is becoming increasingly important in Europe in connection with the ever intensifying management of the last enclaves of natural and primary vegetation.

SINECOLOGY AND DYNAMICS OF *AMORPHA FRUTICOSA* L. COMMUNITIES IN PO PLAIN - ITALY

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In the Po Valley (Lombardia, Italy) about 130 relevés of different vegetation typologies with the presence of *Amorpha fruticosa* L. have been carried out, the analysis of which has contributed to define its ecology and its dynamic and synecologic role.
This species is favourite in human-disturbed environments. In particular, it constitutes an important species in secondary successions, when human activity diminishes (e.g. grown-wild poplar-groves, sides of the quarry-lakes, abandoned fields). In these cases, if the soil moisture is suitable (*Amorpha fruticosa* is an hygrophilous species), it enters early and becomes the most important pioneer shrub species, quickly forming a close and exclusive covering.
Nevertheless *Amorpha fruticosa* is also found in more natural plant communities, such as Large-sedge swamps and Reed swamps where, however, it is often transitory, probably because the water drift is too strong. Furthermore it is distributed in *Cornus sanguinea* and *Sambucus nigra* communities, and, seldom, in Grey Willow scrubs. The subsequent evolution seems leading to the riparian forest (*Populetalia* Br.-Bl. 1931) or, more rarely, to the mesophilous deciduous forest (*Fagetalia sylvaticae* Pawl. 1928).
Under favourable conditions the scrub phase is rather permanent, probably thanks to the high competitivity of the species.
As regards synecology the *Amorpha fruticosa* scrub includes particularly characteristic species belonging to Artemisietea vulgaris Lohm., Prsg. *et* Tx. 1950 (*i.e.* Convolvuletalia sepium Tx. 1950) and Phragmitetea Tx. *et* Prsg. 1942, and, subordinately, others belonging to Querco-Fagetea Br.-Bl. *et* Vlieg. 1937 (*i.e.* Prunetalia Tx. 1952).

Key words: *Amorpha fruticosa*, Bastard Indigo, Lombardy, Po Valley, shrubs

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VALUING ECOSYSTEM SERVICES LOST TO *TAMARIX* INVASION IN THE UNITED STATES

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Recent interest in the valuation of ecosystem services has provided tools for assessing the market and non-market monetary impacts of invasive species. This study provides an economic evaluation of the effects of the invasive *Tamarix* species complex on societally-valued ecosystem services in its naturalized range. *Tamarix*, a woody plant introduced in the 19th century from Eurasia, has invaded most riparian areas of the arid and semiarid western United States. In its naturalized range, *Tamarix* has at least three major impacts on natural systems. First, it transpires more water than native riparian vegetation, which in a region marked by drought and water scarcity has significant economic implications. Second, it increases sedimentation in river channels, leading to increases in the frequency and severity of floods. Third, *Tamarix* provides poor habitat for native fauna, including birds, mammals, reptiles, and phytophagous insects. With growing public interest in parks, preserves, birdwatching, and wildlife conservation, these impacts on native fauna have economic implications as well. Conservative economic estimates of each of these impacts indicate that over the next 55 years, the costs of *Tamarix* to the western United States will total $6-16 billion. The cost of eradicating the invader and restoring native riparian ecosystems is significantly lower ($3-5 billion). These findings are robust to variations in discount rate and to the exclusion of non-market values from the analysis. Furthermore, changing climate, rising atmospheric CO2, and growing human populations will likely increase the costs of tolerating *Tamarix*. The economic argument for eradication will therefore likely grow stronger in the future, illustrating the importance of acting soon in the case of *Tamarix* and of examining the effects of other harmful invasives before global change has the opportunity to increase their impacts on society.

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