Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

SCOTTISH JOURNAL OF ARTS, SOCIAL SCIENCES AND SCIENTIFIC STUDIES

VOLUME 7, ISSUE I
DECEMBER, 2012

Articles

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

The Use of Multiple Linear Regressions in Determining the Relationship between Housing Unit Price and Some Major Components in a Real Estate Building

Paul Boye
University of Mines and Technology
Department of Mathematics
Tarkwa, Ghana.

Abstract

Real estate is of most importance to any developing society as it usually one of the indicators for development. Pricing housing units by real estate developers usually depends on cost of materials and the profit margins set by the developers. This study seeks to find if there exist a relationship between housing unit price and some major components in a real estate building using Multiple Regression Analysis, Microsoft Excel and SPSS programs. A case study of housing units of Regimanual Gray Estate Developers of Ghana shows high consistency between housing units and the model analysis. The coefficient of determination $\left(R^2\right)$ also suggests that approximately 98.7% of the total variation in the dependent variable was explained by the independent variables of the multiple regression model. Sensitivity analysis had been performed to show how 'sensitive' the model is to changes in the model coefficient parameters. The model is recommendable to be used for further researches to find the present value of a Single - Family Housing Unit by using the housing unit components.

Keywords: Multiple Regression Analysis, Coefficient of Determination, Sensitivity Analysis, Single- Family Housing Unit, Regimanuel Gray Ltd -Ghana.

Introduction

The problem of inadequate housing in developing countries including Ghana has become a very crucial one and may soon get out of control, especially due to rapid increasing population, uncontrollable urbanization, deterioration of rural mud and swish houses, and the high cost of building materials. As a result of aforementioned factors have resulted in the high cost of constructing houses and have worsened the housing situation in Ghana.

The issue of real estate valuation in Ghana is regulated by legal and professional standards. The term 'real estate valuation' denotes the process of valuing a real estate as the subject of the right of ownership and other rights to the real estate. Real estate can only be assessed by certified valuers. A real estate valuer is a person qualified to value real estate. The relevant certificate is issued by the Minister for works and Housing to the provision of the law of real estate management.

The valuation of real estate is a central tenet for all businesses. Land and property are factors of production and, as with any other asset, the value flows from the use to which it is put, and that in turn is dependent upon the demand and supply for the product that is produced. Valuation, in its simplest form, is the determination of the amount for which the property will transact on a particular date. However, there is a wide range of purposes for which valuation atr required. These range from valuations for purchase and sale, transfer, tax assessment, expropriation, inheritance or estate settlement, investment and financing (Bonbright, 1937).

Real property is defined as all the interests, benefits, rights and encumbrances inherent in the ownership of physical real estate, where real estate is the land together with all improvements that are permanently affixed to it and all appurtenances associated thereto (Pricier and Alec, 1996).

Due to the increasing significance attributed to real estate and its value in the process of taking various economic and political decisions, it has become necessary to develop and propagate knowledge of real estate buildings as well as the principles and methods of valuation used. The knowledge of real estate value and the basic factors which affect it are required of government and self-government administration workers.

The links between financial institutions, insurance companies and developers, on the other hand, and real estate owners on the other, are becoming noticeably stronger. These tendencies have resulted in the emergence of the real estate developers like Regimanuel Gray Ltd, SSNIT, Parakuo, Home Finance Company with the noble aim of providing adequate and affordable housing for Ghanaians.

Applying the principle of market economy to the decision-making process in real estate buildings has prompted a decision on unifying the opinions in the field as well as determining new areas of research, which would concern, for example, real estate valuation.

In this research, we seek to find a relationship between housing unit price and some major components such as plot size, building size, number of apartment units, number of car parking lots in a real estate building using Multiple Regression Analysis, Microsoft Excel and SPSS programs.

In real estate valuation and house market research, house prices and rental value are generally analyzed by hedonic model based on micro economic theory. Selim, (2008)

used Hedonic model to examine the effect of characteristics of goods on their prices. Factors that determined the house prices in Turkey were analyzed using 2004 Household Budget Survey Data. The most important variables that affected house rents were type of house, type of building, number of rooms, size, and other structural characteristics such as water system, pool, natural gas.

Ordinary Least Square (OLS) regression has typically been used in housing research to determine the relationship of a particular housing characteristic with selling price. Results differ across studies, not only in terms of size of OLS coefficients and statistical significance, but sometimes in direction of effect. Zietz et al., (2007) suggested that some of the observed variation in the estimated prices of housing characteristics may reflect in the fact that housing characteristics are not priced the same across a given distribution of house prices. To examine this issue, they used quantile regression, with and without accounting for spatial autocorrelation, to identify the coefficients of a large set of diverse variables across different quantiles. The results showed that purchasers of higher-priced homes value certain housing characteristics such as square footage and the number of bathrooms differently from buyers of lower-priced homes. Other variables such as age are also shown to vary across the distribution of house prices.

The housing market is special in that houses are immobile, costly and durable. Mynbaev and Ibrayeba (2011) looked at the determinants of prices of the housing market of Almaty. What affects the prices of houses and apartments? How was the housing market developing during the economic boom and after the financial crisis started? They started with a review of the existing models. The theory indicated the size, quality and location as the main determinants. To apply the hedonic model, They collected a random sample of about 2,500 observations on housing units in seven districts of Almaty from newspaper advertisements. Those units were categorized by the number of rooms, quality, district, floor, etc. Some of those characteristics were non-numerical and require dummy variables. With the data collected, They ran several regressions in Eviews. They obtained valuation figures for different characteristics of housing units. The data clearly showed existence of a bubble during 2006-2007. The regression results revealed the differences between different districts, dependence on the quality and floor. Among unexpected results were the facts that corner apartments and floor level had negative coefficients, perhaps because first floor apartments were considered as potential commercial property or perhaps lower stories were preferred in general but the first storey is the least preferred**.** Some questions, such as valuation of luxury apartments or those in the north of the city remain unanswered because of lack of data. It would be also interesting to correlate housing prices with the interest rate on mortgages.

Sirmans, et al., (1989), examined the effects of various amenities, services, and external factors on rent for multifamily housing. The attributes studied include amenities and services such as covered parking, modern kitchen and maid service, occupancy restrictions such as no pet allowed, and external factors such as traffic congestion, proximity to work, and access to public transportation. The empirical results showed that a number of these characteristics do affect rent. Specially, such items as covered parking and modern kitchen are important determinants of rent. External factors such as traffic congestion and access to public transportation also have a significant impact. A model was presented to compare the costs and benefits of providing certain amenities and services.

Habans, (2004), analyzed the role of local land use policies in determining the levels and changes of housing prices in California cities between 1990 and 2000. Three models were developed. First, a cross-sectional model fits price levels to income, demographic, and regulatory variables that characterize the extent to which a given city's land use policy reflects exclusivity or growth-hospitality. Second, a "before and after" transformation of the cross-sectional model compares housing price changes with variables that relate the extent to which local policy favors single-family, detached housing construction through the permits process. Third, the "initial conditions" model relates changes in housing prices to the permits variables. The models addressed potential endogeneity built in the permits variables with a two-stage least squares procedure. For each sampled municipality, the mentioned exclusivity and growth-hospitality variables, along with state-proposition voting outcomes, served as instrumental variables. On the whole, the regressions substantiated the hypotheses that both regulations and demographics influence housing prices.

Residential house prices in New Zealand (NZ) have experienced substantial increases even as the rate of house transactions began to slow down in 2007. Ge, (2009) developed house price forecasting models using Multiple Regression Analysis in order to analyze the main determinants of house prices in the New Zealand market. Quarterly time series data for the period from March 1980 to December 2007 were collected from the Department of Statistics and the Reserved Bank New Zealand for the model development. The estimated that house prices will fall after 2007 and will continue to fall in 2008 and 2009, and that migration plays an important role in determining house price fluctuation, so that a one-percent increase in migration arrivals was associated with approximately a ten- percent change in house prices with a one-year lag. Investment expectations, unemployment, mortgage rate and building permits were also the main determinants of price variations. The model showed that even before the sub-prime crisis hit New Zealand, the prices had been on the way down.

Sirmans, G.S. et al. (2005) provided a meta regression analysis of nine housing characteristics that were presented most often in hedonic pricing models for single-family housing: square footage, lot size, age, bedrooms, bathrooms, garage, swimming pool, fireplace, and air conditioning. Meta regression analysis is useful for comparing the estimated regression coefficients from different studies. The major interest is to determine if the estimated coefficients vary by geographical location, time, type of data, controlling for other variables, and model specification. The results showed that some estimated coefficients vary significantly by geographical location. These include square footage, lot size, age, bedrooms, bathrooms, garage, swimming pool, and air conditioning. Only the coefficient for age was sensitive to time. Controlling for type of data produced differences in coefficients for age, bathrooms, and fireplace. Only the air conditioning coefficient was affected by level of household income. Controlling for square footage produced lower coefficients for lot size and bedrooms. Controlling for the size of the hedonic model does not affect the coefficients for any of the characteristics.

Low-cost housing plays a vital role in the development process especially in providing accommodation to those who are less fortunate and the lower income group. This effort is also a step in overcoming the squatter problem which could cripple the competitive drive of the local community especially in the state of Sabah, Malaysia. Mulok, (2008) attempted to look into the influencing factors to low-cost housing in Sabah namely the government's budget (allocation) for low cost housing projects and Sabah's

total population. At the same time, he attempted to show the implication from the development and economic crises which occurred during period 1971 to 2000 towards the provision of low cost houses in Sabah. Empirical analyses were conducted using the multiple linear regression method, stepwise and also the dummy variable approach in demonstrating the link. The empirical result showed that the government's budget for low-cost housing is the main contributor to the provision of low-cost housing in Sabah. The empirical decision also suggested that economic growth namely Gross Domestic Product (GDP) did not provide a significant effect to the low-cost housing in Sabah. However, almost all major crises that have beset upon Malaysia's economy caused a significant and consistent effect to the low-cost housing in Sabah especially the financial crisis which occurred in mid 1997.

The spiraling increase in housing construction costs in Nigeria has been adduced to various factors such as the high cost of production and of building materials. Windapo and AIyagba (2007) sets to find out if there is any significant relationship between housing construction costs and economic factors proposed in the study as leading indicators of future levels of housing construction costs. It also sought to construct a model from the economic factors for use as predictors of future levels of housing construction costs. Literature was reviewed to aid the direction of the study. Data analyzed with the use of Pearson Product Moment Correlation and Multiple Regression Analysis was annual based over a fifteen-year period. The study revealed that future levels of housing construction cost in Nigeria could be predicted from future estimated levels of labor costs among other findings.

Yazgi, (2007) explored the spatial distribution of housing prices in the Metropolitan Area of Istanbul, the largest city of Turkey and the most important socioeconomic centre with a long historical background. After 1980s, multi-center development of the city played an important role for distribution of population, jobs and housing prices at the city level. By examining certain cases that were developed over time in different parts of the city, the factors affecting the housing prices were investigated. The samples were taken from three different zones: The core area, the intermediate zone, and the periphery. Housing prices were taken from real estate agents and presented with computer based techniques and with other variables collectively. Regression analysis was used for the investigation. Housing prices were considered as dependent variables while road area ratio, distance to the sea shore, distance to the center, floor area ratio, the size of the floor area of the houses and access-integration value as space-syntax indices were measured as independent variables. The results of the analysis indicated that the most important factor affecting the housing prices was the size of the floor area. The second and third most effective factors were the road surface ratio and the floor area ratio consecutively. The distance to the sea shore was fourth most important factor particularly for cities surrounded by a sea; such as Istanbul. The access-integration values as space-syntax indices were not found significant. The other factor distance to the center included in the analysis was not found significant, either. Results of this study could be useful for the investors, urban planners and the policy makers. Time series analysis was suggested for further research.

In real estate valuation and house market research, house prices and rental value are generally analyzed by hedonic model based on micro economic theory. Selim, (2008) used Hedonic model to examine the effect of characteristics of goods on their prices. Factors that determined the house prices in Turkey were analyzed using 2004 Household

Budget Survey Data. The most important variables that affected house rents were type of house, type of building, number of rooms, size, and other structural characteristics such as water system, pool, natural gas.

Research on housing set out for various reasons but the focus of all research lies in the three main traits: price, affordability and ownership. Whilst affordability captures the attention of social scientist, an interest in property investment identifies price determinants and what actually paid for a house and whether the decision to invest in housing is guided by sufficient information. Yusof, (2008) analyzed the impact of macro and micro determinant of house price in five selected location in Malaysia. A literature review revealed that house price was determined by an inter play of some macro factors such as income per capita. Twelve macro models proved that economic indicators were significant in explaining the price variation. The finding indicated that for all models, economic growth plays an important role in price but as the income-related variables were included in the model, income-related variables gained significance. Thus, the regression models led to a conclusion that price was greatly influenced by income and income-related factors. While this finding pertains to the national and state level, local market was investigated via the development of hedonic equation. A total of twenty-six (26) models has been developed for five different locations in Malaysia. Transaction prices of secondary double storey terrace houses were regressed against the identified attributes and collected from secondary and primary sources. Appropriate statistical analysis was performed to minimize any potential technical disability in the model development which may affect the interpretation ability. Stepwise regression process was employed to eliminate multicollinearity that might affect the stability of the models. The analysis indicated that price was actually specific to a particular location. One location was greatly explained by building area, which means people are paying for larger area. Whilst in some other location, the price was significantly explained by the locational related factors. The finding for each location was quite consistent even though there was a tendency of shift in paying preference. For example Penang imposed higher implicit price observed in the model for distance factor, but in 2000s model showed that price was dominated by various factors. It shows that the implicit prices for each attribute vary from one year to another. Hence suggest that the price paid is not fixed but need adjustment from time to time. The findings thus suggests that it is quite impossible to draw general conclusion for the local market as it is influenced by factors or attributes that pertains to or specific to the particular market.

Yung, (2010) detailed the uses of multivariate regression method in construction cost studies. It covers most practical operations that students or researchers may encounter when undertaking similar studies. These include the treatment of original data, discounting of data with appropriate tender price indices, sample size, the use of dummy variables, hypothesis testing, interpretation of results, diagnosis of problems, etc. A demonstration with real data was also conducted to consolidate the ideas. It is believed that the practical method presented in this paper will help readers explore the rich database of the Building Cost Information Service compiled by the Royal Institution of Chartered Surveyors.

Real estate is often used to refer to things that are not movable such as land and improvements permanently attached to the land. Different types of real estate can have very different cyclic properties. Real estates go through bubbles followed by slumps in Meru municipality and some real estate properties take shorter time to sell while others

take longer time despite that the prevailing conditions seem similar. Several studies done especially on changes in prices of real estates revealed that real estate prices go through bubbles and slumps. Messah and Kigige (2011) investigated the factors at play in determining real estate property prices in Meru Munincipality in Kenya. They investigated factors such as incomes of real estate investors, the influence of location on the price, demand and realtors influence on the price. They adopted descriptive research design to obtain information on the current status of the phenomenon. Structured questionnaires were used in data collection to obtain the required information needed for the study. The population consisted of all 15,844 registered real estate owners in the 5 (five) selected areas of Meru municipality from which a sample of 390 real estate owners were selected by stratifying the population and then selecting the respondents by use of simple random sampling. The data obtained was analyzed by use of available statistical packages for social sciences to obtain descriptive statistics and a regression model. Findings indicated that incomes alone contributed almost 70% of the variations in prices. Demand alone contributed 20% of the changes in prices of real estate. Location and Realtors were found insignificant in determining real estate prices. A summary regression showed that the variables considered could explain up to about 70% of variations in prices. The study recommended that further investigation be done on reasons why location and realtors were not significant in determining real estate property prices in Meru municipality.

The hedonic pricing model has been employed with a degree of success in housing market analysis in developed countries. Babawale, et al. (2012) demonstrated the potentials of the same technique to the study of housing markets in a developing country like Nigeria. They used data from Ikeja area of Lagos state, Nigeria, to provide empirical evidence on market parameters that described the hedonic price structure for apartments (flats) in a typical Nigerian city. Primary data were elicited through structured questionnaire, complemented with selective interviews and personal observations. The results revealed that number of bedrooms, condition of the property, availability of pipe-borne water, average size of bedrooms, and numbers of bath/toilets, in that order, were the main descriptors of apartment rentals in the study area. The results of this empirical investigation are of particular importance to investors, developers, financiers, and real estate valuers operating in the property sub-market under consideration. Among others, adequate knowledge of issues investigated and raised would assist developers to build to consumer tastes and preferences. The resulting model also provided an alternative to traditional valuation techniques and afforded greater flexibility in accounting for sustainability in real estate valuation.

An application of rigorous statistical analysis in aiding investment decision making gains momentum in the United States of America as well as the United Kingdom. Nonetheless in Malaysia the responses from the local academician were rather slow and the rate is even slower as far as the practitioners were concerned. Yusof and Ismail, (2012) illustrated how Multiple Regression Analysis (MRA) and its extension, Hedonic Regression Analysis been used in explaining price variation for selected houses in Malaysia. Each attribute that theoretically identified as price determinant was priced and the perceived contribution of each was explicitly shown. They demonstrated how the statistical analysis is capable of analyzing property investment by considering multiple determinants. The consideration of various characteristics which is more rigorous enables better investment decision making.

This paper analyzed the main determinants of real estate prices. Investigation of Kiev real estate market confirmed the influence of different macro and micro factors on real estate market. Mavrodiy, (2005) examined the effect of changes in Gross Domestic Product (GDP), income level, population and interest rate. The analysis inferred the direct relationship between GDP, income level, population and housing prices. It was observed that interest rate affected price level negatively. Examination results also provided the evidence of the relationship between micro factors and housing prices. Location and qualitative attributes appeared to have significant effect on real estate prices.

Description of the Study Area

The study area is in Accra the capital of Ghana and has a geographic location of 5°33'N latitude and 0°15'W longitude. Accra is in the Southern part of Ghana which is very close to the Gulf of Guinea (fig. 1).

Fig. 1 Location map of the Study Area

History of Regimanuel Gray Ltd.

Regimanuel gray Ltd. was incorporated in 1991 in order to pursue real estate development and general construction projects in Ghana. Since its inception, it has completed over 1000 houses on six project sites. It has also undertaken the construction of schools, office buildings and warehouses. Its mission is to provide quality and timely projects at affordable prices. It offers a wide range of houses including two, three and four bedroom units, detached and semi- detached storey and bungalow types. Each house is delivered with complete documentation as the property. It works closely with many local financial institutions including the Home Finance Company Ltd, which has mortgage facilities for resident and non-resident Ghanaians.

Materials and Methodology

In this study, we used multiple linear regression to model the relationship between housing unit price (Y) and some major components of a Single-Family apartment (X_i). The independent variables in the model were number of apartment units, plot size, gross area of building, and number of site parking spaces.

$$\text{Model: } E[y] = \beta_0 + \sum_{i=1}^{n} \beta_i X_{1i} \text{ ; where } i = 1, 2, 3, 4.$$

This study utilized the sample data in Table 1, to examine the relationship between the dependent variable and the independent variables.

Hypotesis Testing

$H_0: \beta_1 = \beta_2 = ... = \beta_k = 0$ There are no significant differences among the parameter coefficients

$H_1: \beta_j \neq 0$ for at least one j. There are significant differences among the parameter coefficients.

Results

Table 1 presents information on dependent variable and the independent variables. Table 2 shows the computed ANOVA for the linear model. Tables 3a and 3b up to tables 6a and 6b shows the computations of the sensitivity analysis of the coefficients of the independent variables varied in the range of ± 1 and their corresponding computed coefficient of determinations. Using table 1, the results of the findings are presented in table 2 to table 7.

Table 1: Sample Data

Comps Code number	Sales price (Y) ($)	Number of apartment units (x_1)	Plotsize(x_2) (sq. meter)	Gross Area (Sq.meter) (x_3)	Number of sitepacking spaces (x_4)
RG- 5E	88400	20	8000	248	2
RG- 5E	99600	23	8000	279	2
RG- 7	26400	8	5600	96	0
RG-7	45000	16	5600	178	0
RG-9F	55100	16	6000	182	0
RG-11	135700	22	8000	339	2
RG-12	133700	22	8000	334	2
RG-1	16000	14	2800	76	0
RG-2	19800	7	5200	82	2
RG- 2	22500	7	5200	82	2
RG-2	23000	8	5200	96	2
RG-2	27800	8	5200	96	2
RG-2	28800	10	5200	120	1
RG-2	32700	11	5200	140	1
RG-2	34800	10	5200	120	1
RG-2	38700	11	5200	120	1
RG-2C	42800	12	5200	178	1
RG-2C	50300	12	5200	178	1
RG-2C	46000	12	5200	192	1
RG-2C	55600	12	5200	192	1

Table 2: Computed Anova for the Linear Model

SOURCE OF VARIATION	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F-STATISTIC	Test Statistic
REGRESSION	2.466778E10	4	6166945000	101.029983	2.7278
ERROR	1648100000	27	61040740.74		
TOTAL	2.631588E10	31			

Tables 3a and 3b were the results of the sensitivity analysis performed by varying Beta-zero in the range of ±1.

Table 3 a

Confidence Level	1.00	0.50	0.00	-0.50	-1.00
Beta Value	-25796.78	1452.61	0.13	316.31	2583.11
Beta New	-25795.80	1452.61	-25796.80	-25797.30	-25797.80
Y New	87873.24	87872.74	87872.24	87871.74	87871.24

Table 3 b

R^2	F- Statistic	Standard Dev(Y)	SSR	SSE	Slope	Intercept	Deg. of Freedom
0.9999	1254869.04	0.001409	2.49	6E-06	0.99	11362.2	3

Tables 4a and 4b were the results of the sensitivity analysis performed by varying Beta-one in the range of ±1.

Table 4 a

Confidence Level	1.00	0.50	0.00	-0.50	-1.00
Beta Value	-25796.78	1452.61	0.13	316.31	2583.11
Beta New	1453.61	1453.61	0.13	1452.11	1451.61
Y New	87892.24	87882.24	58822.60	87862.24	87852.24

Table 4 b

R^2	F- Statistic	Standard Dev(Y)	SSR	SSE	Slope	Intercept	Deg. of Freedom
1	7.6963E+32	9.37E-13	6.75E+08	2.6E-24	20	58820.09	3

Tables 5a and 5b were the results of the sensitivity analysis performed by varying Beta-two in the range of ±1.

Table 5 a

Confidence Level	1.00	0.50	0.00	-0.50	-1.00
Beta Value	-25796.78	1452.61	0.13	316.31	2583.11
Beta New	1.13	0.63	0.13	-0.37	-0.87
Y New	95872.24	91872.24	87872.24	83872.25	79872.25

Table 5 b

R^2	F- Statistic	Standard Dev(Y)	SSR	SSE	Slope	Intercept	Deg. of Freedom
1	1.249E+13	0.0036	1.6E+08	3.8E-05	8846	84804	3

Tables 6a and 6b were the results of the sensitivity analysis performed by varying Beta-three in the range of ±1.

Table 6a

Confidence Level	1.00	0.50	0.00	-0.50	-1.00
Beta Value	-25796.78	1452.61	0.13	316.31	2583.11
Beta New	317.31	316.81	316.31	315.81	315.31
Y New	88120.24	87996.24	87872.24	87748.24	87624.24

Table 6 b

R^2	F- Statistic	Standard Dev(Y)	SSR	SSE	Slope	Intercept	Deg. of Freedom
1	1.0877E+32	3.75E-14	153760	4.2E-27	248	9426.5445	3

Tables 7a and 7b were the results of the sensitivity analysis performed by varying Beta-four in the range of ±1.

Table 7a

Confidence Level	1.00	0.50	0.00	-0.50	-1.00
Beta Value	-25796.78	1452.61	0.13	316.31	2583.11
Beta New	2584.11	2583.61	2583.11	2582.61	2582.11
Y New	87874.24	87873.24	87872.24	87871.24	87870.24

Table 7b

R^2	**F- Statistic**	**Standard Dev(Y)**	**SSR**	**SSE**	**Slope**	**Intercept**	**Deg. of Freedom**
1	1.159E+32	2.937E-16	10	2.6E-31	2	82706.014	3

Discussion of Results

Table 2 presents information on hypothesis as measured by F- statistic to determine the statistical significant predictive capability of the model. Since the computed F-statistic is 101.029983 which is greater than the test statistic $f_{(0.05,4,27)} = 2.7278$, the null hypothesis is rejected and we concluded that the independent variables contributed significantly to the estimated model.

Results of Beta zero does not represent coefficient of any housing unit component. Tables 3a and 3b showed a minimal variation in Y_{new} values, which indicates that the model does not change in the range of ± 1 variation. The coefficient of determination (R^2) was 0.9999 which indicates that there is a very good fit of the data to the model. The standard deviation in Y is also very small. This explains the variation in Y our knowledge of X_i full of error brings to bear. Smaller deviations, better predictions.

Results of Beta one is the coefficient representing the number of housing units and its usefulness to the model. Tables 4a and 4b showed minimal variations for Y_{new}, which indicates that the model does not change in the range of ± 1 variation. The coefficient of determination (R^2) was 1, which indicates that the data fits the model perfectly well. The standard deviation in Y is also very small. This explains the variation in Y our knowledge of X_i full of error brings to bear. Smaller deviations, better predictions.

Results of Beta two is the coefficient representing the plot size and its usefulness to the model. Tables 5a and 5b showed minimal variations for Y_{new}, which indicates that the model does not change in the range of ± 1 variation. The coefficient of determination (R^2) was 1, which indicates that the data fits the model perfectly well. The standard deviation in Y is also very small. This explains the variation in Y our knowledge of X_i full of error brings to bear. Smaller deviations, better predictions.

Results of Beta three is the coefficient representing the gross area of building and its usefulness to the model. Tables 6a and 6b showed minimal variations for Y_{new}, which indicates that the model does not change in the range of ± 1 variation. The coefficient of determination (R^2) was 1, which indicates that the data fits the model perfectly well. The standard deviation in Y is also very small. This explains the variation in Y our knowledge of X_i full of error brings to bear. Smaller deviations, better predictions.

Results of Beta four is the coefficient representing the number of site parking spaces and its usefulness to the model. Tables 7a and 7b showed minimal variations for Y_{new}, which indicates that the model does not change in the range of ± 1 variation. The coefficient of determination (R^2) was 1, which indicates that the data fits the model perfectly well. The standard deviation in Y is also very small. This explains the variation in Y our knowledge of X_i full of error brings to bear. Smaller deviations, better predictions.

Conclusion

From the above research findings, it is clear that the estimated model does not only fits the data very well, but also shows a perfect relationship between housing unit price and some major components both within and around the real estate building. The following are the conclusions from the research:

(i) The multiple coefficient of determination calculation (R^2) made revealed that the four independent variables in the model explained 93.74% of the total variation of the dependent variable. This shows that there exists a very good fit of the Multiple regression model to the sample data.

(ii) The residuals obtained do not only appear to behave randomly, but also suggests that the model fits the data well.

(iii) From all the five sensitivity analysis carried out, the statistical outputs show that all the four parameters that were varied in the range of ±1 has no significant effect on the output results.

Acknowledgement:

Prof. Adetunde, I.A, Dean of Faculty of Engineering, University of Mines and Technology, Tarkwa, Ghgana is highly acknowledged for fruitful discussions, his criticism, suggestions and making this article publishable.

References

Anon, (2005) "Ground Floor Plan" Regimanuel Gray Estates, pp1

Ameen, J. R. M, Neale, R. H., and Abrahamson, M. (2003). "An application of regression analysis to quantify a claim for increased costs" . Journal of Construction Management and Economics, U.K., Vol.2; pp.159-167.

Bonbright, J.C. (1937): "The valuation of property", New York: MC Graw Hill. Vol. 7; ***pp***.18 – 33.

Castle and Gilbert, (1998): "Property Investment & Finance" Journal of brokers participating in transactions.Vol.1; pp. 59- 66.

Cohen Jacob (2003), Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences, Routledge Academic; Third edition, pp. 480 - 499.

Doane P. David, Lori E. Seward (2000), *Applied Statistics for Business and Economics*, Irwin/mcgraw-hill, pp. 91- 110.

Eple R. Donald, Burns William (2004), "Real estate and insurance business" Journal of the American Real Estate and Urban Economics Association, Vol. 6, Issue 1, 1978.

Friedman, S.L. (1979) 'Use of multiple regression analysis to test for a deferent effect of capital punishment- prospects and problems'. From Criminology Review Yearbook, V1, 1979 by Sheldon L Messinger and Egon Bittner-See NCJ-60767.

John D. Benjamin, (2004), " An Introduction to Multiple Regression Analysis for Real Estate Valuation" Journal, Vol.7, pp.65-78).

Kazmierczak, S. C. , Catrou, P. G. , Best, A. E. , Sullivan, S. , W. and Briley, K. P. (1998). "Multiple regression analysis of interference effects from a hemoglobin-based oxygen carrier solution" Journal of Clinical chemistry and laboratory medicine**,** Spain. Volume 37. Page 453-464

Kruse, C. G., Hubert, W. A., (1998)."Single-Pass Electro fishing Predicts Trout Abundance in Mountain Streams with Sparse Habitat", Journal of Fisheries Management**,** USA. Vol. 112, PP. 451-469.

Kucharik, J. C.(2008) **"**Contribution of Planting Date Trends to Increased Maize Yields in the Central United States" Agronomy journal, USA. Vol.3; PP. 451-469.

Michiaki, I., Yukinori, S. and Atsushi, K. (2002), 'Calculation of Underpinning Loads Based on Multiple Regression Analysis'. Proceedings of Japan Society of Civil Engineers Vol.2; pp 159-167.

Morris Hamburg (1993), *Statistical* Analysis *for Decision Makers*, Springer, pp. 451-469.

Nick French, Edwards Jonathan (2003), "The Journal of Business", Journal of Property Investment & Finance, Vol.2, pp.617- 632.

Pannell, J.D.(1997), *Sensitivity and uncertainty analysis*, John Wiley & Sons, pp. 337- 350).

Pricier W. Robert, Alec C. Johnson (1996), "Dallas Business Journal": Journal of Small Business Management, Vol.32; PP.27-35.

Satish, K. P.,Srinivasan, R. (2010). 'Total quality management and its impact on innovation performance' International Journal of Electronic Customer Relationship Management, India. Vol. 4, PP. 19-32.

Tooru, S. (2003).'Application of Multiple Regression Analysis to Extract Promising Areas of Kuroko Deposits in the Hokuroku Area'. Journal of the Mining and Materials Processing Institute of Japan. Vol. 119, PP. 149-154.

William Dale Berry, Stanley Feldman (1985), *Multiple regression in Practice*, Sage Publications, pp. 37- 50.

Yongjae, K., Sehun, R., (1989)'Arc sensor model using multiple-regression analysis and a neural network' Mechanical Engineering Publications, London. Vol. 73; PP. 363-369.

Yuqing, L. (2008).'Multiple Stepwise Regression Analysis on Knowledge Evaluation'. Journal of Management of e-Commerce and e-Government, China. Vol. 26; PP. 251-256.

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Consumption Pattern, Supplementation and Organoleptic Assessment of Plantain (musa paradisiaca) and the Snacks Made from its Flour.

Bridget Uyoyou Nora Imonikebe
Home Economics Unit, Vocational Education Department
Delta State University, Abraka, Nigeria.
E-Mail: bridgetimonikebe@yahoo.com

Abstract

The study investigated various forms of the use of plantain in meal preparation in Isoko North Local Government Area in Delta State, Nigeria and the production from the flour cheap nutritious acceptable food for infants, adolescents and adults. A sample of 400 mothers from various occupational groups was randomly selected. Questionnaire was used for data collection. A – 6 point scale was used to access the sensory properties of the flour products (chinchin, fish pie and pancake) by 40 mothers. Percentage, means, analysis of variance (ANOVA) were used for data analysis Duncan's New Multiple Range Test was used to detect the means that were different. Findings showed that plantain was consumed by most people once a week, some prefer eating it whenever it was available and when boiled or as pottage. Mashed plantain was fed to infants as weaning food. The plantain wheat flour pancakes, fish pies and chinchin were acceptable to the mothers. It was recommended that mothers in Isoko North should give pancake, fish pies and chinchin made from plantain wheat flour to their family members especially the adolescents.

Keywords: Plantain, Meal preparation, flour products, Fish pie, pancake, chinchin , pottage, acceptable, weaning food

Introduction

At present, the population of Nigeria was been increasing rapidly. This has made it difficult for most families to feed adequately. This has led o malnutrition. World Bank (1993) reported that a third part of the world is poor, hungry and malnourished. During harvest, season, there is usually abundance of food stuffs. However much of these get wasted due to inappropriate and inadequate methods of processing, preservation and storage. As a result of post harvest losses, there is much reduction in the total amount of food left to feed the growing populace. If food can be well processed, it could increase its shelf life and make it to be available even when out of season.

A lot of plant foods are consumed in Nigeria. Examples are yam, plantain, rice, beans and maize. Plant based foods are cheaper and form the larger proportion of the food consumed by many Nigerians. These form the major sources of energy, protein and small quantities of other nutrients. Plantain, cassava and yam form the primary sources of carbohydrates (Imonikebe 2007). Plantains are prepared and eaten in various forms. They are eaten alone or in combination with legumes or with fried eggs. Plantain is mixed with palm oil or eaten as pottage (Imonikebe 2007). Plantains cultivated in many parts of Nigeria.

Much of plant foods are usually consumed. One setback in the consumption of plant foods is that they contain only some essential amino acids. They also contain anti-nutritional factors which lead to interference with the availability of such nutrients present in the food that are needed for adequate body functioning (Imonikebe 2007). Any measure which could improve the nutritional quality, shelf life, organolephtic qualities, reduce bulk to enhance storage and promote the use of local staples and could minimize hunger and malnutrition will be of great importance. One of such methods is food processing.

Food processing enhances the quality of food because foodstuffs are converted to forms which may be more acceptable and may be completely different from the original food in terms of odour, taste, flavour, appearance and texture (Enwere 1998). Most of the time the processed food may have a longer shelf life than the original food. Food processing usually improves the nutrient quality of plant foods and enhances nutritional quality.

Plantain is abundantly eaten in various forms boiled, roasted or stewed. Processing of plantain into flour can increase its shelf life and allow for supplementation with other food items. Plantain is used as a complementary food mixed with palm oil. The continuous dependence on the consumption of such unsupplemented foods could precipitate under - nutrition. When processed into flour, plantain can be supplemented with soy, and other foods especially as flours.

In order to prevent infant and adult malnutrition in Nigeria, it is imperative to increase the production and upgrading of the nutrient content of plantain as complementary food for infants and supplements for adults. The thrust of this study was to identify, the consumption pattern of plantain in Isoko North Local Government Area in Delta State, select plantain for processing and to supplement the flour with wheat flour for snacks production.

Purpose of the Study

The purpose of the study was to find out the consumption pattern of plantain and to process it into flour and supplement with wheat flour for the production of chinchin pancakes and fish pies.

Objectives of the Study

1. To identify the consumption pattern of plantain in Isoko North Local Government Area, Delta State in Nigeria.
2. To process plantain into flour and supplement with wheat flour for the preparation of chinchin fish pies and pancakes.
3. To evaluate the sensory properties of the snacks.

Materials and Methods

The study investigated the consumption pattern of plantain in Isoko North Local Government Area in Delta State. The study was also on the production of plantain flour and the organoleptic evaluation of the supplemented products (chin-chin, pancake and fish pies)

Sampling Techniques: A systematic random sampling technique was used to obtain the sample. Six towns Owhelogbo, Ozoro, lyede, Otibio, Otor-Owhe and Emevor were sources of sample (subjects). These towns are in the rain forest region of Nigeria. The major occupations of these communities are teaching, farming, trading and civil service. The subjects were married women (400), who had up to two children in Isoko North Local Government Area.

Preparation of Samples: The plantain were purchased from local sources, washed with clean cold water to remove dirt, after which they were peeled, sun dried to 95% dry matter The thin slices were crushed and milled into fine flour (70 mesh) using a local grinding machine. The flour was allowed to cool prior to name labeling and packaging into polythene bags and stored in air-tight tins until used.

Organoleptic Attributes of Samples: A recipe was developed from plantain flour and used for preparation of chin-chin, fish pies and pancakes. A pilot tasting session was conducted to standardize the recipe. Ten Economics teachers from six secondary schools in lsoko North Local Government Area served as panelists. After session of tasting, some adjustments were made on the recipes: Several tasting sessions were made on each product. The panelists were asked to tick their responses into the checklist questionnaire based on their opinions about each product A 6-point hedonic scale was used for the sensory evaluation (Piggot 1984) of the plantain products. A mean score 3.50-6.00 indicated that the product was palatable and below this showed unpalatability. Another 6-point hedonic scale was used to evaluate the flavour, colour, texture and overall acceptability of the product. A mean score 3.50-6.00 showed that the product was liked by members of taste panel and below 3.50 showed dislike.

Preparation of Plantain Products: The plantain flour was supplemented with wheat flour in ratio of 50:50 and 70:30 and used to prepare some dishes (pancakes, fish pies and chin-chin). These were served with orange drink as accompaniment. The snacks were displayed to a panel of 40 judges for assessment. Prior to tasting, the panelists were educated on how to conduct the tasting and assessment of qualities of each sample.

Organoleptic Evaluation: Each flour product (snacks) were displayed on a table with name labeled product code in a well-lit room Forty panelists were involved in the

study Each panelist was given a small saucer to place the sample, a teaspoon for taking a portion of the sample, and a glass of clean drinking water. Each person was advised to rinse mouth after tasting each product to prevent a carryover of taste. Each panelist was given evaluation form for each product. They evaluated each product and ticked the attributes that corresponded with their observations. The forms were retrieved at the end of the session.

Statistical Analysis: The data collected were analysed using percentages, mean, standard deviations, variance, standard error of the mean, One Way Analysis of Variance. The mean separation was conducted using Duncan's New Multiple Range Test as Steel and Torrie (1960).

Results

Age range of the mothers

Table 1 presented the age range of the mothers. The women who were between 31-40 years were 154 (38.4%) of the total subjects (400). However, those between 20-30 years and above 40 years were 123 or 30 8% respectively

Qualification of the mothers

Finding showed that 30 (7.50%) of the subjects had either no formal education or First School Leaving Certificate or WASC/Teachers Grade II Certificate. Sixty-two (15.5%) had BSc/BA/BEd. Some 248 (62.0%) of the total subjects (400) had NCE/HND.

Average monthly income of the mothers

Results revealed presented the average monthly income of the mothers. Findings showed that 90 (22.5%) of the total mothers (400) earned below ₦l0,000.00 monthly. However, 123 (30.8%) of the women earned between ₦10,000.00 – ₦20,000.00 monthly. One hundred and sixty-five (41.3%) of the mothers earned between ₦21,000.00 – ₦60,000.00 monthly. Ten subjects (2.50%) earned above ₦60,000.00 monthly.

Results showed that 30 (7.50%) of the respondents had formal education. Another 30 (7.50%) had first school leaving certificate, WASC, Teachers' Grade II Certificate. Most of the respondents 249 (62.0%) had NCE/HND sixty-two (15.5%) had BSc/BA/Bed.

Results showed that 30 (7.75%) had a family size of 3; 130 (32.5%) had a family size of 4. Also 60 (15.0%) were 5 or 6 in their families. Thirty (7.25%) were 7 in their families. Ninety (22.5%) were more than 7 in number in their families.

Table 1 showed the frequency of consumption of plantain by each family. Ninety –one (22.8%) of the families consumed plantain up to four times a week.

Table 1: Frequency of consumption of plantain by each family in Isoko North Local Government Area in Delta State.

Frequency of Consumption	Frequency	Percentage
Once in a while	33	8.25
Once in a week	93	23.3
Twice a week	-	-
Thrice a week	30	7.50
Four times a week	91	22.8
Five times a week	-	-
Six times a week	-	-
Everyday	32	8.00
Total	279	68.9

In table 2, results showed that majority of the women (84.0%) cooked plantain by boiling unripe peeled plantain. Few (15.5%) boil unripe and unpeeled plantain. More than 22.3% of the women cook plantain pottage.

Table 2: Method of cooking plantain by the women

Frequency of Consumption	Frequency	Percentage
Boiling unripe peeled plantain	336	84.0
Boiling unripe unpeeled plantain	62	15.5
Boiling ripe unpeeled plantain	37	9.25
Boiling ripe peeled plantain	22	5.50
Roasting	75	18.8
Stewing for preparing pottage	89	22.3
Baking	-	-
Total	400	100

Food consumed together with plantain by the families.

Table 3 showed that some of the women (40.2%) used unripe plantain to prepare beans pottage. At least 44.0% of the families consumed fried ripe plantain and beans pottage.

Table 3: Food consumed together with plantain by the families.

Food	Frequency	Percentage
Ripe plantain + beans pottage	161	40.2
Fried ripe plantain (dodo) + beans pottage	179	44.8
Unripe plantain starch + oil soup (owo soup)	60	15
Total	400	100

Table 4: Occasions plantain must be served in Isoko North Local Government Area.

Occasion	Frequency	Percentage
No occasion	10	2.50
When cooking for a women who has just given birth	123	38.8
Burial ceremony	-	-
Immediately after wedding, to only in-laws	200	50.0
During bride price paying ceremony to only in-laws	162	40.5

Table 5: The forms mothers prepared plantain as complementary food for their babies. The table showed that 120 (30.0%) mashed plantain prior to feeding their babies. Very few (6.25%) soften plantain prior to feeding their babies. Other form mothers prepared plantain and fed to their babies are shown on the table.

Table 5: The forms mothers prepared plantain as complementary food for their babies.

Food	Frequency	Percentage
Mashed with hand	120	30
Mashed with spoon	30	7.50
Mashed and mixed with palm oil	65	16.3
Mashed and mixed with margarine	-	-
Mashed with fish	30	7.50
Mashed and mixed with stew	-	-
In form of pottage	20	5.00
Whole	-	-
Mashed with fried egg	20	5.00

Organoleptic evaluation of plantain, wheat and soybean flour products: (chinchin, fish pies, pancakes and foofoo dishes).

Organoleptic attributes of chinchin made from plantain and wheat flour

Table 6 showed the organoleptic attributes of chinchin based on plantain and wheat flours.

Flavour

The flavour of the samples differed. The 70:30 plantain/wheat flour chinchin had lower flavour value than the 50:50 plantain wheat/flour (4.80 versus 3.98). The difference was significant (P <0.05). Wheat flour chinchin had higher flavour value than any of the chinchin products (P<0.05)

Texture

There were variations in the texture of the chinchin. This was influenced by the components of the chinchin. The texture of the chinchin ranged from 3.33 to 4.85. The products were significantly different (P < 0.05) from each other.

The texture of the 70:30 plantain/wheat flour chinchin (PWFCHNa) had lower value (3.33) than the 50:50 plantain/wheat flour chinchin (4.75) (P<0.05). The control (wheat flour chinchin) had the highest acceptable texture (4.85). The PWFCHN, and the WFCHN did not differ in textures (P>0.05).

Colour

There were differences in colour of chinchin samples. The 70:30 plantain/wheat flour chinchin (PWFCFINa) had the least acceptable colour (3.33) and the control (wheat flour chinchin) had (5.55). The 70:30 plantain/wheat flour chinchin had lower acceptable colour than the 50:50 plantain/wheat flour chinchin. The difference was significant (P<0.05). The wheat flour chinchin (WFCHN) had the highest acceptable colour (5.55). The PWFCHN, and the WFCHN had no difference in colours (P>0.05).

Palatability

The level of palatability of the samples of chinchin was different. The 70:30 p1antain/wheat flour chinchin (PWFCHNa) had the least (4.20) and the control (wheat l:flour chinchin (WFCHN) was the most palatable (5.85). The PWFCHNa, which is the (70:30 plantain/ wheat flour chinchin) had a lower palatability than the 50:50 plantain flour chinchin (PWFCHN). The difference however, was significant (P<0.05). The control (wheat flour chinchin) WFCHN had significantly different palpability from the rest of the fur chinchin samples. The samples had palatability that was highly acceptable or accepted.

Overall acceptability

The overall acceptability of chinchin samples was different. The control wheat flour chinchin (WFCFIN) was the most accepted (5.63). The PWFCHNa (70:30) plantain/wheat flour chinchin had (4.53) and the (50:50) plantain/wheat flour chinchin (PWFCHN) had (5.55). The difference was significant (P<0.05) The WFCHN had different overall acceptability than others (P<0.05).

Table 6: Organoleptic attributes of chinchin made from plantain and wheat flours.

Samples	Flavour	Texture	Colour	Palatability	Overall acceptability
PWFCHNa	3.98±0.28	3.33±0.31	3.33±0.31	4.20±0.26	4.53±0.27
PWFCHN	4.80±0.17a	4.75±0.19a	5.43±0.10a	5.45±0.11a	5.55±0.80a
WFCHN	5.70±0.07ab	4.85±0.18	5.55±0.18a	5.85±0.06ab	5.63±0.08ab

Letters (abc) indicate significant differences. Mean not followed by the same letter along the same vertical column are significantly different from each other (P<0.05) as determined by Duncan's New Multiple Range Test.

Mean ± SEM of 40 subjects.

PWFCHNa = Plantain wheat flour chinchin (70:30)

PWFCHN = Plantain wheat flour chinchin (50:50)

WFCHN = Wheat flour chinchin (control) (100% wheat flour)

It is based on a 6-point scale where 1 is the least acceptable score and 6 is the highest acceptable score based on people's general food attitude.

6 = 1 will always eat this food at every given opportunity (highest).

1 = 1 will never want to eat this food again (least).

Organoleptic attributes of fish pies produced from plantain and wheat flours.

Table 7 showed the mean responses of the organoleptic attributes of fish pies produced from plantain and wheat flours.

Flavour

The flavour of fish pies varied. The (70:30) plantain/wheat flour fish pie had lower flavour than the (50:50) plantain wheat flew fish pie (PWFFPI). The values were 3.23 and 4.52, respectively. The difference was not significant (P>0.05). The PWFFPI was different from the PWFFP1a. The wheat flour fish pie (WFFPI) control had higher flavour value than any of the fish pies (P<0.5).

Texture

The texture of fish pies varied: The values ranged from 2.88 to 5.73. The (70:30) p1antain/wheat flour fish pie (PWFFP1a had the least (2.88). The PWFFP1a had lesser desirable texture than the (50:50) plantain wheat/flour fish pie (PWFFPI) (4.88). The difference was significant (P<0.05). The wheat flour fish pie (WFFPI) (control) had the best acceptable texture (P<0.05).

Colour

There were differences in colours of fish pies. The values ranged from 2.83 to 5.88. The (70:30) plantain/wheat flour fish pie had lower value (2.83) than the (50:50) plantain/wheat flour fish pie (PWFFPI) (4.35). The difference in colours was significant (P<0.05). The mean colour rating for the wheat flour fish pie (WFFPI) was (5.78). The colour was different from the other samples of fish pies (P<0.05).

Palatability

There were variations in palatability of the fish pies. The values ranged from 3.33 to 5.28. The control (WFFPI) (5.85) was the most palatable pie (P<0.05). The palatability of the (70:30) plantain/wheat flour fish pie (PWFFP1a) was lower (3.33) than the (50:50) plantain fish pie (PWFFPI) (4.60). The difference was significant (P<0.05). On the other hand, the WFFPI had the highest level of palatability than any of the fish pies' (P<0.05).

Overall acceptability

There were differences in overall acceptability of the fish pie samples. The (70:30) PWFFPla (plantain/wheat flour fish pie) was less accepted (3.60) than the (50:50) (PWFFPI) (plantain/wheat flour fish pie) (5.30). The control (WFFPI) wheat flour fish pie had the highest acceptability (5.63) which was not significantly different from the PWFFPI (P>0.05).

Table 7 Organoleptic attributes of fish pies prepared form plantain and wheat flours.

Samples	Flavour	Texture	Colour	Palatability	Overall acceptability
PWFFPla	3.23±0.32	2.88±0.28	2.83±0.29	3.33±0.31	3.60±0.24a
PWFFPI	4.52±0.68ab	4.88±0.19a	4.35±0.27a	4.6±0.20a	5.30±0.14ab
WFFPI	5.18±0.16abc	5.73±0.07abc	5.88±0.05ab	5.28±0.14ab	5.63±0.08abc

Letters (abc) indicate significant differences. Mean not followed by the same letter along the same vertical column are significantly different from each other (P<0.05) as determined by Duncan's New Multiple Range Test.

Mean ± SEM of 40 subjects.

PWFFPla = Plantain wheat flour fish pie (70:30)

PWFFPI = Plantain wheat flour fish pie (50:50)

WFFPI= Wheat flour fish pie (control) 100% wheat flour

It is based on a 6-point scale where 1 is the least acceptable score and 6 is the highest acceptable score based on people's general food attitude.

6 = I will always eat this food at every given opportunity (highest).

1 = I will never want to eat this food again (least).

Organoleptic evaluation of pancakes made from plantain and wheat flours

Table 8 shows the organoleptic evaluation of pancakes made from plantain and wheat flours.

Flavour

The flavour ratings of the pancakes varied. Supplementation of plantain with wheat flour (PWFPC) had a desirable flavour. The flaour of the PWFPC compared favourably with wheat flour pancakes (WFPC) (P<0.05). There was no significant difference in flavour between the PWFPC and the wheat flour pancake (WFPC).

Texture

The texture of the pancakes ranged from 3.00 to 5.75 for the wheat flour (WFPC). The WFPC was significantly different in texture from the PWFPC pancake (P<0.05).

Colour

The colour of the products (pancakes) were 4.85 for the PWFPC and the YWFPC

4.83. The wheat flour pancake (control) had 5.43. The high value particularly for the WFPC products showed that the food was acceptable. The colour of the PWFPC was much more acceptable than that of the PWFPC pancake. However, the WFPC (control) had the most acceptable colour (5.43) (P<0.05). The PWFPC, and the WFPC pancakes colour were not different (P>0.05).

Palatability

The scores for palatability of the plantain pancakes are 4.57 for the PWFPC. The control wheat flour pancake (WFPC) had 5.00. These scores showed that the two samples had comparable palatability (P>0.05). The control WFPC had the highest score.

Overall acceptability

There were differences in the general acceptability of the pancakes. The value ranged from to 3.29 to 5.63. The PWFPCa had the least general acceptability (3.29) (P<0.05).

Table 8 Organoleptic attributes of pancakes prepared from plantain and wheat flours.

Samples	Flavour	Texture	Colour	Palatability	Overall acceptability
PWFPCa	5.08±0.01a	3.00±0.10	2.64±0.29	3.55±0.29	3.29±0.24
PWFPC	5.04±0.01a	4.43±0.27a	4.85±0.30a	4.57±0.26a	4.44±0.25a
WFPC	5.8±0.03a	5.75±0.07ab	5.43±0.11a	5.00±0.18ab	5.63±0.08abc

Letters (abc) indicate significant differences. Mean not followed by the same letter along the same vertical column are significantly different from each other (P<0.05) as determined by Duncan's New Multiple Range Test.

Mean ± SEM of 40 subjects.

PWFPCa = Plantain wheat flour pancake (70:30)

PWFPC = Plantain wheat flour pancake (50:50)

WFPC = Wheat flour pancake (100% wheat flour)

It is based on a 6-point scale where 1 is the least acceptable score and 6 is the highest acceptable score based on people's general food attitude.

6 = I will always eat this food at every given opportunity (highest).

1 = I will never want to eat this food again (least).

Organoleptic evaluation of the foofoo dishes produced from plantain and soybean flours

Table 9 showed the mean responses of the organoleptic evaluation of the foofoo dishes produced from plantain and soybean flours.

Flavour

The flavour of foofoo dishes were different. The flavour values ranged from 4.15 in plantain/soybean flour foofoo dish (PFFV) 5.26 to 51.3 which is unripe pounded plantain (plantain foofoo). The pounded plantain dish (PDPV) had a flavour value of 3.26. This was the control. The PFFV had 4.15 which was the unsupplemented plantain flour foofoo. However the PSFFV (5.18), and the PDPV (5.26) were not significantly different (P>O.05).

Texture

There were differences in texture value for the foofoo dishes. The pounded plantain dish PDPV had 5.11 and the PFFV had 5.30. The texture ratings of these dishes were not significantly different P> 0.05. The unsupplemented plantain flour foofoo dish with soyabean (PSFFV) had 4.95.

Colour

The colour of the foofoos were different. The mean colour ratings ranged from 4.15 in plantain flour foofoo dish (PFFV) to 5.54 in pounded plantain flour foofoo dish (PDPV). The unsupplemented plantain flour foofoo dish had a mean of 4.15. The soyabean supplemented plantain (PSFFV) dish had 4.60.

Palatability

There were variations in palatability of the foofoo dishes. The values ranged from 4.95 to 5.63. The pounded plantain foofoo dish (PDPV) was (5.60). The plantain flour foofoo dish (PFFV) (5.63) had higher rating than the control for the plantain (PDPV). The supplemented plantain/soybean foofoo dish (PSFFV) had the value of 4.95. The unsupplemented plantain flour foofoo dish (PFFV) had 5.63 which was higher tin that supplemented with soybean flour. Similarly PFFV (5.63), and PDPV (5.60) were not significantly different (P>0.05). However, these dishes were significantly different from the other foofoo dish (P<0.05).

Overall acceptability

There were differences in the overall acceptability of the foofoo dishes. The values ranged from 4.25 to 5.62. The plantain flour foofoo dish (PFFV) was least accepted (4.25). The soybean supplemented plantain flour foofoo (PSFFV) had comparable value (5.50) with the control. The plantain flour foofoo dish (unsupplemented) had lower acceptability value (4.25) than the soybean supplemented dish (PSFFV) 5.50. The difference was significant (P<0.05).

Table 9 Organoleptic attributes of foofoo dishes prepared from plantain, and soybean flours.

Samples	Flavour	Texture	Colour	Palatability	Overall acceptability
PFFV	4.15±0.28	5.30±0.14ab	4.15±0.28	5.63±0.78ab	4.25±0.25
PSFFV	5.18±0.16abc	4.95±0.16a	4.60±0.29a	4.95±0.74	5.50±0.0ab
PDPV	5.26±0.10abc	5.11±0.12ab	5.54±0.07abc	5.60±0.17ab	5.45±0.76a

Letters (abc) indicate significant differences. Mean not followed by the same letter along the same vertical column are significantly different from each other ($P<0.05$) as determined by Duncan's New Multiple Range Test.

Mean ± SEM of 40 subjects.

PFFV is plantain flour foofoo + vegetable melon soup (100% plantain flour).

PSFPV is plantain soybean flour foofoo + vegetable melon soup (70:30).

PDPV is pounded unripe plantain (plantain foofoo) + vegetable melon soup (100% boiled plantain).

It is based on a 6-point scale where 1 is the least acceptable score and 6 is the highest acceptable score based on people's general food attitude.

6 = 1 will always eat this food at every given opportunity (highest).

1 = 1 will never want to eat this food again (least).

Discussion of Results

The study investigated the utilization and supplementation of plantain and thee floury. The use of plantain was influenced by many factors. Food forms, where prepared, nutrition education and food availability were the major constraints against diversification of use of plantain. The highly educated and high income group of the communities (urban) consumed less plantain weekly. This is because they had nutrition education and avoided too much consumption of starchy foods. Their high level of education and high income employment enabled them to purchase expensive and high quality foods.

The lower educated and lower income segments of Isoko North Local Government Area consumed more starchy food (plantain). This was because of their poor knowledge of nutrition to make good choice of foods and low income to purchase expensive and high quality foods. The lower family size of 4 was much more among the educated and high income earners. The groups knew that the fewer the family the more resources they have for family. The consumption of combination of plantain with egg among the educated and high income was because they had nutrition education which enabled them to make better choice of foods. The small segments of Isoko North Local Government Area that include egg in their diets did so because they know their nutritional implications. They have also the purchasing power to have these high quality foods available in their families.

The high percentage, of serving plantain dishes during bride price paying ceremony depicts the food habit of the community. Many cultures in Nigeria serve their best traditional dishes during occasions like bride price paying ceremony. It is not a surprise then to find such a high percentage of serving of plantain dishes in various forms in Isoko North Local Government Area.

Vegetables were not added to the weaning foods. These are sources of minerals which are needed by babies. The continuous dependence on such carbohydrate foods could be detrimental to the health of such children. Addition of food with protein of high biological value and food rich, in other nutrients are essential to babies for maintaining good nutritional status.

The lower flavour score for the 70% plantain and 30% wheat flour chinchin was because there was no mutual supplementation effects. On the other hand the higher

flavour value obtained when plantain flour was 50:50 with wheat flour was because of desirable mutual supplementation effect. This is a commonly observed phenomenon. The higher flavour value for whole wheat flour chinchin was because the judges were used to the flavour of whole wheat products. The lower texture, colour and palatability value of 70% plantain to 30% wheat flour was due to poor mutual supplementation effect. The similarities in textures, flavour, palatability and overall acceptability for 50:50 ratio (plantain and wheat flour), suggests that wheat flour may not have a superiority over other flours for preparation of chinchin. They were similar.

The lower flavour score for both. 70% plantain based fish pie might be due to poor mutual supplementation effect. The high flavour for the 50:50 plantain wheat blend demonstrates that the flavour is acceptable to the judges. The much higher flavour value of (5.18) for the control indicates its superiority or edge over other fish pies. Wheat flour products are usually highly acceptable by most people due to their pleasant flavour.

The values for the 50:50 mixture (plantain versus wheat flour) was high in texture, colour palatability and overall acceptability of the product. The high texture value of the PWFFPI indicates their good's mutual supplementation effect. The products could be used as acceptable mixes to reduce cost than wheat flour. The higher values 5.18, 5.73, 5.88, 5.28, and 5.63 for fish pies based on 100% whole wheat flour was because the judges were much more familiar with these organoleptic attributes of whole wheat.

The PWFPC 50:50 products had higher rating because they had desirable and acceptable flavour, colour, palatability and overall acceptability. They could be used as good substitutes for lower cost fish pies based on wheat flour.

The high value for flavour of foofoo dish based on PSFFV (5.18) indicates that the flavour from the product is liked by the judges. The high palatability value of the PFFV indicates it was liked. The higher overall acceptability for the and PSFFV, (5.33) product might be attributed to components of the dishes.

Conclusion

Sun drying is a simple domestic processing method of preserving plantain. The production of cheap, nutritious, safe and acceptable snacks from plantain shows that more of such foods can be produced and utilized from many neglected foods in Nigeria. Mothers need to practice the preparation of the plantain wheat flour snacks. They can vary the ingredients/spices added to allow for variety.

Recommendations

1. Mothers in Isoko North Local Government Area and other status in Nigeria should be educated through workshops and clinics to give these snacks e.g. plantain wheat flour chinchin and plantain wheat flour pancake, fish pies to their family members e.g. adolescents.
2. Mothers in the area of study should be educated on how to prepare plantain flour. This could serve as a means of increasing the shelf life of plantain and hence prevent possible post harvest losses.
3. Studies should be carried out to determine the longest possible safe shelf life of plantain flour.

References

Enwere, N.J. and Okeke (1993) Processing and Marketing of fresh soymilk in the University of Nigeria, Nsukka Community: Problems and Prospects. A Paper presented at the 17th Annual Conference of the Nigerian Institute of Food Science and Technology, Ilorin, Kwara State. Dec. 6 – 11, Book of Abstract, p.22.

Ezema, P.A. (2001) Poverty Alleviation in Rural Nigeria: The Role of Home Economics. Conference Proceedings of the Home Economics Research Association of Nigeria.

Imonikebe B.U. (2007) Utilization, Development, Chemical, Microbial and Organoleptic Evaluation of Yam (*dioscorea rotundata poir*) and plantain (*Musa paradisciaca*) flour products in Isoko North LGA of Delta State. A Doctoral thesis, Home Science, Nutrition and Dietetics, Department, University of Nigeria, Nsukka, Nigeria.

World Bank (1993) Overcoming Global Hunger. Edited by Sereldin, I. and Landell –Mills. P. Environmentally Sustainable Development. Proceeding series No. 3 Appendix 3. Lesson of Experience. Twelve case studies World Bank. Washington, D.C. USA.

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Impact of Gender Diversity on Organizational Performance in Telecom Sector of Pakistan: The Moderating Role of Organizational Culture

S. M. M. Raza Naqvi
Assistant Professor, Department of Management Sciences, Muhammad Ali Jinnah University, Islamabad, Email: razanaqvi@jinnah.edu.pk

Maria Ishtiaq
MS scholar, Muhammad Ali Jinnah University, Islamabad, Email: maria.ishtiaq@hotmail.com

Nousheen Kanwal
MS scholar, Muhammad Ali Jinnah University, Islamabad, Email: noshkanwal@gmail.com

Samar Inderyas
MS scholar, Muhammad Ali Jinnah University, Islamabad, Email: samarinderyas@hotmail.com

Abstract:
This paper examined the relationship between gender diversity and organizational performance in telecom sector of Pakistan with moderating role of organizational performance. Data were collected from 129 employees of three top telecom companies. Three hypotheses were developed and all of them were accepted and findings showed that telecom sector of Pakistan is now moving from gender discrimination to gender diversity and both males and females have now equal opportunities of employment and career wise growth.

Key words: gender diversity, organizational performance, organizational culture, gender discrimination.

Introduction

Relationship between gender diversity and organizational performance has been established by a number of researchers but they mainly focused on developed countries. Little evidence is available about gender diversity and organizational performance from a developing country like Pakistan. In case of HRM practices Pakistan has been termed as an under researched country. Even if the research is done then it focused on gender discrimination not on gender diversity.

Government of Pakistan has made several attempts to elevate and uplift the status of females and now females have more educational and job opportunities as compared to 1990s.During 1990s female workers were not given importance in Pakistan but due to economic condition and inflation now it's the need of today that females should educate themselves to avail the employment opportunities. According labour force survey 2009, the size of total work force was 53.7 million in 2009 and 41.91 million males and 11.81 million females were employed. If we compare this rate of female labour participation with other South Asian countries then its v low but it is increasing with the passage of time.

The present study is an attempt to investigate the relationship between gender diversity and organizational performance in telecom sector of Pakistan. The main reason of selecting telecom sector is because of its rapid growth rate. It is considered as one of the fastest growing industries of Pakistan. There are six top telecommunication companies in Pakistan i.e. Mobilink , Telenor ,Warid ,Ufone , Zong and PTCL and all these companies are giving tough time to each other. In telecom sector organizations require diverse workforce so that they can properly and effectively deal with the increasing number of diverse customer base. In this research paper the focus was only on Mobilink , Ufone and Telenor.

We often see slogans that "without women there is no development". It is the need of present era that both males and females should work head to head. The main reason of conducting this research is to find out 1) Are both genders given equal importance in an organization and is the career path of both males and females equally smooth? 2) What is the impact of gender diversity on organizational performance? 3) In a gender diverse organization what is the impact of organizational culture on organizational performance?

Objectives

1) To find out the relationship between gender diversity and organizational performance.
2) To investigate the effect of organizational culture on gender diversity and organizational performance.
3) To find out does gender diversity strengthen the organization or not.
4) To facilitate decision makers how to manage gender diversity in an effective way.
5) To find out the factors that affect the performance of a gender diverse organization.
6) To find out what type of organizational culture prevails in telecommunication companies of Pakistan.

Literature Review

Workforce gender diversity is increasing rapidly especially in developed countries as they are experiencing exceptional and unprecedented gender diversity in their workforces and this trend is increasing with the passage of time (Ali , Metz & Kulik , 2007). The term Diversity is widely used to present the demographic composition of workforce and the researchers who have studied gender diversity and organizational performance assess the extent to which the workforce of an organization differ to each other and how that difference effects the organizational performance (Jackson & Joshi, 2004).Empirical research and theories suggest that diversity can either lead to positive outcomes or negative outcomes. According to resource – based view of firm there is a positive relationship between diversity and performance whereas according to social identity theory there is a negative relationship between diversity and performance.

Gender Diversity

During 1990s research on gender diversity focused on discrimination and biasness and it was considered that because of women the performance decreases. Due to the research reporting negative effects of women on the performance and discrimination in pays, women experienced aloofness, detachment and stereotyping. It has also been found that gender diversity has more negative effects on males than females with reference to outcomes such as attachment to organization (Shore et al., 2009).Diversification has given researchers something new to think about and investigate that how genders work in organizations and what is the outcome of diversity so we can say that diversity has become a hot issue in legal, political, economic and social circles. Organizations of present era need to recognize and manage workforce diversity in an effective way (Henry & Evans, 2007).First it is important to understand what diversity is as diversity has a great impact on the productivity of a firm .It helps in motivating the workforce, leads to innovation and the end result is high market share and customer loyalty (Bagshaw, 2004). “Diversity refers to the co-existence of employees from various socio-cultural backgrounds within the company. Diversity includes cultural factors such as race, gender, age, colour, physical ability, ethnicity, etc. The broader definition of diversity may include age, national origin, religion, disability, sexual orientation, values, ethnic culture, education, language, lifestyle, beliefs, physical appearance and economic status” (Wentling & Rivas, 2000).So we can say that diversity refers to ways in which an individual differs from others on some dimensions.

Most of the research on gender diversity is built on two schools of thought. The first is based on theories such as social identity (Tajfel , 1981) and similarity-attraction (Byrne , 1971) whereas second is based on information and decision making theory. Social identity theory deals with how members develop a sense of ownership in a group and how they coordinate and interact with their other group members and also how they view other groups (Stets & Burke , 2000).According to social identity theory the persons who are similar to the self are labeled as “ in-group” and the persons who differ from the self are labeled as “out-group” and it also tells that in homogeneous group the behavior of individuals will be different as compared to heterogeneous group (Tajfel & Turner, 1979) .This theory explains that the main motivational force which helps in the group formation is the human need for self-esteem (Campbell , 1997).In order to achieve high self-esteem individuals start to compare themselves with others and this process leads each individual to establish his or her own social identity (Pitts & Jarry 2007).

Similarity/attraction theory states that individuals who belong to same back ground find it easier to interact and communicate with each other than those who belong to different back ground. Similarity allows an individual to reinforce his ideas and values whereas dissimilarity allows or causes an individual to question his ideas and values. Research has shown that if an individual gets a chance to interact with different people then he will select a person who is similar (Lincoln & Miller, 1979).

Information and decision making theory in groups predicts that the composition of work group will be effected by how group processes information, how the members of group communicate and how they make decisions (Wittenbaum & Stasser, 1996).Research has shown that even in situations where gender diversity creates problems and has a negative impact on performance then the increase in information that comes from gender diversity can offset those problems . Diversity in employees brings creativity and this helps in solving the problem quickly (Ancona & Caldwell, 1992).

The literature offers two conflicting perspectives regarding the relationship between gender diversity and organizational performance. Some researchers suggest that gender diversity leads to improved organizational performance and therefore leads an organization to achieve competitive advantage (Cox & Blake, 1991).Whereas some researchers found that gender diversity has a great impact on the communication style, behavior and experience of an individual but it doesn't affect the performance (Kimble, Yoshikawa & Zehr 1981; Mabry, 1985; Smith-Lovin & Brody, 1989). According to Wood (1987), groups which are gender balanced would interact positively and this will help in reduction of conflict as compared to the groups having predominant males and females.

Literature on social identity and similarity/attraction theories predicts that there is a negative relationship between gender diversity and organizational performance .As groups or teams in an organization become more diverse then it results in breakdown of communication, coordination becomes difficult and as a result it becomes harder for members to work together in an effective way. Ely and Thomas (2001) found out that heterogeneity in an organization is beneficial only if unstructured tasks are to be performed. For routine tasks gender diversity is not suggested.

However literature on information and decision making theory predicts that there is a positive relationship between gender diversity and organizational performance. In gender diverse organizations a large number of ideas are generated so there is a large pool of knowledge which in turn results in creativity and innovation ((Tziner & Eden, 1985). Gender diversity is most likely to provide positive results when the task is complex as there are more chances of new ideas and creativity whereas in routine and simple task there are less chances of creativity and innovation (Kochan et al.,2003).As a result we frame the following hypotheses relating gender diversity to organizational performance:

H1: Gender diversity is positively and significantly related to organizational performance.

Organizational Performance

Organizational performance has its basic origin from the theory which is known as resource based view, according to this theory the organizational performance is taken as an entity which is having resources and capabilities, a firm can achieve its competitive advantage by using its resources efficiently and effectively and then can boost its

performance (Jung & Takeuchi, 2010). Different theorists have recommended that through these competencies of resources and capabilities, sustainable competitive advantage can be achieved, which results in higher organizational performance (Ogbonna & Harris, 2000).

Another study has found that organizational performance refers to whether the managers are performing different functions of the company competently to achieve their goals and objectives, and organizational performance also means that whether the managers of the company are giving the desired productivity to the company in order to remain in position (Kim, 2005). An organizational performance cannot be weighed up without focusing on its goals and objectives (Sˇ kerlavaj, Sˇ temberger, Sˇ krinjar & Dimovski, 2006). A firm with no objectives cannot lead to the constructive performance ever. These objectives with the help of resources, make an organization able to perform well in its competitive environment which would then result in positive outcome.

Further studies on the organizational performance indicates that there are some fundamentals which are known as resources, activities and processes, they play very important role in the enhancement of organizational performance (Carmeli & Tishler, 2004). Because resources are something which can be used for the help or support in increasing productivity, activities involve actions which are done in order to get more profit and finally processes include all those actions which are done by using resources for the improvement of performance. A study done in past years have told that resources should be precious, exceptional, and hard to emulate, and the organization must be structured to take the advantage of those valueable resources (Coff, 1999).

Organizational performance cannot only be enhanced through an individual worker of the company, according to the prior literature it is suggested that the whole management team's performance is required to get organizational success. If the entire management is working for its own goals, organizational performance will be affected negatively (Bloom & Mikovich, 1998).

Every company has its own objectives; in the previous researches it was found that organizational performance can be defined as to what extent the company has achieved its goals and objectives (Lee & Choi, 2004).

Researchers have found after studying many organizations that in most of the company's performance of an organization is measured or determined by the output and efficiency of its departments, plants, panels etc (Meier & O'Toole, 2002). And one more study in past years have shown the results that in present era, Human Resource departments are expected to contribute towards organizational performance(Zellars & Fiorito, 1999). Because from recent past years it has been seen that now employees are treated as human assets. By human assets we mean that employees are given much importance at present, traditionally they were just taken as machines that are there to work for the company but now, all care is done by the managers of employee's personal and work life in order to retain the best employees with them. And when human assets in Human Resource Department are efficient, definitely it would positively lead toward the success of the organization and organizational performance will be augmented.

A study found that the performance of the organizations (small) is dependent on the management and its ability to plan for its future so that they can increase their outcome (Dess & Robinson, 1984).

It was bring into being in a further study that it is employees who bring competitive advantage for an organization, because of their skills implied within the organization (Evans & Davis, 2005). Because the dexterity that employees have cannot be copied or replicated by any other firm and this gives a unique and competitive advantage to the firm which results in higher organizational performance. Human Resource Practices can contribute for the achievement of the competitive advantage for the organization which would definitely lead towards the higher organizational performance(Lado & Wilson, 1994). And the root of gaining competitive advantage lies within the resources.

In a preview of literature review, it was shown by some researchers that performance of an organization can become increased by producing product fast. At the same time, it was found that only the fast development of products does not result in the step up of the performance. The performance depends much on the eminence of the product, and not alone only on the rapidly developed products (Ittner & Larcker, 1997).

A study done by researchers illustrates that it is not only because of administrative competence that performance of a company can be declined or increased. There are a lot of factors and forces which are muffling the leader's competency in the organization which could result in performance decline (Lieberson & O'Connor, 1972).

Researchers have found in previous studies that the organization having poor of lack of performance should move from their recent structures towards a suitable environment in which they can survive and can improve their performance (Freguson & Ketchen, 1999). But, this is not easy at all because the cost of such changes is almost unbearable for most of the organizations; those who can afford may be followed by the wrong strategy and get destroyed. These costs affect excessively and the discrepancies exist within the environment and the performance of an organization declines.

It was seen in a study that an organization's performance can also be affected in a positive way through competition (Barnett, Greve & Park, 1994). Because, in competition an organization is required to innovate its products, and this helps in enhancing its performance outcomes. A study have shown that firms obtain their sustained competitive advantage through implantation of different strategies which are according to their strengths to gain edge and their weaknesses to ignore the potential loss (Barney, 1991).

One more study have found that performance is the crucial target of an organization (Wischnevsk & Damanpour, 2006). It was further explained in the same study that whenever an organization encounters a decline in performance, it start moving towards the settlement. Which means, it start changes its strategies to increase the performance rapidly. This does not only is the case with poor performing firms but far above the ground performance organizations also need to change their strategies because of the changing environment.

A study done for determining the organization's profitability shows that there are number of determeinants which include 1. The industry in which the organization is competing with others. 2. The point where firm lies in comparison to its competitors & 3. The quality and the quantity which the firm already have(Hansen & Wernerfelt, 1989). Researchers have found in their studies that these three can determine the overall level of firm's performance in which the quality of resources is also playing a very important role. The more quality assured resources(workforce) you have, the more the level of performance will get high.

From the above discussion we can frame the following hypothesis:

H_2: Organizational performance is positively related to gender diversity.

Organizational Culture

The origin of organizational culture is lying in the theory of Hofstede in which he has presented four dimensions of culture which can illustrate the culture of a society. According to his model: individualism-collectivism, masculinity-femininity, uncertainty avoidance, power distance; these are the main dimensions or culture with which an organization could decrease or increase its performance (Hofstede 1980a, b; 1993, c; 2001). Organizational culture is something which is a consistent system with the postulations and basic customs which differentiates one group from another one (Gagliardi, 1986). These norms are then embedded into the organization and help in increasing organizational performance.

Another study has found that current literature has its roots in early 1980s, and this concentration is due to scholars advocate that cultural factors play an important role in influential levels of organizational outcomes. Many researchers proposed a model of organizational culture and effectiveness and authentic method of measurement. One of these models consists of four cultural traits (Involvement, Consistency, Adaptability and Mission) of successful organization, these traits have relationship with effectiveness. (Denison & Mishra,1995). According to another study culture is based on two beliefs that is internally oriented beliefs tell how to manage within the organization and externally oriented beliefs relates how to compete outside the organization. (Davis,1984).

Another definition of culture states that culture is the collective programming of the mind that makes a distinction between the members of one human group from another. (Hofstede, 1980, p. 26). Organizational culture is established on the basis of its nature, in the beginning people share their ideas and then construct and influence a developed culture that identifies the relationship and purpose of group (Budd, 1996). Studies have shown that a culture of an organization depends upon bringing into life the affluence and liveliness of population income and functioning with each other (Ouchi &Wilkins, 1985).

Three major collections of articles on organizational culture had been highlighted by the researchers in 1983. Culture has been described as it is relatively stable set of inner values and beliefs generally held by factions in countries or regions and the perceptible impact those values and beliefs have on the peoples' outward behaviors and environment".(Peterson, 2004, p.17). According to (Goll & Zeitz, 1991) Culture can be defined as "major beliefs and values" on the other hand according to (Guundry & Rousseau, 1994) culture is mainly described as the norms and patterns of behaviors.

Another study reveals that culture has two perspectives, according to cognitive perspective culture is "a system of knowledge, of standards for perceiving, believing, evaluating and acting," and another is ecological adaptations perspective in which culture refers to "a system of socially transmitted behavior patterns that serve to relate human communities to their ecological settings" (Allaire & Firsirotu, 1984). Organizational culture is not only novelistic it is also practically applicable. Study of organizational culture help to illuminate how organization has arrived to its present state. Culture explains precedent influence on decisions and actions. (Smith & Steadman, 1981).

According to some researchers there are certain factors like corporate norms, organized structure, values and culture that play significant role in encouraging or discouraging ethical conduct. Culture plays an important role because it orchestrates organizational structure by "filling in the gaps" which is an essential part of formal organizational structures. (Chen et al., 1997; Trevino, 1990; Trevino et al., 1998; Victor & Cullen, 1988). Another study identifies culture as "social glue" provides a link among individuals and form organizational cohesiveness. According to scholars selection decisions are determined by strategic and financial considerations, however many organizational unions were unsuccessful in meeting scenarios because of unmatched cultures of partners. (Cartwright & Cooper, 1993).

An integrative framework of organizational culture has been developed by many researchers but little attention is given to a general theory. As culture refers to the complex phenomena due to diversity of values and possibility to noticeable structures and practices, most of the viewer's had a query that whether culture can actually be "measured "in a comparative sense or not. (Allaire & Firsirotu 1984; Hatch 1993; Martin 1992; Ott 1989; Schein 1985, 1990). Most of the economists have not significantly concentrated on culture. It has been found that there is a relationship between culture and language, it is mainly a degree which smoothes the progress of talented economic exchange. (Lazear, 1999).

A study done by researchers demonstrates that culture varies from one society to another due to conception of "National Culture". Theorists say that national culture represents a set of political, economic and social values which are necessarily for a scrupulous nation. And national culture of a society characterizes the peoples live and work. (George & Jones, 1996). Organizational culture realistic says that it can be and in fact it should be supervised and these pragmatics also tell that how to manage and supervise it (Witte & Muijen, 2010).

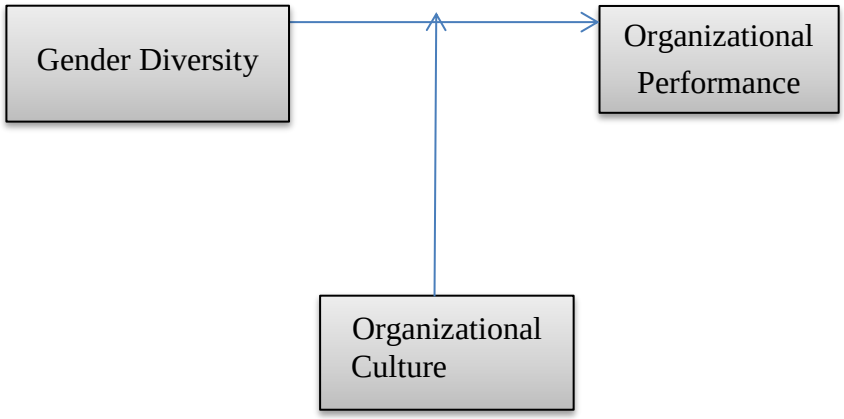
Another study has found that gender is an initial component of organizational structure and work life. The gender element of work organizations influence the work behavior and performance, decisions that increase productivity and efficiency, help to set the support criteria and employees ancestors existence are also consider at place of work. (Britton, 2000, p. 419).

Research on culture has found that when there is diversity of values in an organization, it would definitely allocate the extra polished decisions, and which is going to result in a positive organizational performance (Hofstede, 1984 & McsCarrey, 1988). Another research has found that an cherished awareness and understanding of culture will improve decision maker's ability to evaluate organizational performance in order to manage and lead. (Brooks, 2006).

From the above discussion we can frame the following hypothesis:

H3: Organizational culture moderates the relationship between gender diversity and organizational performance.

Conceptual Framework



Methodology

This paper examined the relationship of gender diversity, organizational performance and organizational culture in telecommunication sector of Pakistan. The purpose of this paper was specific context exploratory research. The primary data were collected with the help of survey through personally administered questionnaires from 129 respondents in a non-contrived environment during May 2012 so it was a cross sectional study. Respondents included both workers and managers. Data were then analyzed and hypotheses were tested using correlation and regression analysis.

Questionnaire

The variables which are being taken can be seen in theoretical framework. Gender diversity is the independent variable. Organizational performance is the dependent variable whereas organizational culture is the moderating variable.

In order to examine the response rate from all the respondents 14 items of gender diversity were adopted from Watkins, K.E., & Marsick , V.J.(1993). 12 items of organizational performance were adopted from Watkins, K.E., & Marsick , V.J.(2003) and 14 items of organizational culture were taken from Vadi,M., Allik ,J., & Realo,A. (2002).Questionnaire was based on 5-point scale i.e. 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree.

Questionnaire included four sections. First section was about demographics which included gender, age, level of education and position. Then second section asked questions related to independent variable which was gender diversity. Third section was about dependent variable i.e. organizational performance and the last section was based on question related to organizational culture which was the moderating variable. Pilot testing was also conducted to check the reliability of questionnaire and the value of alpha came out 0.9 which showed that the questionnaire was highly reliable and there was no need to delete any item.

Table 1. Reliability Analysis

Reliability Statistics	
Cronbach's Alpha	N of terms
.903	43

Variable	Adopted from	Number of items	Reliability
GD	Watkins, K.E., & Marsick , V.J.(1993)	13	.807
OP	Watkins, K.E., & Marsick , V.J.(2003)	12	.856
OC	Vadi,M., Allik ,J., & Realo,A. (2002)	14	.764

Population and Sample

The participants included both managers and workers from three leading telecom companies of Pakistan.160 questionnaires were distributed however only 129 were returned back despite of the best efforts from the side of researchers. This made the response rate as 80.6% and convenient sampling technique was used.

Table 2. Sample Characteristics

Sample Characteristics			
Description	Range	Frequency	Percentage
Gender	Male	74	57.4
	Female	55	42.6
Qualification	Matriculation	1	.8
	Intermediate	17	13.2
	Bachelors	52	40.3
	Maters	49	38.0
	MS	10	7.8
Age	20-30	87	67.4
	31-40	30	23.3
	41-50	12	9.3
Position	Manager	13	10.1
	Worker	116	89.9

Table 3. Correlation Analysis

Correlation Analysis					
Variable	Mean	SD	GD	OP	OC
GD	3.7	.57	1		
OP	3.7	.67	.474**	1	
OC	3.6	.55	.628**	.485**	1

** Correlation is significant at the 0.01 level (2-tailed).

Table 4. Regression Analysis

	Regression Analysis		
Variable	Beta	t value	Significance
GD	.474	6.073	0.000

n: 129, R Square: 0.283, Adjusted R Square: 0.272, F: 24.867, Dependent Variable: Organizational Performance

Table 5. Moderated Regression Analysis

	OP		
	Beta	**R square**	**Change in R square**
GD	.474	.225	.225
	.581	.293	.068

Results

Demographic profile of the respondents can be seen in table 2. 57.4% of the respondents were males and 42.6% were females. This difference is due to the fact that in Pakistan gender diversity in organizations is quite low as male is responsible for earning activities and still in many families females are not encouraged to do jobs after studies. Majority of the respondents were holding bachelors degree. Only one respondent was holding matric degree and a huge number i.e. 49 was holding masters degree. As far as age is concerned then most of the respondents were quite young and less than 30 years. This shows that majority of the employees working in telecom sector of Pakistan are quite young.

Table 3 shows correlation analysis. It shows the strength of relationship between independent variable i.e. gender diversity and dependent variable i.e. organizational performance. Correlation analysis showed a strong relationship between gender diversity and organizational performance (0.474**, $p < 0.05$)..This shows that gender diversity in Pakistan is positively related to organizational performance.

Table 4 represents linear regression analysis to find out the combined effect of independent and dependent variables. The result indicated that gender diversity has a significant impact on organizational performance (beta=.474** , $p<0.05$). The value of t turned out to be 6.073.

Before moving to the multiple regression analysis the correlation between interaction term and gender diversity was found.it turned out to be .893** which showed that there is a strong and significant relationship between gender diversity and interaction term.

Table no 5 shows multiple regression analysis, the impact of on organizational culture on organizational performance and gender diversity. From the table it can be seen that it strengthens the relationship of gender diversity and organizational performance (beta .581).

Discussion

The purpose of this research paper was to examine the relationship between gender diversity and organizational performance in telecom sector of Pakistan. Three hypotheses were developed and all of them were accepted. The possible explanation to this can be that if there is a diverse workforce then there is a pool of ideas. Chances of

creativity are more. Gender diversity leads to innovation and the end result is high market share and customer loyalty. Even if a problem arises then because of gender diversity so many ideas and information is generated that it can easily off set that problem.

Moreover organizational culture also has a great and positive impact on organizational performance in a gender diverse organization. This shows that if there are well defined rules and regulations, there is an environment of trust, employees are rewarded for their good work and there are well defined standards of communication then gender diversity can easily be managed and it will lead to high organizational performance. From this study it was found that in telecom sector of Pakistan clan culture exists. Employees help each other during tough time and there is a feeling of togetherness.

Conclusion

This study has a numbers of implications to manage gender diversity in organizations of Pakistan. Due to economic condition of Pakistan now females are educating themselves to get jobs. As it is a male dominating society so even in organizations males are given importance but with the passage of time gender diverse organizations are gaining attention .This study shows that if both genders are given equal importance and if the career path of both genders is smooth then nothing can stop an organization to achieve its objectives and goals. From the demographic profile shown in table 2 it can be seen that 49 respondents were having degrees of master of philosophy which is a great number it means that now it's the need of today that both genders should be given equal opportunities to grow and the environment should be such that employees can easily discuss job related problems and also help each other to solve them.

In order to move forward organizations should put aside discrimination and now they should explore gender diversity in a positive way. When we talk about diversity then we move from management to opportunity. In order to manage gender diversity the management should ask both male and female employees about the changes they want to see in environment and about their work tasks. In Pakistan organizations still need to set rules, regulations, policies and values in such a way that it creates positive environment for diverse workforce.

Limitations

The sample size was not representative of population.160 questionnaires were personally distributed but even after great efforts only 129 were returned and there are 6 top telecom companies in Pakistan but for this research paper only 3 were targeted.

Future Research Directions

The findings of this research papers were quite useful to find the impact of gender diversity on organizational performance. As the present study was conducted in Pakistani context so only those determinants of gender diversity were used which exist in this society. Future researchers can take other determinants like physical disability, race, language etc. As far as organizational culture is considered then Hofstede's cultural dimensions and competing value framework can be taken into account too to get more accurate results. The sample size taken for this paper was not representative of population. Data were collected from only 129 respondents so future researchers can take a good sample size to conduct this research. If any researcher wants to conduct research

in Pakistani context again then all 6 top telecom companies should be considered to get accuracy of results. In this paper only 3 were targeted.

References

Aluko,M.A.O.(2003).The impact of culture on organizational performance in selected textile firms in Nigeria. Nordic Journal of African Studies,12(2), 164-179.

Alvesson,M.(1990). On the Popularity of Organizational Culture. Acta Sociologica, 33(1), 31-49.

Ali, M., Metz, I., & Tulik, C.T.(2007). Workforce gender diversity: Is it a source of competitive advantage?. 21st ANZAM conference, Sydney,Australia.

Ancona, D.G., & Caldwell, D.F.(1992). Demography and Design: Predictors of New Product Team Performance. Organization Science, 3(3), 321-341.

Bagshaw,M. (2004). Is diversity divisive? A positive training approach. Journal of industrial and commercial training, 36(4), 153-157.

Byrne, D. E. (1971). The attraction paradigm. New York: Academic Press.

Barnett, W.P., Greve, H.R., Park, D.Y. (1994). An Evolutionary Model of Organizational Performance. Strategic Management Journal, Vol. 15, Special Issue: Competitive Organizational Behavior , 11-28.

Bloom, M., Milkovich, T.G., (1998). Relationships among Risk, Incentive Pay, and organizational Performance. The Academy of Management Journal, 41(3), 283-297.

Barney, J. (1991). Firms Resources And Sustained Competitive Advantage. Journal of Management,17 (1), 99-120.

Budd, J.M.(1996).The Organizational Culture of the Research University: Implications for LIS Education. Journal of Education for Library and Information Science, 37(2), 154-162.

Cox, T.H., & Blake, S. (1991). Managing cultural diversity: implications for organizational competitiveness. The Academy of Management Executive,5(3), 45-56.

Campbell,C.(1997).Self-esteem in context : A case study of the motivational processes underlying social identity construction by township youth. Psychology in society, 22, 20-36.

Carmeli, A., Tishler, A. (2004). The Relationships between Intangible Organizational Elements and Organizational Performance. Strategic Management Journal, 25 (13), 1257-1278.

Coff, R.W. (1999). When Competitive Advantage Doesn't Lead to Performance: The Resource-Based View and Stakeholder Bargaining Power. Organization science ,10 (2).

Dess, G.G., Robinson, R.B. (1984). Measuring Organizational Performance in the Absence of Ojective Measures: The Case of Privately- Held Firm and Conglomerate Business Unit. Strategic Management Journal, 5(3), 265-273.

Delobbe, N., Haccoun, R.R., Vandenberghe, C. Core Dimensions of Organizational Culture. Farley, J.U., Hoenig, S., (2008). Ismail, Z. Organizational Culture.

Denison,D.R.,Mishra,A.K.(1995). Toward a Theory of Organizational Culture and Effectiveness. Organization Science,6(2), 204-223.

Evans, W.R., Davis, W.D. (2005). High-Performance Work Systems and Organizational Performance: The Mediating Role of Internal Social Structure. Journal of Management 2005, 31 (758).

Ely, R. J., & Thomas, D. A. (2001).Cultural diversity at work: The effects of diversity perspectives on work group processes and outcomes , Administrative Science Quarterly, 46(2),229-273.

Fergusan, T.D., & Ketchen,D.J. (1999). Organizational Configurations and Performance: The Role of Statistical Power in Extant Research. Strategic Management Journal, 20 (4), 385-395.

Gigliardi, P. (1986). The Creation And Change of Organizational Culture: A Conceptual Framework. Organization Studies Journal, 7(2), 117-134.

Gordon,G.G.(1991). Determinants of Organizational Culture. The Academy of Management Review, 16(2), 396-415.

Gordon,G.G.(1991). Determinants of Organizational Culture. The Academy of Management Review,16(2), 345-350.

Henry,O., & Evans, A.J. (2007). Critical review of literature on workforce diversity. African Journal of Business Management, 072-076.

Hansen, G.S., Wernerfelt, B. (1989). Determinants of Firm Performance: The Relative Importance of Economic and Organizational Factors. Strategic Management Journal,10 (5), 399-411.

Haas, L., Hwang, C,P.(2007). Gender and Organizational Culture: Correlates of Companies' Responsiveness to Fathers in Sweden. Gender and Society, 22(1), 52-79.

Innovativeness, Market Orientation and Firm Performance in South Africa: An Interdisciplinary. Journal of African Business, 9(1), 59-76.

Ittner, C.D., Larcker, D.F. (1997). Product Development Cycle Time and Organizational Performance. Journal of Marketing Research, 34 (1), pp. 13-23.

Jung,Y.,Takeuchi, N. (2010). Performance implications for the relationships among top management leadership, organizational culture, and appraisal practice: testing two theory-based models of organizational learning theory in Japan. The International Journal of Human Resource Management, 21(11), 1931-1950.

Jackson, S. E., & Joshi ,A.(2004) Diversity in social context: a multi-attribute, multilevel analysis of team diversity and sales performance. Journal of Organizational Behavior, 25(6), 675-702.

James,H.S.(2000). Reinforcing Ethical Decision Making through Organizational Structure. Journal of Business Ethics, 8(1), 43-58.

Kim, S. (2005). Individual-Level Factors and Organizational Performance in Government Organizations. JPART 15, 245–261.

Kimble , C. E., Yoshikawa, J. C., & Zehr, H. D.(1981). Vocal and verbal assertiveness in same-sex and mixed sex groups. Journal of Personality and Social Psychology, 40(6), 1047-1054.

Kochan,T., Bezrukova,K., Ely,R., Jackson,S., Joshi,A., Jehn,K., Leonard,J., Levine,D., & Thomas, D. (2003). The Effects of Diversity on Business Performance: Report of the Diversity Research Network. Human Resource Management,42(1), 3-21.

Lincoln, J., & Miller, J. (1979). Work and friendship ties in organizations: A comparative analysis of relational networks. Administrative Science Quarterly, 24, 181-199.

Lee, H., Choi, B. (2004). Knowledge Management Enablers, Processes, and Organizational Performance: An Integrative View and Empirical Examination. Journal of Management information Systems / Summer, 20 (1), 179–228.

Lieberson, O'Connor, J.F. (1972). Leadership and Organizational Performance: A study of large corporations. American Sociological Review, 37 (2), pp. 117-130.

Lado, A.A., Wilson, M.C. (1994). Human resource systems and sustained competitive advantage: A competency-based perspectives. The Academy of Management Review, 19 (4), 699.

Meier, K.J., O'Toole, L.J. (2002). Public Management and Organizational Performance: The Impact of Managerial Quality. Forthcoming Journal of Policy Analysis and Management 21.

Ogbonna, E., Harris, L.C. (2000). Leadership style, organizational culture and performance: empirical evidence from UK companies. The International Journal of Human Resource Management, 11 (4), 766-788.

Ouchi, W.G., Wilkins, A.L.(1985).Organizational Culture. Annual Review of sociology, 11, 457-483.

Ojo,O. Organizational Culture and Corporate Performance. Journal of Business System, Governance and Ethics,5(2).

Pothukuchi,V., Damanpour,F., Choi,J., Chen,C.C., Park,S.H.(2002). National and Organizational Culture Differences and International Joint Venture Performance. Journal of International Business Studies,33(2), 243-265.

Piepenburg, K.(2011). Critical Analysis of Hofstede's Model of Cultural Dimensions, pg.8 GRIN Verlag.

Piepenburg, K.(2011). Critical Analysis of Hofstede's Model of Cultural Dimensions, pg.9. GRIN Verlag.

Skerlavaj, M., Stemberger, M.I., Skrinjar, R., Dimovski, V. (1996). Organizational learning culture—the missing link between business process change and organizational performance. Int. J. Production Economics, 106, 346–367.

Smith-Lovin, L., & Brody,C. (1989). Interruptions in Group Discussions: The Effects of Gender and Group Composition. American Sociological Review, 54(3), 424-435.

Stets,J.E., & Burke,P.J. (2000).Identity theory and social identity theory, Social psychology quarterly, 63(3), 224-237.

Shore, L.M., Herrera, B.G., Dean, M.A., Ehrhart, K.H., Jung,D.I., Randel ,A.E., & Singh, G. (2009). Diversity in organizations: Where are we now and where are we going?. Human Resource Management Review, 19,117-133.

Tosi,H.L., Greckhamer,T.(2004). Culture and CEO Compensation. Organization Science, .15(6), 657-670.

Tziner, A. E., & Eden, D. (1985). Effects of crew composition on crew performance: does the whole equal the sum of its parts? Journal of Applied Psychology, 70(1), 85-93.

Tajfel, H. (1981). Human groups and social categories: Studies in social psychology. Cambridge, England: Cambridge University Press.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. The social Psychology of intergroup relations, 33, 33-47.

Umans,T.(2011). Globalisation in the lecture room? Gender and cultural diversity in work groups. Issues in Educational Research,21(1), 88.

Wentling, R.M., & Rivas ,N.P. (2000). Current status of diversity initiatives in selected multinational corporations. Human Resource Development Quarterly, 11 (1),35-60.

Witte, K.D., Jaap J. van Muijen, J.J.V. (2010). Organizational Culture. European Journal of Work and Organizational Psychology,8(4), 497-502.

Wischnevsky, J.D., Damanpour, F. (2006). Organizational Transformation and Performance: An Examination of Three Perspectives. Journal of Managerial Issues, 18(1), pp. 104-128.

Weber, R.A., Camerer, C.F.(2003). Cultural Conflict and Merger Failure: An Experimental Approach. Management Science,49(4), 400-415.

Wittenbaum, G., & Stasser, G. (1996). Management of information in small groups. In J. Nye & M. Bower (Eds.), What's social about social cognition? Social Cognition research in small groups (pp. 3-28). Thousand Oaks, CA: Sage.

Wood, W. (1987). Meta-analytic review of sex differences in group performance. Psychological Bulletin, 102, 53-71.

Zellars, K.L., Fiorito, J. (1999). Evaluations Of Organizational Effectiveness Among HR Managers: Cues And Implications. Journal of Managerial Issues, 11(1), pp. 37-55.

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Differences in the Linguistic Features of Text Messages send with an Alphanumeric Multi-Press Keypad Mobile Phone versus a Full Keypad Touchscreen Smartphone

Sarah Penelope Kent
School of Education, Curtin University
Perth, Western Australia

Genevieve Marie Johnson
School of Education, Curtin University
Perth, Western Australia

Abstract

Technology often mediates, and thus influences, patterns of human communication. Mobile phones have recently improved, most notably, full keypad touchscreen smartphones. Fifty university students send text messages with a traditional multi-press alphanumeric keypad mobile phone and a full keypad touchscreen smartphone. Compared to messages sent via multi-press mobile phones, smartphone messages where longer, contained fewer number/letter homophones (e.g., cu rather than see you) and contained more punctuation and fewer misspelled words. Nonetheless, regardless of type of phone used, text messages evidenced use of the language form known as digitalk or textese, suggesting that keypad limitations cannot entirely explain the unique patterns of written communication associated with mobile phones.

Keywords: Mobile phone; cell phone; smartphone; text message; multi-press; touchscreen

Differences in the Linguistic Features of Text Messages send with an Alphanumeric Multi-Press Keypad Mobile Phone versus a Full Keypad Touchscreen Smartphone

Text messaging, or texting, is the act of typing and sending a written message from one mobile phone to another. Globally, there were 7.8 trillion text messages were sent in 2011 (Portio Research, 2012). It is forecasted that text messaging traffic will continue to increase reaching 9.4 trillion messages by 2016 (Informa Telecoms and Media, 2012). American adolescent text messaging rates are reported at an average of 4,050 texts per month and young adults, age 18-24, average 1,630 texts per month (Nielsen, 2009). In popular media, adolescents in the United Kingdom are referred to as *text maniacs* (Waugh, 2012). Pervasive, intense and prolonged use of mobile phones to send text messages is transforming patterns of human communication (Wei, Wang, & Klausner, 2012).

At the beginning of the current century, mobile phone technology was restricted to the alphanumeric keypad where one button was pressed up to four times to select a specific character, for example, the number seven key was pressed four times to input the letter s (Taylor & Vincent, 2005). More recently, "the advent of new multimedia smartphones, touchscreens, and full keypads has facilitated the process by which texting has become a commonplace occurrence for the youth of today" (Skierkowski & Wood, 2012, p. 744). In 2010, 43% of American youth reported that text messaging was the primary reason for owning a mobile phone and, in particular, that a device with a full keypad, as in smartphones, facilitated text messaging (Nielsen, 2011). In fact, the original alphanumeric mobile phones took almost seven years to approximate 50% popular use while smartphones have taken only four years to reach the same level of market penetration (Technology Review, 2012). In 2012, Singapore, China and Thailand all reported smartphone ownership in excess of 50% of the adult population (Mastercard Worldwide, 2012). On the eve of Apple's unveiling of the iPhone 5, 66% of Americans aged 18-29 years reported owning a smartphone (Rainie, 2012). In general, mobile phone technology has dramatically increased opportunities for human communication (Johnson, 2012) and, specifically, full keypad touchscreen smartphone technology may further enhance human capacity to communicate. However, as with all communication tools, the nature and form of communication is affected (Olson, 2005).

Mobile Phones and Text-Based Communication

"The use of text messaging by adolescents is a widely accepted phenomenon that has grown rapidly in the last few years in response to the advent of new and more affordable mobile phone technologies" (Skierkowski & Wood, 2012, p. 744). The practice of text messaging has birthed a language form with its own vocabulary referred to as *textese* (Drouin, 2011) including unique "grammatical, lexical, stylistic and visual features" (Taylor, 2009, p. 33). Such linguistic features include "abbreviations, acronyms, emoticons, misspellings, omission of vowels, subject pronouns and punctuation" (Ling & Baron, 2007, p. 292). Since creative use of text-based communication first emerged in forms of computer-mediated communication (e.g., instant messages), the term *digitalk* is also commonly used to refer to the playful manner in which text messages attempt to capture "voice of the speaker" (Turner, 2010, p. 43). However, linguists postulate that interaction between the mobile phone device and the mobile phone user creates unique and specific patterns of text-based communication (Thurlow & Poff, 2011). Kemp and

Bushnell (2011) attributed many of the linguistic features of text messages "to texters' desire to overcome the confines of the alphanumeric mobile phone keypad" (p. 19).

When texting, adolescents and young adults demonstrating considerable creativity in maximizing meaning while minimizing effort (Watt, 2010). Several studies (Kemp & Bushnell, 2011; Plester, Wood & Joshi, 2009; Powell & Dixon, 2011) have concluded that textese reflects linguistic originality and playfulness where users access existing phonological knowledge to produce textisms that are variants on Standard English forms. Thurlow and Poff (2011) claimed that "the language of text messaging is constantly changing" (p. 13). Therefore, the linguistic features and "glossaries of textisms should be seen as descriptive and possibly idiosyncratic rather than proscriptive and general" (Kemp, 2010, p. 66). The lack of a standard collection of text message conventions and specific textisms suggest that, according to Coe and Oakhill (2011) "variations evolve and disappear so quickly" (p. 12).

Turner (2010) identified distinct features in text messages including unconventional capitalisation, unconventional end-of-sentence punctuation, lengthening words with additional consonants or vowels, unconventional use of ellipses, omitted apostrophes, phonetic spelling, abbreviations and formation of new compound words. Baron and Ling (2011) reported that traditional punctuation had been "repurposed" (p. 61) to suit the needs of the text message creator and recipient, for instance, ellipses and smileys in place of periods. This aligns with Watt's (2010) contention that existing language and literacy skills are being adapted (p. 143) as users craft text messages. Varnhagen et al. (2010) created a taxonomy of new language forms identified in instant messages and described these variations as "a natural experiment in the development of written communication" (p. 731).

Taylor and Vincent (2005) queried the effect of the predictive text function, built into the text messaging application, where the user presses a sequence of single keys and the mobile phone uses a dictionary to predict the intended word. Supporting the notion of textese as an enduring language form, Kemp and Bushnell (2011) reported similar occurrences of testisms in messages sent with and without the predictive text function activated. While De Jonge and Kemp (2012) hypothesised that predictive text would "greatly reduce or even eliminate" (p. 62) the use of textisms, half their sample of high school and university students used textisms in sending text messages (13-16% of total words per message) regardless of activation of the predictive text function. However, Drouin and Driver (2012) found that use of the predictive text application moderated text message errors of capitalisation and punctuation due to the autocorrect feature. Thus, as the technology improves, the quality of text messages, according to the conventions of standard written English, improves in some, but not all, cases.

Although text messaging is a relatively recent phenomenon, a considerable volume of research has described the patterns of written communication associated with mobile phones. The impact of increasingly popular full keypad touchscreen smartphones on text messages features requires investigation. The aim of the current investigation was to determine the effect of mobile phone input method on the linguistic features of text messages. Specifically, does mobile phone input device (i.e., alphanumeric multi-press versus full keypad touchscreen) have an effect on the linguistic features of text messages including message length, occurrences of specific textisms and variation in patterns of punctuation and capitalization?

Research Methods

Because young adults are associated with emerging technologies and changing patterns of communication (Skierkowski & Wood, 2012; Wei et al., 2012), research participants were recruited from a student study area at a comprehensive university. Individuals in the study area who did not appear to be engaged in learning activities (e.g. on Facebook, browsing the internet or talking to others in the study area) were queried as to their willingness to participate in a study on text messaging. University students who agreed to participate were invited to complete research tasks at their convenience. Approximately 90% of students opted to participate immediately, while approximately 10% delayed participation to a later time. Research participant recruitment stopped when a sample of 50 university students had completed required research tasks; the data provided by 50 university students allowed for statistical comparison of the linguistic features of text messages sent with an alphanumeric multi-press keypad mobile phone and a full keypad touchscreen smartphone.

Research participants: Fifty university students.

The mean age of the 50 research participants was 21.3 years (SD 4.34) with the oldest participant reportedly 41 years of age and the youngest participant reportedly 17 years of age. Seventy percent of participants were female and 30% were male. Participating university students were enrolled in 17 different courses of study. Forty-four percent of research participants reported enrolment in Bachelor of Education programs, 32% reported enrolment in a Bachelor of Arts program and 20% reported enrolment in Engineering, Science, Commerce, Pharmacy or Psychology programs of study. The final 4% (i.e., two participants) reported enrolment in English language studies in order to gain entrance into further university study. Students reported an average of 1.9 completed years of university study (SD 1.40). Thirty-nine participants (78%) indicated English as their first language while eleven participants (22%) reported speaking a first language other than English.

Data collection: Student text messages across distinct devices.

In an office located adjacent to the study area, each university student was individually advised of their rights as research participants. Next, students received instructions regarding required research tasks and, finally, students sent two text messages, one with an alphanumeric multi-press keypad mobile phone and another with a full keypad touchscreen smartphone. Similar to procedures used in previous studies (Coe & Oakhill, 2011; Plester et al., 2009), students send text messages in response to scenarios. Since two text messages were sent with two distinct devices, two scenarios were required, as follows:

1. It’s a Friday afternoon and you text a friend, inviting them to meet you and some other friends that night. You suggest some ideas [describe three of your typical Friday night activities] but tell them that you don’t mind what you do, but that you’ve got to get out, after a busy week at university. Also ask your friend if you can spend the night at their place so you don’t have to drive home.
2. You have come back from spending a weekend away. You text your friend and tell them where you went and describe three activities you enjoyed while on holiday. Tell your friend to look at your Facebook page to view the photos you’ve uploaded from the weekend. Then ask your friend how their weekend was and that you’d hope to catch up soon.

Participant text messages were composed on two different types of mobile phones, each installed with a pre-paid sim card purchased specifically for the study. A Nokia 1101 was used as the traditional multi-press mobile phone and an Apple iPhone 4 was used as the full keypad smartphone. To minimize extraneous influences, predictive text and auto-correction functions were disabled on both mobile phones. The order of use of phone type was systematically varied, that is, the first individual to participate was given the smartphone to send a text message in response to scenario one; the second individual to participate was given the Nokia mobile phone to send a text message in response to scenario one; the third individual to participate was given the smartphone to send a text message in response to scenario one and so on). The text message composed in response to scenario two was created on whichever device remained to be used. Thus, the confounding variable of order of device used was controlled because half the research participants started with the full keypad touchscreen smartphone and half the participants started with the alphanumeric multi-press mobile phone.

Each participant was given their first mobile phone and informed that they had 30 seconds to become familiar with the keypad and text messaging application (i.e., to reduce the effect of previous experience). The student was then given an instruction sheet containing the mobile phone number to which the text message was to be sent and scenario one, typed in a large, clear font. Participants were told that they had up to one minute to read the instruction sheet. Once the minute had lapsed or sooner if the student indicated readiness to start texting, students were told that they had exactly three minutes to create a text message in response to the scenario. When three minutes had elapsed, participants were directed to send the message to the number specified on the instruction sheet. The instruction sheet and relevant mobile phone for the alternate scenario were then given to the student, and an identical procedure was followed as with the first scenario.

Archiving and analysing text messages.

The smartphone messaging software had the capability of forwarding text messages to an email address. Thus, after each student texting session, messages were forward to an email address and subsequently collated into a word document. Student text messages composed on the alphanumeric multi-press mobile phone were manually typed from the phone screen into a word document because the text messaging application of the handset did not allow for email forwarding. Upon completion of 50 student texting sessions, the word document containing 100 text messages (i.e., 50 sent for each of two devices under identical conditions and having controlled for confounding variables). These 100 text messages were analysed for linguistic features and specific textisms. Initially, the features assessed were based on those identified by Thurlow and Brown (2003) and used by Ling and Baron (2007) in analysing instant messages and text messages sent by American college students. However, additional linguistic features emerged through analysis of the actual text messages. To allow for detailed comparison, a precise list of linguistic features was generated such that specific textisms were narrowly defined (e.g. lexical shortenings, acronyms and abbreviations) while other manifestations of digitalk were descriptively categorized (e.g., omitted capitalization and misspellings). Summarised and presented in Table 1, the linguistic features that emerged from the 100 text messages included message length (i.e., characters, words and sentences), emoticons, specific testisms (e.g., 2nite and omg), punctuation, capitalization and misspellings.

Table 1

Description of Linguistic Features Evident in Text Messages

Linguistic Feature	Description of Linguistic Feature
Length	Characters, words and sentences
Emoticon	Graphic or iconic representations of facial expressions and emotions
Specific Textism	Lexical shortening and lengthening, contraction, clipping, initials, symbol, homophone, unconventional spelling, acronym, abbreviation
Punctuation	Punctuation marks contributing to meaning including repurposed punctuation (e.g., an ellipsis in place of a period)
Capitalisation	Use of capital letters in personal pronouns, proper nouns and the first word of a sentence
Omitted Capitalisation	Absence of capital letters in personal pronouns, proper nouns and the first word of a sentence
Misspellings	Misspelled words not classified as textisms

Specific textisms found in the 100 text messages were analysed using a classification system adapted from previous studies (Plester et al., 2009; Thurlow & Brown, 2003). Summarized and presented in Table 2, specific textisms included shortening words (e.g., pics rather that pictures), lengthening words for effect (e.g., soooo rather than so), contractions (e.g., ur rather than you are), clippings (goin rather than going), initialisms (e.g., btw rather than by the way), symbols (e.g., @ rather than at), letter/number homophones (e.g., c rather than see), unconventional spelling (gurls rather that girls), acronyms (ASAP rather than as soon as possible) and indication of emotion and humour with letters (e.g., mwa to indicate the sound of a kiss).

Table 2

Categories and Examples of Specific Textisms Evident in Text Messages

Category	Example
Shortening	pics, Freo, hols, uni
Lengthening	helll, sooo, doooo, loooove, heeey
Contraction	ur, urs, plz, hv
G-clipping	goin, gettin, doin
Other clipping	lemme, wanna, gotta, outta
Initialism	cbf, omg, btw, ceebs
Symbol	@, &, xx
Letter/number homophone	2nite, c, r, b, 4
Unconventional spelling	gurls, tonite, coz, fotos, kool,
Acronym	ASAP, FB, BBQ
Humour/emotion	hehe, haha, mwa, eeek

The word document with 100 text messages was examined to determine the number of occurrences of each of eight linguistics features (i.e., characters, words, sentences, emoticons, punctuation, capitalization, omitted capitalization and misspelled word) and 11 specific textisms (as specified in Table 2). Analysis of text message length in terms of number of characters and words was determinded using the word count feature in Microsoft Word. All other linguistic features and specific textisms for each of the 100 text messages were counted manually by a single rater and recorded in SPSS for Windows, with particular attention to ensuring messages sent by the same students (but with different devices) were correctly linked to allow for subsequent statistical comparisons.

Inter-rater reliability is defined as the degree to which raters give consistent estimates of the same phenomenon. To ensure the reliability of the linguistic features and specific textisms identified in text messages, five pairs of text messages, located using an online random number generator (Psychicscience.org, 2012), were re-coded by an alternate rater. The second ratings were compared with the original ratings. Each text message was coded in terms of eight linguistics features and 11 specific textisms for a total of 17 descriptors applied to each text message. Applying 17 descriptors to each of five re-coded text messages resulted in 85 potential points of rater agreement or disagreement for messages sent from either mobile phone (i.e., 17 x 5 = 85). Across the five re-coded smartphone text messages, there were 81 out of 85 agreements in ratings, that is, 95% consistency across two independent raters of the linguistic features and specific textisms in the text messages. With respect to messages sent on the multi-press mobile phone, there were 77 out of 85 agreements in ratings, that is, 91% consistency across two independent raters of the linguistic features and specific textisms in text

messages. Such high levels of inter-rater reliability suggest that the categorization and counting of the occurrences of linguistic features and specific textisms in text messages is consistent and, therefore, dependable (Gwet, 2010).

Results

Descriptive statistics (i.e., least, most, mean and standard deviation) for each of the linguistic features counted in the university students' text messages are presented in Table 3 for messages composed on the full keypad touchscreen smartphone and in Table 4 for messages composed on the alphanumeric multi-press mobile phone. The mean number of words used in the 50 smartphone messages was 43.06, the shortest message was 18 words and the longest message was 73 words. Whereas for multi-press text messages, the mean number of words was 32.00, the shortest message was 12 words and the longest message was 56 words. Average student use of specific textisms in smartphone messages was 2.76, with the lowest frequency at zero and the highest frequency at 22. For multi-press mobile phone messages, the mean specific textism use was 3.70, with the lowest frequency at zero and the highest frequency at 23. Omitted capitalization was more common in smartphone messages than in multi-press mobile phone text messages. The reverse pattern emerged for punctuation marks.

Table 3

Linguistic Features of Text Messages send with a Full Keypad Touchscreen Smartphone

Linguistic Feature	Minimum	Maximum	Mean	Standard Deviation
Characters	82	359	206.40	61.21
Words	18	73	43.06	12.37
Sentences	1	9	4.48	1.98
Specific Textisms	0	22	2.76	3.61
Punctuation	0	14	6.60	3.06
Capitalisation	0	11	1.82	3.00
Omitted Capitalisation	0	14	4.92	3.22
Misspellings	0	4	0.80	1.07

Table 4

Linguistic Features of Text Messages send with a Multi-Press Keypad Mobile Phone

Linguistic Feature	Minimum	Maximum	Mean	Standard Deviation
Characters	56	249	151.48	48.86
Words	12	56	32.00	10.87
Sentences	1	9	3.68	1.71
Emoticons	0	3	0.28	0.61
Specific Textisms	0	23	3.70	4.83
Punctuation	0	12	4.56	2.72
Capitalisation	0	9	3.72	1.93
Omitted Capitalisation	0	6	2.34	1.47
Misspellings	0	1	0.26	0.44

Occurrences of specific textisms in messages composed on the touchscreen smartphone are presented in Table 5 and in Table 6 for messages composed on the multi-press mobile phone. The most common type of specific textism was the shortening of words (e.g., uni for university) with 50% usage in smartphone messages and 44% usage in multi-press mobile phone messages. On average, participating university students used 0.56 word shortenings in each smartphone message and 0.66 word shortenings in each multi-press mobile phone message. The second most frequently used specific textism was contractions (e.g., hv for have) with 34% of participants using this type of textism in their smartphone messages (mean 0.88) and 40% of participants using this type of textism in their multi-press mobile phone message (mean 1.38). Mean number/letter homophone usage in smartphone messages was 0.02 compared with 0.28 in multi-press mobile phone messages. Two percent of participating university students used number/letter homophones in their smartphone messages while 14% of participants used this textism type in their multi-press mobile phone messages.

Table 5

Specific Textisms in Messages send with a Full Keypad Touchscreen Smartphone

Textism Type	Min	Max	Mean	SD	Occurrence
Shortening	0	2	0.56	0.61	50%
Contraction	0	11	0.88	1.87	34%
Lengthening	0	1	0.10	0.30	10%
G-clipping	0	5	0.10	0.71	2%
Other clippings	0	3	0.40	0.73	28%
Intialism	0	1	0.06	0.24	6%
Symbols	0	1	0.08	0.27	8%
Number/letter homophones	0	1	0.02	0.14	2%
Unconventional spelling	0	3	0.18	0.56	12%
Acronyms	0	1	0.22	0.42	22%
Humour/emotion	0	2	0.14	0.45	10%

Table 6

Specific Textisms in Messages send with a Multi-Press Keypad Mobile Phone

Specific Textism	Min	Max	Mean	SD	Occurrence
Shortening	0	4	0.66	0.92	44%
Contraction	0	12	1.38	2.55	40%
Lengthening	0	1	0.02	0.14	2%
G-clippings	0	1	0.06	0.24	6%
Other clippings	0	3	0.28	0.57	24%
Intialisms	0	1	0.08	0.27	8%
Symbols	0	1	0.10	0.30	10%
Number/letter homophones	0	4	0.28	0.81	14%
Unconventional spelling	0	4	0.28	0.76	16%
Acronyms	0	2	0.36	0.53	34%
Humour/emotion	0	3	0.16	0.55	10%

Paired-sample t-tests established significant differences in some of the linguistic features of text messages composed on the two distinct types of mobile phones. As summarized and presented in Table 7, text messages composed with the full keypad touchscreen smartphone were longer (i.e., greater number of characters, words and

sentences) than text messages composed with the alphanumeric multi-press mobile phone. Only one category of specific textisms revealed significant difference in use; participating university students used significantly fewer number/letter homophones in smartphone messages than in multi-press mobile phone messages. Compared to multi-press mobile phone text messages, capitalization was significantly less common in smartphone messages. While punctuation marks were more common in text messages composed on the smartphone, misspelled words were also more frequent.

Table 7

Differences in the Linguistic Features of Text Messages sent via a Full Keypad Touchscreen Smartphone and a Multi-Press Keypad Mobile Phone

Linguistic Feature	Mean Occurrence (SD)	*t*	*df*	*p*
Characters	Smart 206.40 (61.21)	6.67	49	< 0.01
	Multi 151.48 (48.86)			
Words	Smart 43.06 (12.37)	6.59	49	< 0.01
	Multi 151.48 (48.86)			
Sentences	Smart 4.48 (1.98)	3.85	49	< 0.01
	Multi 3.68 (1.71)			
Number/letter homophones	Smart 0.02 (0.14)	-2.29	49	< 0.05
	Multi 0.28 (0.81)			
Capitalisation	Smart 1.82 (3.00)	-4.59	49	< 0.01
	Multi 3.72 (1.93)			
Omitted Capitalisation	Smart 4.92 (3.22)	5.79	49	< 0.01
	Multi 2.34 (1.47)			
Punctuation	Smart 6.60 (3.06)	6.94	49	< 0.01
	Multi 4.56 (2.72)			
Misspellings	Smart 0.80 (1.07)	3.23	49	< 0.01
	Multi 0.26 (0.44)			

Discussion of Results: Evolving Patterns of Digital Communication

Results of the current investigation suggest that the characteristics of mobile phones affect the linguistic features of text messages but, equally important, that communicative patterns endure regardless of mobile phone characteristics. Analysis of punctuation use, grammatical, lexical, stylistic and visual features of text messages composed on two different handsets revealed that this cohort of young adults was playfully manipulating language to sustain interesting conversations with communication partners (Lewis & Fabos, 2005). However, on average, participating university students

composed significantly longer messages when texting with the full keypad touchscreen smartphone compared with the alphanumeric multi-press mobile phone. Perhaps this is because typing on a full keypad is easier and faster and thus promotes increased word use. Curiously, participating university students used more capital letters in their multi-press text messages than in their smartphone text messages and, correspondingly, the smartphone text messages showed higher instances of omitted capitalisation. While capitalisation for both interfaces follows the same procedure (i.e., users press the shift key directly before selecting the letter to be capitalised), it is possible that the ease and speed with which participants create text messages on the smartphone negated focus on capitalisation. Indeed, it could be argued that capitalization is a convention with minimal influence on comprehension of communication intent. In this regard, the perceived need for and corresponding use of capitalization may be eroding in contemporary forms of text-based digital communication. Compared to the communicative limitations associated with the alphanumeric multi-press mobile phone, the full keypad touchscreen smartphone may be impacting on the conventions of text-based communication at a faster rate. If the objective is efficient communication, capitalization may be unnecessary.

Differences in messaging features may explain the finding that punctuation marks were more prevalent in text messages send from full keypad smartphones compared to multi-press mobile phones. Smartphone users were able to switch to a symbols menu with a single touch and insert a punctuation mark. Multi-tap mobile phone users must press multiple keys to access punctuation marks and this makes it more time consuming to incorporate punctuation into a text message. There were a few instances of repurposed punctuation within the corpora of text messages where participants utilised an ellipsis (i.e., two or more period marks in succession) to end a sentence instead of a single period mark. This use of repurposed punctuation was also found by Baron and Ling (2011) when examining American college students' instant messages which suggests that manipulation of standard punctuation symbols is not specific to young adults of a particular culture or geographical location but appears to be a universal trend among this age group, at least for texting in English. Both conventional (e.g., period at the end of a sentence) and creative (e.g. multiple exclamation marks) use of punctuation enhances communicative quality of text messages (e.g., indicates expression of emotion and alerts the receiver to the sender's communicative intent). In this regard, since the full keypad touchscreen smartphone allows for more efficient punctuation use, it also allows for more effective communication.

On average, participating university students used 2.76 specific textisms in messages sent from the full keypad touchscreen smartphone and 3.70 specific textisms in messages sent from the alphanumeric multi-press mobile phone. The difference was not statistically significant (t = -1.80, df = 49, p = .078). Text messages sent from the two distinct types of mobile phones were further compared in terms of differences in occurrences of eight specific textism conventions including shortening words, lengthening words for effect, contractions, clippings, initialisms, symbols, letter/number homophones, unconventional spelling, acronyms and indication of emotion and humour with letters (Table 2). In seven out of eight cases, there were no significant differences in occurrences of specific testisms in messages sent via a full keypad touchscreen smart phone or an alphanumeric multi-press mobile phone. However, participating university students used more number/letter homophones in multi-press text messages than in smartphone text messages. This may be due to the design of the alphanumeric keypad

where a number can be produced by holding down a specific key for two seconds, rather than having to switch to a separate numeric keypad as is the case with the smartphone. Nonetheless, in general, the touchscreen smartphone input method has not eliminated the use of specific textisms. Participating university students may choose to utilise textisms, regardless of input method, as a mechanism to enhance the communicative quality of their text messages and to conform to the specific language conventions associated with texting culture (Drouin, 2011).

Overall, shortenings (e.g. hols rather than holes) were the most frequently occurring specific textism in both smartphone text messages (i.e., occurred in 50% of messages) and multi-press mobile phone text messages (i.e., occurred in 44% of messages). Similar to shortenings, contractions (e.g. plz rather than please) were also relatively common regardless of texting device (i.e., occurred in 34% of smartphone messages and 40% of multi-press messages). Also similar to shortenings, clippings (e.g., wanna rather than want to), including g-clippings, were used in 30% of text messages regardless of type of mobile phoned used by participating university students. Interestingly, number/letter homophones (e.g., b rather than be) were used sparingly, that is, in 14% of multi-press mobile phone text messages and 2% of messages sent with a full keypad touchscreen smartphone. Such a pattern of specific testisms is inconsistent with patterns reported by Coe and Oakhill (2011) where number/letter homophones were used most frequently by British preadolescent children when composing a text message with pen and paper. Many explanations are possible, for example, use of specific textisms may be influenced by texter age, culture and method of collecting text messages.

Grace, Kemp, Heritage Martin and Parrila (2012) examined the use of specific textisms in Australian university students through scenario-based text messages and naturalistic text message observation (where students provided several text messages recently sent from their mobile phones). Reportedly, accent stylisation (i.e., a word is spelled as it is pronounced in casual speech such as wiv for with and anuva for another) and homophones (e.g., r for are) were used most frequently, followed by shortenings and contractions. In contrast, the current investigation did not utilise the specific category of accent stylisations due to similarities between this category and other clippings where users clip the last letter from a word and replace it with the letter *a* (e.g. gonna for going to). If accent stylisations and other clippings were viewed as one category, specific textisms used by students in the current investigation would more closely reflect specific textisms identified by Grace et al., with the exception of number/letter homophones Given the similarity of research samples (i.e., Australian university students), it may be that age, culture and education level are related to patterns of use of specific textisms in text messaging. Indeed, Australian English is characterised by shortenings of words (e.g., choccie bickie rather than chocolate biscuit; Kidd, Kemp, & Quinn, 2011). Since most texting is likely to occur within the same geographical area, it seems reasonable to assume that texting dialects would develop.

Patterns of use of linguistic features and specific textisms in the current corpus of text messages were similar to patterns reported by De Jonge and Kemp (2010), who also analysed the messages of Australian university students. Their study compared messages composed on an alphanumeric multi-press mobile phone with and without use of the predictive text application. With respect to specific textisms, accent stylisations, contractions and shortenings were most frequently used regardless of the predictive text application. Further, capitalisation was frequently omitted. Participating university

students' text messages in the current study also showed high frequencies of omitted capitalisation, regardless of the type of mobile phone used. Australian texting idiosyncrasies (i.e., textalect) may reflect some of the features of Australian English dialect.

Differences in patterns of textisms in the current study compared to other studies may be attributed to variation in textism classification systems. From a research perspective, a standard list of textism categories and common practices in analysing text messages would likely reduce differences in reported findings, although such standardization seems untenable since textese appears to be evolving rapidly with the continual emergence of new textisms and high variations in individual textism spellings (Coe & Oakhill, 2011; Kemp, 2010; Thurlow & Poff, 2011). In oral language, location affects dialect (e.g., America versus British versus Australian English). Location also appears to affect the linguistics features and specific textisms of text messages regardless of mobile phone input method (i.e., alphanumeric multi-press versus full keypad smartphone).

Indeed, the rate of change in patterns of human communication due to the rate of change in human communication technologies appears to be transforming the very nature of human interaction. Language conventions were once held sacred, perhaps because ridged expectations facilitated communication. However, contemporary technologies, embraced initially by adolescents and young adults, appear to be accelerating personalized and efficient communication rather than tradition and convention. While all living languages change over time, communication technologies have accelerating the rate of language change. Since many communication technologies are text-based, the change in written language conventions is particularly apparent. Results of the current investigation suggest that message quality may be enhanced by emerging technology (i.e., full keypad touchscreen smartphones) but not necessarily by use of standard written English language conventions.

References

Baron, N. S., & Ling, R. (2011). Necessary smileys & useless periods. *Visible Language, 45*(1), 45-67. Retrieved from http://search.proquest.com/

Coe, J., & Oakhill, J. (2011). txtN is ez f u no h2 rd: The relation between reading ability and text-messaging behaviour. *Journal of Computer Assisted Learning, 27*(4), 4-17. doi: 10.1111/j.1365-2729.2010.00404.x

De Jonge, S., & Kemp, N. (2012). Text-message abbreviations and language skills in high school and university students. *Journal of Research in Reading 35*(1), 49-68. doi: 10.1111/j.1467-9817.2010.01466.x

Drouin, M. (2011). College students' text messaging, use of textese and literacy skills. *Journal of Computer Assisted Learning 27*, 67-75. doi: 10.1111/j.13652729.2010.00399.x

Drouin, M. & Driver, B. (2012). Texting, textese and literacy abilities: a naturalistic study. *Journal of Research in Reading.* doi: 10.1111/j.1467-9817.2012.01532.x

Grace, A., Kemp, N., Heritage Martin, F. & Parrila, R. (2012) Undergraduates' use of text messaging language: Effects of country and collection method. *Writing Systems Research 1*, 1-18. doi: 10.1080/17586801.2012.712875

Gwet, K. L. (2010). Handbook of inter-rater reliability: The definitive guide to measuring extent of agreement among multiple raters. Gainsborough, MD: Advanced Analytics.

Informa Telecoms and Media. (2012). *SMS will remain more popular than mobile messaging apps over the next five years*. Retrieved from http://blogs.informatandm.com/4971/press-release-sms-will-remain-more-popular-than-mobile-messaging-apps-over-next-five-years/

Johnson, G. M. (2012). Comprehension of Standard English text and digital textism during childhood. *Internet Journal of Culture, Language and Society, 35(*1), 1-6. Retrieved from http://www.educ.utas.edu.au/users/tle/JOURNAL/issues/2012/35-01.pdf

Kemp, N. (2010). Texting versus txtng: reading and writing text messages, and links with other linguistic skills. *Writing Systems Research, 2*(1), 53-71. doi: 10.1093/wsr/wsq002

Kemp, N., & Bushnell, C. (2011). Children's text messaging: abbreviations, input methods and links with literacy. *Journal of Computer Assisted Learning, 27*, 18-27. doi: 10.1111/j.1365-2729.2010.00400.x

Kidd, E., Kemp, N. M., & Quinn, S. (2011). Did you have a choccie bickie this arvo? A quantitative look at Australian hypocoristics. *Language Sciences: A World Journal of the Sciences of Language, 33*(3), 359-368.

Lewis, C. & B. Fabos (2005). Instant messaging, literacies, and social identities. *Reading Research Quarterly 40*(4), 470-501. doi: 10.1598/RRQ.40.4.5

Ling, R. & Baron, N. S. (2007). Text messaging and IM: Linguistic comparison of American college data. *Journal of Language and Social Psychology 26*(3), 291-298. doi: 10.1177/0261927X06303480

Mastercard Worldwide. (2012). *Smartphone and tablet ownership by country*. Payments Perspectives Blog. Retrieved from http://insights.mastercard.com/2012/03/23/mobile-web-on-smartphones-and-tablets-gaining-fast/smartphone-and-tablet-ownership-by-country-2/

Nielsen. (2009). *In US, SMS text messaging tops mobile phone calling*. Retrieved from http://blog.nielsen.com/nielsenwire/online_mobile/u-s-teen-mobile-report-calling-yesterday-texting-today-using-apps-tomorrow/

Nielsen. (2011). *State of the media: U.S. digital consumer report, Q3-Q4 2011*. Retrieved from http://www.nielsen.com/content/dam/corporate/us/en/reports-downloads/2012-Reports/Digital-Consumer-Report-Q4-2012.pdf

Olson, D. R. (2005). Technology and intelligence in a literate society. In R. J. Sternberg &D. D. Preiss (Eds.), *Intelligence and technology: The impact of tools on the nature and development of human abilities* (pp. 55-67). Mahwah, NJ: Lawrence Erlbaum.

Plester, B., Wood, C. & Joshi, P. (2009). Exploring the relationship between children's knowledge of text message abbreviations and school literacy outcomes. *British Journal of Developmental Psychology*, *27*, 145-161. doi: 10.1348/026151008X320507

Portio Research. (2012). *Mobile messaging futures 2012-2016*. Retrieved from http://www.portioresearch.com/en/reports/current-portfolio/mobile-messaging-futures-2012-2016.aspx

Powell, D. & Dixon, M. (2011). Does SMS text messaging help or harm adults' knowledge of standard spelling? *Journal of Computer Assisted Learning, 27*(1), 58-66. doi: 10.1111/j.1365-2729.2010.00403.x

psychicscience.org (2012) *Random number generator and checker*. Retrieved from http://www.psychicscience.org/random.aspx

Rainie, L. (2012). *Smartphone ownership update: September 2012*. Pew Research Center. Retrieved from http://pewinternet.org/Reports/2012/Smartphone-Update-Sept-2012.aspx

Skierkowski, D., & Wood. R. M. (2012). To text or not to text? The importance of text messaging among college-aged youth. *Computers in Human Behavior, 28*(2), 744-756. doi: http://dx.doi.org.dbgw.lis.curtin.edu.au/10.1016/j.chb.2011.11.023

Taylor, A. & Vincent. J. (2005). An SMS history. In L. Hamill & A. Lasen (Eds.), *Mobile world: Past, present and future* (pp. 75-91). New York, NY: Springer. Retrieved from download.springer.com

Taylor, C. (2009). Pre-paid literacy: Negotiating the cost of adolescent mobile technology use. *English in Australia, 44*(2), 26-34. Retrieved from http://search.informit.com.au

Technology Review. (2012). Are smart phones spreading faster than any *technology in human history*? Retrieved from http://www.technologyreview.com/news/427787/are-smart-phones-spreading-faster-than-any/

Thurlow, C., & Brown, A. (2003). Generation Txt? The sociolinguistics of young people's text-messaging. *Discourse Analysis Online*. Retrieved from http://extra.shu.ac.uk/daol/articles/v1/n1/a3/thurlow2002003.html

Thurlow, C., & Poff, M. (2011). Text messaging. In S. C. Herring, D. Stein, & T. Virtanen (Eds.), *Handbook of the Pragmatics of CMC*. New York: Mouton de Gruyter. Retrieved from http://faculty.washington.edu/thurlow/papers/thurlow&poff%282010%29.pdf

Turner, K. H. (2010). Digitalk: A new literacy for a digital generation. *Phi Delta Kappan 92*(1), 41-46. doi: 10.2307/25753626

Varnhagen, C., McFall, G., Pugh, N., Routledge, L., Sumida-MacDonald, H. & Kwong, T. (2010). lol: new language and spelling in instant messaging. Reading and Writing 23(6), 719-733. doi:10.1007/s11145-009-9181-y

Watt, H. J. (2010). How does the use of modern communication technology influence language and literacy development? A review. *Contemporary Issues in Communication Science and Disorders, 37*,141-148. doi: 1092-5171/10/3702-0141

Waugh, R. (2012). Text maniacs: American teens message 60 times a day, claims new report - and UK figure could be even higher. *MailOnline: Science and Technology*. Retrieved from http://www.dailymail.co.uk/sciencetech/article-2118639/Text-maniacs-American-teens-text-60-times-day-claims-new-report--UK-figure-higher.html

Wei, F-Y., Wang, Y. K., & Klausner, M. (2012). Rethinking college students' self-regulation and sustained attention: Does text messaging during class

influence cognitive learning? *Communication Education*, *61*(3), 185-204. doi: 10.1080/03634523.2012.672755

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Continuous beam analysis using slope deflection and moment distribution method: the difference

Kachalla, M
Department of Civil Engineering,
University of Maiduguri. NIGERIA
wuniwuni2@yahoo.com

Abstract

The paper present a study on comparism between two different methods used for structural analysis of indeterminate structures. A continuous beam of unequal span in relation to constant loading and uniform flexural rigidity were numerically asses using moment distribution and slope deflection methods, as the spans were varied in relation to one another so as to evaluate the internal joint performance in terms of the moment at the joint. The findings indicates the two method are highly correlated and the relationship between the span variations and moment were found to be linear also, as 10% difference in span between spans of two span continuous beam will result in 25% increase in moment at the internal joint.

Keywords: Continuous beam, Moment distribution, Slope deflection, Span

Introduction

Structural analysis and design is a very old art and is known to human beings since early civilizations. The main purpose of any structure is to support the loads coming on it by properly transferring them to the foundation. In the early periods, houses are constructed along the riverbanks using the locally available material. They were design to withstand rain and moderate wind. Today structures are design to withstand earthquakes, tsunamis, cyclones and blast loadings. Aircraft structures are design for more complex aerodynamic loadings. These have been made possible with the advances in structural engineering and a revolution in electronic computation in the past 50 years.

The development of a new material, reinforced concrete, made it imperative to find solutions for statically indeterminate frames. Monolithic reinforced concrete structures are highly indeterminate. Hence, methods that gave reasonably accurate results and did not require a horrendous amount of calculation were a necessity. Perhaps, various methods have been developed over the years for determining the bending moment and shearing forces on statically indeterminate structures **(**Khurmi, 2005).

In the course of this paper, it is discussed how specifically the two commonly method used in the analysis of statically indeterminate structures differs from one another. It is focused on the behaviour of the internal support for a continuous beam of two span having uniformly distributed load and constant flexural rigidity. The research question asks about in addition to how these two methods differ from one another; the effect of unequal span of continuous beam is also of top most interest.

Continuous beam

Continuous beams like fixed-end beams are statically indeterminate. Bending moments in these beams are functions of the geometry, moments of inertia, and modulus of elasticity of individual members, besides the load and span. They may be determined by Clapeyron's theorem of three moments, the moment distribution method, or the slope deflection method.

Perhaps, Clapeyron was the first to offer a practical solution to the problem of continuous beams over supports. His Three Moment Method was widely used well into the 20th century [Timeoshenko 1953]. He still had as many equations as there were indeterminacies (number of supports beyond two) but in any of these, there were only a maximum of three unknowns.

Slope deflection and moment distribution methods are two such methods commonly employed. Slope deflection is a method that takes into account the flexural displacements such as rotations and deflections and involves solutions of simultaneous equations. Moment distribution, on the other hand, involves successive cycles of computation, each cycle drawing closer to the "exact" answers. The method is more labour intensive but yields accuracy equivalent to that obtained from the "exact" methods.

Slope Deflection Method

Axel Bendixen in 1914 offered a procedure known as the slope deflection method as cited in Eaton (2001). It was the first readily practiced way to solve rigid frame structures. His method leads to an easily written series of simultaneous equations. The initial writing of the equations required little work. Each equation is rather "sparse" (i.e. it contains only a few of the unknowns). Thus, the effort required for the solution of these

simultaneous equations became less as compared to the methods developed earlier. The results from the solution of the simultaneous equations yielded rotations and displacements at the ends of individual members that in turn could be used to find moments and shears.

In 1922, K. A. Calisev, writing in Croatian, offered a method of solving the slope deflection equations by successive approximations [Timoshenko 1983; Bulletin 108 as cited in Eaton (2001)]. Probably because of the linguistic difficulty, Hardy Cross seems not to have been aware of Calisev's contribution. Though cumbersome, it was a pioneering work. The problem with it was that method was that successively adjusted rotations were used to establish moment balances at the nodes.

Consider a typical span of continuous beam as shown below, which has a constant flexural rigidity EI and subjected to a uniformly distributed loading

The slope deflection equation are derived by super imposing the end moments due to (i) applied loads, (ii) rotations θ_A and θ_B. from the kinematically determinate or restrained structure as shown in fig. above, this condition is obtained by modifying the support condition to a fixed, so that the unknown joints rotation become zero. There exist relationship between the end moments (M'_{AB} and M'_{BA}) and the joint rotations (θ_A and θ_B). the rotations θ_A and θ_B are calculated from moment area method theorem:

$$\theta_A = \frac{M'_{AB} L}{3EI} \quad \text{..... (i)}$$

$$\theta_B = -\frac{M'_{AB} L}{6EI} \quad \text{..... (ii)}$$

Now similar relation may be derived if only M'_{BA} is acting at end B, thus

$$\theta_B = \frac{M'_{BA} L}{3EI} \quad \text{..... (iii)}$$

$$\theta_A = -\frac{M'_{BA} L}{6EI} \quad \text{..... (iv)}$$

Combining these rotations , we could relate end moments acting at A and B to rotation produced at A and B as:

$$\theta_A = \frac{M'_{AB} L}{3EI} - \frac{M'_{BA} L}{6EI} \quad \text{..... (v)}$$

$$\theta_B = \frac{M'_{AB} L}{3EI} - \frac{M'_{BA} L}{6EI} \quad \text{..... (vi)}$$

Solving for M'_{AB} and M'_{BA} in terms of θ_A and θ_B

$$M'_{AB} = \frac{2EI}{L}(2\theta_A + \theta_B) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(vii)}$$

$$M'_{BA} = \frac{2EI}{L}(2\theta_B + \theta_A) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(viii)}$$

Now re-writing the equilibrium equation for joint moments at A and B

$$M_{AB} = M^F_{AB} + M'_{AB} = M^F_{AB} + \frac{2EI}{L}(2\theta_A + \theta_B) \quad \ldots\ldots\ldots\ldots\ldots \text{(ix)}$$

$$M_{BA} = M^F_{BA} + M'_{BA} = M^F_{BA} + \frac{2EI}{L}(2\theta_B + \theta_A) \quad \ldots\ldots\ldots\ldots\ldots \text{(x)}$$

Where M^F_{AB} and M^F_{BA} are end moments. The equations (ix and x) are simply referred to as the slope deflection equation. The slope deflection equation is nothing but a load displacement relationship

Moment Distribution Method

Many practicing engineers had dubious mathematical skills in handling simultaneous equations, and many had difficulties in visualizing rotations and displacements. Moment's are much more "friendly" for the average engineer and therefore easier to deal with. Thus, the Moment Distribution Method (also known as the Cross Method) became the preferred calculation technique for reinforced concrete structures. The description of the moment distribution method by Hardy Cross is a little masterpiece. He wrote: "Moment Distribution. The method of moment distribution is this: (a) Imagine all joints in the structure held so that they cannot rotate and compute the moments at the ends of the members for this condition; (b) at each joint distribute the unbalanced fixed-end moment among the connecting members in proportion to the constant for each member defined as "stiffness"; (c) multiply the moment distributed to each member at a joint by the carry-over factor at the end of the member and set this product at the other end of the member; (d) distribute these moments just "carried over"; (e) repeat the process until the moments to be carried over are small enough to be neglected; and (f) add all moments - fixed-end moments, distributed moments, moments carried over - at each end of each member to obtain the true moment at the end." [Cross 1949:2].

To analyse the beam in figure 1 above using moment distribution method, the unbalanced loading can cause rotation @ B, θ_B if the span are subjected to different loadings.

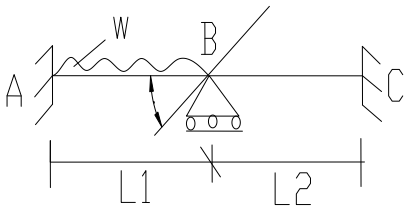
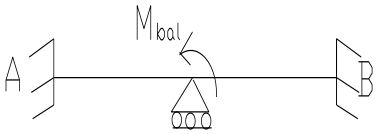


Figure 1



Using the principle of superposition, by introducing a fixed support @ B it does not allow any rotation at joint B. the moment result @ this new support – a moment that 'balance' the loading, M_{bal} now occur for the effect of the restraint by applying M_{bal}. the amount of M_{bal} in each span is M_{BC} and M_{BA} respectively.

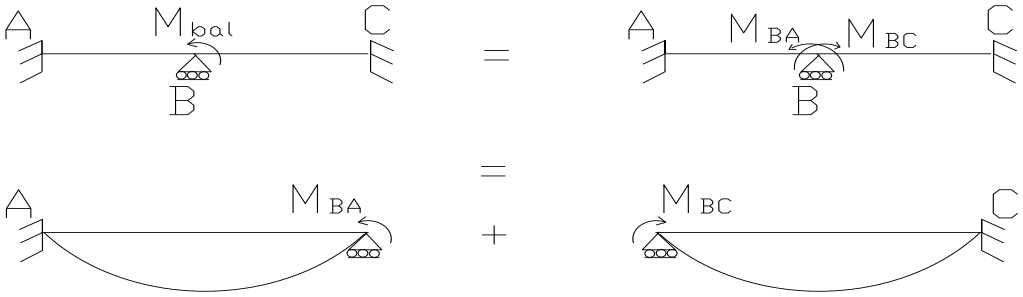


Figure 2

For each fixed- fixed span and its loading, both of these new locked beam have fixe ends moments reactions, and the differences in the two FEMs' at the joint is applied as the balancing moment in the opposite direction.

ii) Carry – over: is a factor relating the moments applied at one end of a beam to the resulting moment at the far end.

Fixed – pinned type

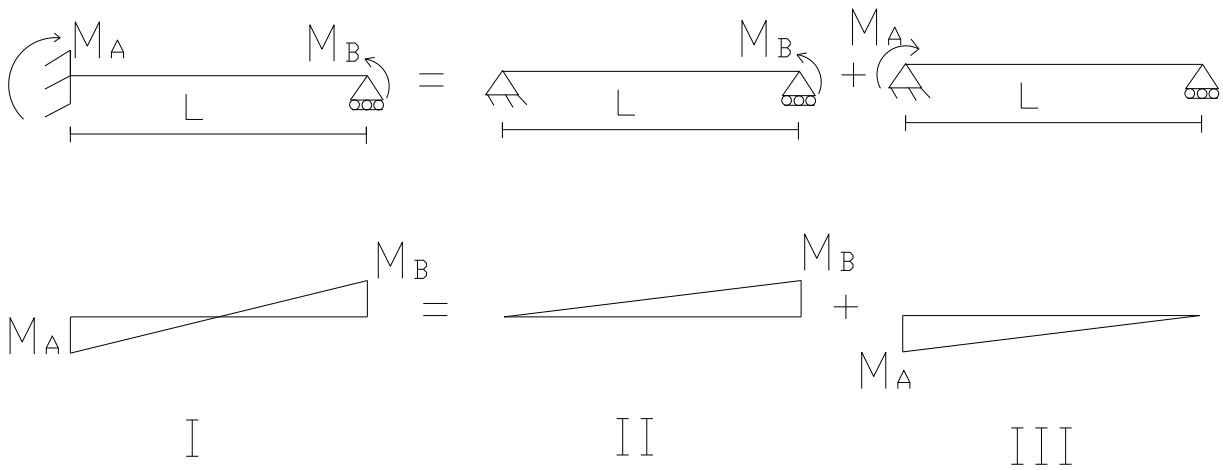


Figure 3

The deflection @ B in structure I is zero (δ_B) as shown in figure 3, the vertical intercept is also zero (Δ_{BA}=zero), thus $[(\Delta_{BA}]_I$ is

$[(\Delta_{BA}]_I = [(\Delta_{BA}]_{II} + [(\Delta_{BA}]_{III,}$ the subscript relates to the structure above. Consequently, by applying Mohr's' second theorem:

$$EI\Delta_{BA} = \left[\frac{1}{2}M_B L\right].\frac{L}{3} - \left[\frac{1}{2}M_A L\right].\frac{2L}{3} = 0 \text{ , this gives}$$

$$\frac{M_B L^2}{6} = \frac{M_A L^2}{3} \Rightarrow 3M_B = 6M_A \Rightarrow M_A = +\tfrac{1}{2}.M_B \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\text{(xi)}$$

The factor of $+\frac{1}{2}$ that relates M_A to M_B is known as the carry over factor (COF), the positive sign indicating that M_A acts in the same direction as M_B.

Fixed End Moment (FEM): when the joints are initially locked, the moment reactions (FEM) are obtained from the standard solution, for a uniformly distributed load w, the FEM $\pm\left(wl^2/12\right)$.

Rotational Stiffness: recalling that $F = K\delta$, where F is the force, K is the stiffness of the structure and δ is the resulting deflection. As moment are applied to the end of a beam, a rotation result as shown in figure 1, thus moment $M = K_\theta \theta$.

The change in rotation from A to B is found using the Mohr's first theorem and the fact that the rotation @ the fixed support θ_A is zero.

$$\theta_{AB} = \theta_B - \theta_A = \theta_B \quad \text{.....(xii)}$$

Thus $EI\theta_B = \frac{1}{2}M_B L - \frac{1}{2}M_A L \Rightarrow \frac{M_B L}{2} - \frac{M_B L}{4} = \frac{M_B L}{4}$

$$\theta_B = \frac{L}{4EI}M_B \Rightarrow M_B = \frac{4EI}{L}\theta_B \quad \text{.....(xiii)}$$

Moreover, the rotational stiffness for this type of support is

$$K_\theta = \frac{4EI}{L} \quad \text{.....(xiv)}$$

Distributing Factor: splitting the beam @ joint B, having θ_B rotation at joint B for compatibility of displacement in the original beam, thus;

$$[\theta_B]_{AB} = \frac{M_{BA}}{K_{AB}} \quad and \quad [\theta_B]_{BC} = \frac{M_{BC}}{K_{BC}}$$

$$M_{BAL} = M_{BA} + M_{BC} \Rightarrow K_{BA}\theta_B + K_{BC}\theta_B = (K_{BA} + K_{BC})\theta_B \quad \text{.....(xv)}$$

$$\Rightarrow \theta_B = \frac{M_{BAl}}{(K_{BA} + K_{BC})} \quad \text{.....(xvi)}$$

Thus,

$$M_{BA} = K_{AB}\theta_B \Rightarrow [\frac{K_{AB}}{(K_{AB} + K_{BC})}].M_{BAL} \quad and \quad M_{BC} = K_{BC}\theta_B \Rightarrow [\frac{K_{BC}}{(K_{AB} + K_{BC})}].M_{BAL}$$

..(xvii)

The terms in the bracket are called distribution factor (DF). In general, the DF for a member at a joint is the member stiffness divided by the sum of the stiffness of the member at that joint.

$DF_{BA} = \frac{K_{BA}}{\sum K}$, and as useful checks on calculation, the sum of DF for joint must add up to unity, $\sum_{joint} DF = 1$ ……(xviii)

Numerical Study

The investigation consist of two span continuous beam (span AB and BC) loaded with uniformly distributed load of 30 KN/m. the variations considered for span BC were additions of 10-, 20-, 30-, 40 and 50 % of span AB, which was taken to be 3. 0 m. the beam assumed to have uniform flexural rigidity throughout.

Results and Discussion

The results obtained are presented in table one (1) and two (2) respectively. The moment values are the ends moment for the span considered.

Table 1: Estimated Ends Moment using Moment Distribution

Spans Variation (%)	Joints Moments (KN.m)			
	A	B		C
10	0	37.42	-37.42	0
20	0	41.92	-41.92	0
30	0	46.79	-46.79	0
40	0	52.54	-52.54	0
50	0	59.07	-59.07	0

Table 2: Estimated Ends Moment using Slope deflection method

Spans Variation (%)	Joints Moments (KN.m)			
	A	B		C
10	0	37.45	-37.44	0
20	0	41.86	-41.82	0
30	0	47.05	-47.0	0
40	0	52.69	-52.58	0
50	0	59.12	-59.25	0

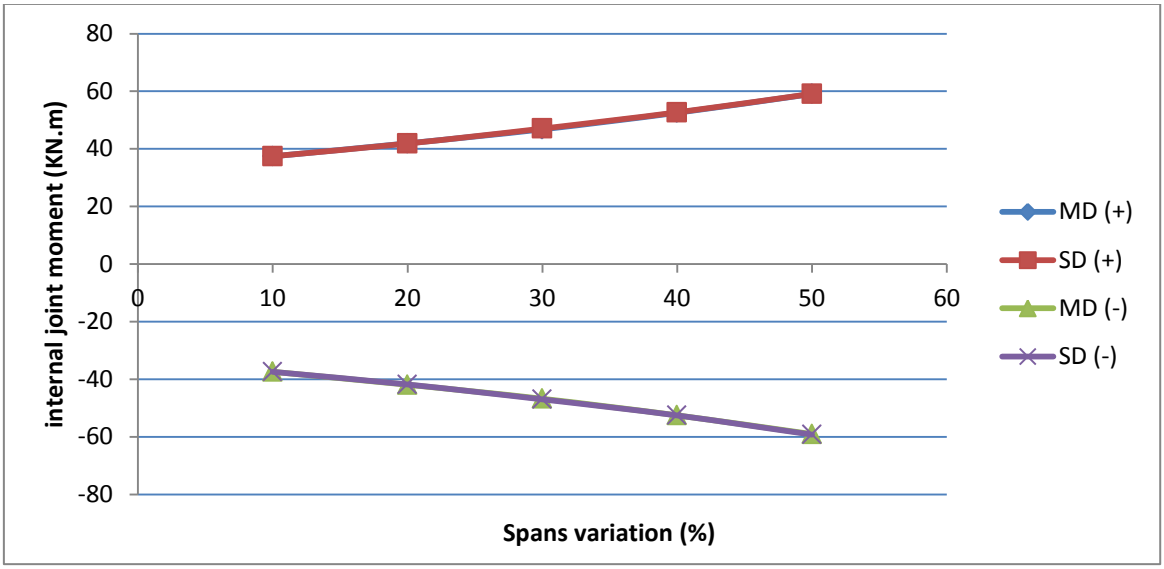


Figure 4: Graph of moments against span variations for the internal joint B

The behaviour of the internal joint moments is presented in figure 4, where MD and SD stand for the Moment Distribution and Slope deflection respectively. Statistical tools are employed to find the relations between the values given by the methods used. The result indicates high correlations between both the positive (+) and negative (-) ends moments. Perhaps the moment distribution method converges faster than the slope distribution method. However, the internal joint moment increases with increasing span variations. In other word as the difference in magnitude between spans of continuous beam (two spans) widens, the joint moment increases' with constant uniformly distribute load as shown in figure 4. Furthermore, a 10% difference between spans of continuous beam as analysed above will result in approximately 25% increase in joint moment under the specified condition above. The relationship between spans length variation with respect to internal joint moment could be define as a linear relationship as clearly shown in figure 4.

Conclusion

Conclusively, moment distribution method and slope deflection method are some of the method use for the analysis of statically indeterminate structures. This paper seeks to find the ease to which method yields faster and determine the level of difference between the results from these methods. It can be said from the simple illustration carried out moment distribution method tend to give faster result than the former. Additionally, the two methods are highly correlated.

References

Cross, H. (1949). Analysis of continuous frame by distributing fixed end moment. *In: numerical methods of analysis in engineering successive correction.* L. B. Grinter ed. New York

Eaton, L. K. (2001). Hardy cross and the moment distribution method. *Nexus Network Journal, vol. 3(3).* Retrieved from www.nexusjournal.com/Eaton.html**.**

Khurmi, R. S. (2005). Strength of materials: Mechanics of solid. New-York: S. Chand and company limited.

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Vascular Plant Diversity of Osmaneli (Bilecik-Turkey).

Onur Koyuncu

Ö. Koray Yaylacı

Derviş Öztürk

Kurtuluş Özgişi

Okan Sezer

Filiz Savaroğlu

İsmühan Potoğlu Erkara

Atila Ocak

Eskişehir Osmangazi University Science and Art Faculty
Biology Department, 26480 Meşelik, Eskişehir-Turkey

Abstract

In this article, the floristical characteristics of Osmaneli are given and the vascular plant species growing there are documented. The Osmaneli district belongs to A2 and A3 squares according to the Davis' grid system relating to the floristic aspect. Approximately 2400 plant samples were collected and identified from the Osmaneli between 2006-2010. After the identification studies, 449 genera and 969 species and subspecies taxa belonging to the 97 families were determined. 142 taxa (14.66%) Mediterranian, 110 taxa (11.35%) Euro-Siberian, 106 taxa (10.94%) Iranian-Turanian are the floristic elements of 969 species and subspecies taxa identified in the research area. The rest 611 taxa (66.8%) are the elements of one or more unknown floristic regions. The first 5 families which contain the most taxa are listed below according to the distribution of taxa relating to the families in the research area. They are Asteraceae and Fabaceae 88 (12.64%) taxa, Brassicaceae 79 (8.15%) taxa, Lamiaceae 68 (7.02%) taxa and Apiaceae 58 (5.99%) taxa. 98 taxa (10.11%) in the reseach area are endemic (3 taxa EN, 2 taxa VU, 4 taxa NT and 92 taxa LC).

Key words: Botany, Diversity, Endemism, Flora, Conservation, Turkey

Introduction

Turkey is one of the richest areas in middle latitudes in terms of vascular plant diversity. The main reasons fort his are; climates varieties, geomorphological and soil diversities, and the situation of the area at the junction of three flora region (Euro-Siberian, Mediterranean and Irano-Turanian). When all these factors are combined, it provides many properties fort he plants to grow up and discrepant. The Flora of Turkey is relatively rich (about 12 000 species) and still a great number of new species are being described (Avcı 2005).

In turkey, the rate of endemism is greater than 30% in Turkey, it is 14,9% (Greece), 2,9% (France), 18,6% (Spain), or 0,1% (Poland) in some other European countries. The number of endemic species in Turkey is greater than 3000. Verbascum and Astragalus are the genus that the rate of endemism is greater. Furthermore, there are endemic plants in genus' level. If these endemic plants are considered, serpentine endemics are relatively important (Avcı 2005).

Osmaneli district is located in the north-east part of Bilecik province (Turkey) which is situated in the Irano-Turanian phytogeographic region. The main part of the study area is located in A2 and the rest in A3 according to the grid system adopted in the Flora of Turkey (Davis, 1965-1985). The Osmaneli area is positioned approximately at the latitudes of 40° 10'- 40° 30' N and the longitudes of 29° 50' - 30° 20' E. The research area is about 30 km in diameter and about 400 ha. (Figure 1). The altitude of the area varies from 80 to 900 m. There are 6 large soil groups in the study area, namely brown forest soils, non-calcareous brown forest soils, colluvial soils, brown soils, organic soils and alluvial soils. The most widespread is the non-calcareous brown forest soil type (TGM 1975). The climate of the area was examined using data from the Meteorology Station in Bilecik (MGM, 2011). The meteorological data were obtained from 1970 to 2011. The main annual precipitation in the area is 378,5 mm, and the precipitation type is W.Sp.A.S. The most arid and hottest months are July (18,5 kg/m^2) and August (11,6 kg/m^2), with an mean temperature of 28.5 ºC. The mean temperature for the year is 11,5 ºC. When the climatic data was used in Emberger's formula of rain and temperature factors (Q: 46,72), it was determined that the research area has a Mediterranean semi-dry climate (Akman, 1990). Forest, shrub, rocky, steppe, hydrophyte (riparian), segetal, ruderal are the main vegetation types in the research area.

There have been no other specific studies related to the flora of the Osmaneli (Bilecik) and its environs. In this study, vascular plant diversity are determination of showing the natural distribution in Osmaneli (Bilecik) and its environs so and will contribute to the all related researches and plant diversity of Turkey.

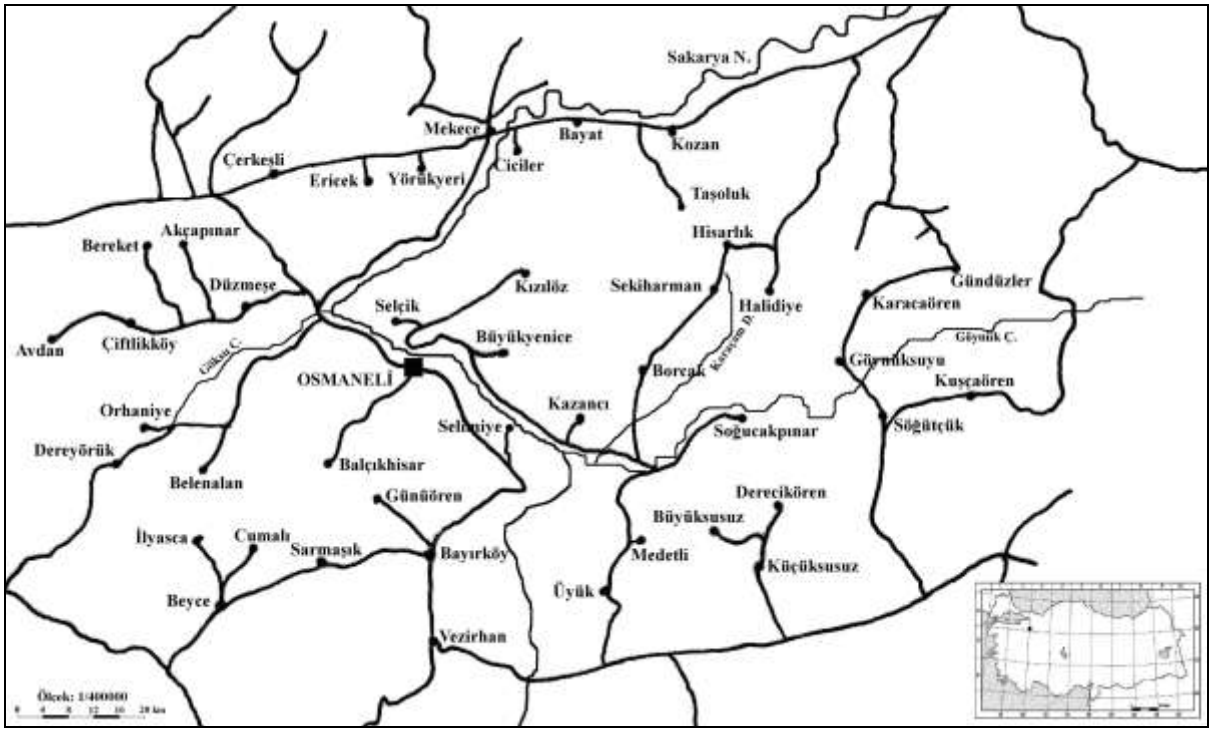


Figure 1. Geographic map of the study area.

Material and Methods

The materials of this study are 2372 vascular plant specimens collected from Osmaneli district (Bilecik) and its environs between 2006 and 2010. The majority of the specimens were identified with the help of the Flora of Turkey and the East Aegean Islands (Davis, 1965-1988; Güner et al., 2000). Some doubtful identifications were checked in Flora Europaea (Tutin et al., 1964-1980), Flora Iranica (Reichinger, 1965-1977), Flora Palestina (Zohary, 1966-1986), Flora of Iraq (Guest and Townsend, 1966-1985), Flora Orientalis (Boissier, 1867-1888). The herbaria of GAZI, ANK and OUFE were used to check the specimens. The plant specimens prepared for herbarium collections have been stored in the Herbarium at OUFE. The data of this study were compared with the results of other studies (Ocak and Tokur 2000; Koyuncu et al. 2012). The floral data are listed in the appendix (excl. Lamiacaeae and Orchidaceae). All taxa in the floristic list are given according to the order in the Flora of Turkey and the East Aegean Islands (Davis, 1965-1985;). In the floristic list, coordinate, collected date, OUFE number, whether the plant is endemic or not, and which phytogeographical region and threatened categories it belongs to are mentioned at the end. Author's abbreviations follow Brummitt and Powell (1992). Threatened categories are proposed for endemic and some nonendemic taxa according to IUCN risk categories (IUCN, 2001; Ekim et al., 2000). The abbreviations used in the text and the floristic list are as follows: Ir.-Tur.: Irano-Turanian; Medit.: Mediterranean; E. Medit. (mt.): East Mediterranean (mountain); Euro-Sib.: Euro-Siberian; En.: Endemic; EN: Endangered; VU: Vulnerable; NT: Near threatened; LC: Least concern; ANK: Ankara University Herbaria; GAZI: Gazi University Herbaria; OUFE: Eskişehir Osmangazi Univeristy Herbaria.

Result and Discussion

In this study, a total of 969 taxa from 97 families and 449 genera were identified. eight of them belonged to Pteridophyta, and the remaining 961 taxa were Spermatophyta, which included 6 taxa from the Gymnospermae and 955 taxa from the Angiospermae.

The Angiospermae also included 832 taxa from the Magnoliopsida and 123 taxa from the Liliopsida. The dispersion of the plant taxa that were defined in the study area according to the large taxonomical groups is shown in Table 1.

After the identification of all taxa, the phytogeographical distributions of 358 taxa were determined and rest of 611 taxa are Multi-regional elements or those of unknown phytogeographic region. The percentage of phytogeographical origins of 358 taxa was 142 (14.66%) Mediterranean, 110 (11.35%) Euro-Siberian, and 106 (10.94%) Irano-Turanian. The rest of the 611 taxa (63.05%) are either multi-area elements or single elements which have not yet been accepted as members of the phytogeographical area (Table 1).

A comparison of phytogeographical distributions and families in terms of the largest number of species found in this study and to previous studies carried out in nearby regions is given in Table 2.

As seen in Table 2, the results of this article were also in agreement with the other similar studies. Differences in several taxa might be derived from the results of dissimilarities in climate, habitat and soil.

The largest families in terms of number of genera are Asteraceae and Fabaceae (88), Brassicaeae (79), Lamiaceae (68), Apiaceae (58), Liliaceae (44), Caryophyllaceae (42), Boraginaceae (38), Poaceae and Scrophulariaceae (30) (Table 2).

The richest genera in terms of the number of taxa are Astragalus L. (20), Alyssum (13), Salvia and Centaurea (12), Allium (11), Euphorbia, Trifolium and Veronica and Silene(9) (Table 2).

Endemism was 10.11% and included 98 endemic taxa (3 taxa EN, 2 taxa VU, 4 taxa NT and 92 taxa LC). The endemism ratio of the study area is very low compared with the average endemism ratio (34.5%) of the Flora of Turkey (Güner et al., 2000). The reasons for the low endemism ratio of the study area may lie uniform habitat and soil structure (Table 2).

A comparison of largest families, richest genera and endemism ratio in nearby regions is given in Table 2. As seen in Table 2, the results of this article were also in agreement with the other similar studies. Differences in several taxa might be derived from the results of dissimilarities in climate, habitat and soil.

In this study, flora of vascular plants were determined of Osmaneli (Bilecik) and its close environs. Thus, it will contribute to the all related researches and plant diversity of Turkey.

Table 1. Floristic properties of the research area.

Taxonomic Groups					**Total**	**Ratio of total taxa in the research area (%)**
	Ferns	**Pteridophyta**				
		Gymno.	**Angiospermae**			
			Dicots	**Monocots**		
Families	4	3	80	10	97	-
Genera	6	3	386	54	449	-
Species and Under Species Taxa	8	6	832	123	969	100
Species	8	6	818	123	955	98,55
Subspecies	-	-	8	-	8	0,83
Varieties	-	-	6	-	6	0,62
Distribution of taxa to Phytogeographic Regions						
Mediterranean (Total)					142	14,66
Mediterranean	-	-	64	17	81	8,36
E. Medit. (mt)	-	-	47	14	61	6,30
Euro-Siberian (Total)					110	11,35
Euro-Siberian	-	-	78	14	92	9,50
Euxine	-	-	12	5	17	1,75
Hyrc.-Euxine			1	-	1	0,10
Irano-Turanian	-	-	97	9	106	10,94
Others	8	6	533	64	611	63,05
Endemism and Risk Categories (IUCN 2001).						
Endemic Taxa	-	-	88	10	98	10,11
EN	-		3	-	3	0,31
VU	-	-	2	-	2	0,21
NT	-	-	4	-	4	0,41
LC	-	-	82	10	92	9,50

Table 2 Comparisons of floristic studies in conducted nearby regions.

	I	II	III
Distribution of large taxonomic groups of taxa			
Families	97	112	74
Genera	449	537	278
Species	955	1141	454
Subspecies	8	8	2
Varieties	6	1	-
Total taxa	969	1150	456
Distribution of taxa to Phytogeographic Regions [Number of taxa and its ratio of research area (%)]			
Euro-Siberian	120-11,35	148-12,86	40-8,77
Mediterranean	142-14,66	109-9,49	77-16,89
Irano-Turanian	106-10,94	65-5,65	48-10,53
Others	611-63,05	828-72,00	291-63,81
Terms of number of taxa included in the large families[Number of taxa and its ratio of research area (%)]			
Asteraceae	88-12,64	124-10,78	52-11,37
Fabaceae	88-12,64	80-6,96	51-11,15
Brassicaceae	79-8,15	57-4,96	34-7,43
Lamiaceae	68-7,02	83-7,22	39-8,33
Apiaceae	58-5,99	52-4,52	16-3,50
Liliaceae	44-4,54	45-3,91	13-2,84
Caryophyllaceae	42-4,33	37-3,22	14-3,07
Boraginaceae	38-3,92	38-3,30	16-3,50
Poaceae	30-3,10	76-6,61	35-7,65
Scrophulariaceae	30-3,10	41-3,57	9-1,96
Diğerleri	407-34,57	517-45	177-39
Terms of number of taxa included in the large genera [Number of taxa and its ratio of research area (%)]			
Astragalus	20-2,06	13-1,13	5-1,10
Alyssum	13-1,34	10-0,87	8-1,75
Salvia	12-1,24	15-1,30	8-1,75
Centaurea	12-1,24	12-1,04	7-1,54
Allium	11-1,14	11-0,96	4-0,87
Euphorbia	9-0,93	16-1,40	7-1,54
Trifolium	9-0,93	15-1,30	7-1,54
Veronica	9-0,93	15-1,30	4-0,87
Silene	9-0,93	10-0,87	3-0,66
Diğerleri	865-89,26	1033-90	407-89
Endemism [Number of taxa and its ratio of research area (%)]			
	98-10,11	72-6,26	35-7,80
Research areas altitude range (m)			
	80-900	50-1482	90-650

I: Present Study, **II**: Vascular Plant Diversity in Geyve (Sakarya-Turkey) and its Environs (Koyuncu et al. 2012, in press), **III:** The Flora of Gülümbe Dağı, Bilecik-Turkey, Ocak and Tokur 2000.

Acknowledgment

This study was financially supported by the Eskişehir Osmangazi University Scientific Research Projects Commission (2006/19005 coded project).

References

Akman, Y. (1990). İklim ve Biyoiklim. Ankara: Palme Yayınları (in Turkish).

Avcı, M. (2005). Çeşitlilik ve Bitki Örtüsü Açısından Türkiye'nin Bitki Örtüsü. Coğrafya Dergisi, 13, 27-55, İstanbul (in Turkish).

Boissier, E. (ed.) (1867-1888). Flora Orientalis. Vols. 1-6, Geneva.

Brummitt, RK. & Powell, CE. (eds) (1992). Authors of Plant Names. Kew: Royal Botanic Gardens.

Davis, P.H. (1965-1985). Flora of Turkey and the East Aegean Island. Vols:1-9. Edinburg: Edinb. Univ. Press.

Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z. & Adıgüzel, N. (2000). Türkiye Bitkileri Kırmızı Kitabı (Pteridophta ve Spermatophyta). Ankara: TTKD ve Van 100. Yıl Üniversitesi (in Turkish).

Guest, E. & Townsend, CC. (1966-85). Flora of Iraq. Vols. 1-9. Ministry of Agriculture and Agrarian Press, Baghdad.

Güner, A., Özhatay N., Ekim T. & Başer KHC. (eds) (2000). Flora of Turkey and the East Aegean Islands. Vol. 11. Edinburgh: Edinburgh.University Press.

IUCN (2001). Red List Categories: Version 3.1. Prepared by the IUCN Species Survival Commission. IUCN, Gland Switzerland and Cambridge, UK: IUCN.

Ocak, A. & Tokur, S. (2000). The Flora of Gülümbe Dağı (Bilecik, Turkey). Turkish Journal of Botany, 24, 2, 121-141.

Koyuncu, O., Yaylacı Ö.K., Öztürk D., Tokur S. (2012). Geyve (Sakarya-Türkiye) ve Çevresinin Damarlı Bitki Çeşitliliği. Biological Diversity and Conservation (in press) (in Turkish).

MGM (2011).http://www.dmi.gov.tr/veridegerlendirme/il-ve-ilceleristatistik.aspx?m=Bilecik.

Rechinger HK. (ed). (1965-77). Flora Iranica. Graz-Austria: Akademische Druck, Verlanglanstalt.

Topraksu Genel Müdürlüğü. (1975). Bilecik İli Toprak Kaynağı Envanter Raporu In Turkey Ankara (in Turkish).

Tutin TG., Heywood VH., Burges NA., Moore DM., Valentine DH., Walters S & Webb BA. (eds) (1964-80). Flora Europaea. Vols. 1-5. Cambridge: Cambridge University Press.

Zohary, M. (1966-1986). Flora Palaestina. Vols. 1-4. Jerusalem: Academic Press, Israel.

APPENDIX

List of Flora

Pteridophyta

Equisetaceae

Equisetum L.

E. ramosissimum DEESF.

N 40° 23'38.0"-E 030°04'05.3", 264m, OUFE: 16477, 01 V 2006.

E. palustre L.

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 16478, 22 V 2008.

Adiantaceae

***Adiatnum* L.**

***A. capillus-veneris* L.**

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 16479, 27 IV 2006.

Hypolepidaceae

Pteridium Scop

P. aquilinum (L.) Kuhn

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 16480,27 III 2006.

Aspleniaceae

Asplenium L.

A. trichomanes L.

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 16481, 08 V 2008.

Cystopteris Bernh**.**

C. fragilis (L.) Bernh

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 16482., 25 VII 2006.

Dryopteris Adans**.**

D. aspidiaceae

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 16483, 10 IV 2008.

***D. filix-mass* (L.)** Schott

N 40°20'53.7"-E 029°58'13.8", 177m, OUFE: 16484, 30 IV 2009.

Spermatophyta

Gymnospermae

Pinaceae

Pinus nigra Arn. subsp. ***nigra*** var. ***caramanica*** (Loudon) Rehder

N 40°18'26.9"-E 030°03'23.0", 108m, OUFE: 13900, 27 III 2006.

P. brutia Tenore

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 13902, 25 VII 2006.

Cupressaceae

Juniperus oxycedrus L.subsp. ***oxycedrus***

N 40°22'33.1"-E 029°50'26.9", 573m, OUFE: 13903, 24 IV 2006.

J. foetidissima Willd

N 40°21'15.3"-E 029°54'06.8", 108m, , OUFE: 13904, 17 IV 2006.

J. excelsa Bieb.

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 13905, 26 V 2006.

EPHEDRACEAE

Ephedra major Host.

N 40°18'36.3"- E 030°03'16.1", 156m, OUFE: 13906, 26 IX 2006.

Angiospermae

Dicotyledonae

Ranunculaceae

Helleborus orientalis Lam.

N 40°21'09.4"-E 029° 55'46.8", 161m, OUFE: 13908, Euxine, 27 III 2006.

Nigella arvensis L. var. ***glauca*** Boiss.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13909, 26 IX 2006.

N. arvensis L. var. ***involucrata*** Boiss.

N 40°18'26.9"-E 030°03'23.0", 108m, OUFE: 13910, 01 V 2006.

Delphinium fissum Waldst&Kit. subsp***. anatolicum*** L.

N 40°26'31.5"-E 030° 03'30.3", 92m, OUFE: 13911, End-LC, 10 IV 2006.

D. peregrinum L.

N 40°19'46.9"- E 030°06'30.1", 117m, OUFE: 13912, 26 V 2006.

D. venulosum Boiss.

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 13913, End- Ir.-Tur. –LC, 01 V 2006.

Consolida thirkeana (Boiss.) Schröd.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 13914, End-LC, 25 VII 2006, 18 V 2006.

C. orientalis (Gay) Schröd.

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 13915, 01 V 2006.

C. regalis S. F. Gray subsp. ***regalis***

N 40°14'35.1"-E 030°06'30.1", 143m, OUFE: 15455,14.XI.2008.

C. regalis S. F. Gray subsp. ***paniculata*** (Host) Soo var. *paniculata*

N 40°17'25.3"-E 030° 03'15.2", 106m, OUFE: 13916, 10 IV 2006.

C. hellespontica (Boiss.) Chater

N 40°24'13.3"-E 030°00'19.8", 96m, OUFE: 13917, 10 IV 2006.

C. raveyi

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15456, End-LC-Ir.-Tur., 23 IV 2009.

Anemone blanda Schott&Kotschy

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 13918, 10 IV 2008.

A. coronaria L.

N 40°20'17.9"-E 030°07'25.9", 185m, OUFE: 13919, Medit., 01 V 2006.

Clematis vitalba L.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 13920, 25 VII 2006.

C. viticella L.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 13921, 10 IV 2006.

C. cirrhosa L.

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 13922, Medit., 01 V 2006.

Adonis annua L.

N 40°14'04.8"-E 030°04'37.4", 123m, OUFE: 15457, Medit., 24 IV 2006.

A. aestivalis L. subsp. ***aestivalis***

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 13923, 10 IV 2006.

A. flammea Jack.

N 40°18'26.9"-E 030°03'23.0", 108m, OUFE: 13924, 01 V 2006.

Ranunculus constantinopolitanus (DC.) d'Urv.

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 13925, 10 IV 2006.

R. damascenus Boiss&Gaill.

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 13926, Ir- Tur., 01 V 2006.

R. illyricus L. subsp. ***illyricus***

N 40° 23'38.0"-E 030°04'05.3", 264m, OUFE: 13927, 01 V 2006.

R. cornutus DC.

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 15458, 15 V 2008.

R. muricatus L.

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 15459, 26 V 2006.

R. arvensis L.

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 15460,01 V 2006.

R. ficaria L. subsp. ***ficariiformis*** Rouy&Fouc.

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 13928, 22 V 2008.

R. trichophyllus Chaix

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 13929, 01 V 2007.

Ceratocephalus falcatus (L.) Pers.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13930, 26 V 2006.

Thalictrum lucidum L**.**

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 13931, 24 VII 2006.

T. minus var. ***minus***

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15461, 30 IV 2009.

PAEONIACEAE

Paeonia peregrina Miller

N 40°17'39.3"-E 029°56'27.6", 784m, OUFE: 13932, 09 V 2007.

BERBERIDACEAE

Berberis crataegina L.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 13933, E. Medit., 10 V 2006.

PAPAVERACEAE

Chelidonium majus L.

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 13934, Euro.-Sib., 26 V 2006.

Glaucium corniculatum (L.) Rud. subsp. ***corniculatum***

N 40°21'38.4"-E 030°13'55.8", 195m, 01 V 2006, OUFE: 13935.

G. grandiflorum Boiss.&Huet var. ***grandiflorum***

N 40°18'48.5"-E 030° 07'14.1", 109m, OUFE: 13936, Ir.-Tur., 12 VI 2008.

G. flavum Crantz

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 13937, 08 V 2008.

Roemeria hybrida (L.) DC: subsp. ***hybrida***

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 13938, 01 V 2007.

Papaver apokrinomenon Fedde

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 13939, End-LC, 08 V 2008.

P. rhoeas L.

N 40°23'19.5"-E 030°14'10.7", 491m, OUFE: 13940, 01 V 2006.

P. dubium L.

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 13941, 01 V 2006.

P. argemone L.

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 13942, 26 V 2006.

P. gracile

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15462, E. Medit., 30 IV 2009.

P. postii

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15463, E. Medit., 03 VII 2009.

Hypecoum procumbens L.

N 40°27'07.5"-E 030° 08'35.0", 87m, OUFE: 13943, Medit., 10 IV 2006.

H. imberbe Sm.

N 40°25'53.5"-E 029° 56'44.8", 381m, OUFE: 13944, 18 V 2006.

Corydalis solida (L.) Swartz subsp. ***solida***

N 40°25'00.6"-E 029°54'57.1", 452m, , OUFE: 13945, 18 V 2006.

Fumaria kralikii Jordan

N 40°23'05.5"-E 029°56'09.9", 204m, OUFE: 13946, Medit., 09 V 2007.

F. officinalis L.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13947, 26 V 2006.

BRASSICACEAE

Brassica elongata Ehrh.

N 40° 22'15.2"-E 029°58'22.8", 147m, , OUFE: 13948, 27 III 2006.

Sinapis arvensis L.

N 40°17'39.3"-E 029°56'27.6", 784m, OUFE: 13949, 09 V 2007.

Hirschfeldia incana (L.) Lag.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 13950, 01 V 2007.

Diplotaxis tenuifolia (L.) DC.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13951, 10 IV 2006.

Eruca sativa Miller

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 13952, 18 V 2006.

Raphanus raphanistrum L.

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 13953, 27 IV 2006.

R. sativus var. ***sativus***

N 40°21'51.3"-E 029°57'06.9", 114m, OUFE: 16485, 03 VI 2009.

Calepina irregularis (Asso) Thellung

N 40°24'58.7"-E 030°01'51.5", 93m, OUFE: 13954, 01 V 2007.

Crambe tataria Sebeök var. ***orientalis***

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13955, 01 V 2006.

C. orientalis L. var. ***orientalis***

N 40°18'35.8"-E 029°53'54.4", 756m, OUFE: 13956, Ir.-Tur., 09 V 2007.

Rapistrum rugosum (L.) All.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 13957, 10 VI 2008.

Conringia orientalis (L.) Andrz.

N 40°25'00.6"-E 029°54'57.1", 452m, OUFE: 13958, 18 V 2006.

C. perfoliata (C.A. Meyer) Busch

N 40°18'22.5"-E 030°06'36.4", 168, OUFE: 15464, 06 VIII 2009.

Lepidium perfoliatum L.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 13959, 18 V 2006.

L. latifolium L.

N 40°25'13.5"-E 030° 01'25.2", 160m, OUFE: 13960, 10 V 2006.

L. sativum L. subsp. ***sativum***

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 13961, 25 VII 2006.

Cardaria draba (L.) Desv subsp. ***draba***

N 40°25'53.5"-E 029°56'44.8", 381m, OUFE: 13962, 18 V 2006.

Isatis glauca Aucher ex Boiss. subsp. ***glauca***

N 40°25'00.6"-E 029°54'57.1", 452m, OUFE: 13963, Ir.-Tur., 18 V 2006.

I. floribunda Boiss.

N 40°20'42.4"-E 030°03'58.0", 156m, OUFE: 13964, End- LC- Ir.-Tur., 26 V 2006.

Iberis taurica DC.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 13965, E. Medit., 10 IV 2008.

I. spruneri Jord.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 13966, 18 V 2006.

Aethionema arabicum (L.) Andr

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 13967, 08 V 2008.

Thlaspi arvense L.

N 40°18'26.9"-E 030°03'23.0", 108m, OUFE: 13968, 01 V 2006.

T. perfoliatum L.

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 13969, 10 IV 2008.

T. jaubertii Hedge

N 40°21'18.5"-E 029°54'45.0", 117m, OUFE: 15465, End-LC,15 IV 2009.

Hymenolobus procumbens (L.) Nutt. ex Torrey&Gray

N 40°20'58.0"-E 030°00'03.1", 363m, OUFE: 15466, 04 IV 2007.

Hutchinsia petraea (L.) R. Br.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 15467,10 IV 2006.

Capsella bursa-pastoris (L.) Medik.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 13970, 10 IV 2006.

Boreava orientalis Jaub&Spach

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 13971, 01 V 2006.

Neslia apiculata Fisch., Mey.&Ave-Lall.

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 13972, 26 V 2006.

Fibigia clypeata (L.) Medik.

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 13973, 18 V 2006.

Aurinia saxatilis (L.) Desv. subsp. ***orientalis*** (Ard.) Dudley

N 40°20'53.7"-E 029°58'13.8", 177m, OUFE: 15468, 30 IV 2009.

Alyssum linifolium Steph ex Willd. var. ***linifolium*** Steph ex Willd.

N 40°21'52.9"-E 030°03'36.2", 177m, OUFE: 15469, 04 IV 2007.

A. dasycarpum Steph

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 13974, 27 III 2006.

A. desertorum Stapf. var. ***desertorum***

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 13975, 01 V 2006.

A. minutum Schlecht. Ex DC.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 13976, 10 IV 2008.

A. smyrnaeum Meyer

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 16486, E. Medit., 10 IV 2006.

A. minus (L.) Rothm. var. ***minus***

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 16487, 08 V 2008.

A. minus (L.) Rothm var. ***micranthum*** (Meyer) Dudley

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 13977, 01 V 2006.

A. strigosum Banks&Sol. subsp. ***strigosum***

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13978, 01 V 2006.

A. pateri Nyar. subsp. ***pateri***

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 15472, End-LC-Ir.-Tur., 22 V 2008.

A. borzaeanum Nyar.

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 15473,26 V 2006.

A. sibiricum Willd.

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 16488, 08 V 2008.

A. murale Waldst&Kit var. ***murale*** Waldst&Kit

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 13979, 25 VII 2006.

A. floribindum

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15474, 23 IV 2009.

Clypeola jonthlaspi L.

N 40°27'07.5"-E 030° 08'35.0", 87m, OUFE: 13980, 26 V 2006.

Draba bruniifolia Stev. subsp. ***olympica*** (Sibth. ex DC.) Coode&Cullen

N 40°17'39.3"-E 029°56'27.6", 784m, OUFE: 13981, 09 V 2007.

Erophila verna (L.) Chevall subsp. ***verna***

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 13982, 10 IV 2006.

E. verna (L.) Chevall subsp. ***praecox*** (Stev.)

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 13982, 27 III 2006

Arabis caucasica Willd. subsp. ***caucasica***

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 13983, 26 V 2006.

A. sagittata (Bertol.) DC.

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 15476, 08 V 2008.

A. nova Will.

N 40°17'25.7"-E 030° 07'15.7", 266m, OUFE: 13984, 10 IV 2006.

Turritis glabra L.

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 13985, 26 V 2006.

Nasturtium officinale R. Br.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 13986, 09 V 2007.

Rorippa sylvestre (L.) Bess.

N 40°20'42.4"-E 030°03'58.0", 156m, OUFE: 13987, 25 VII 2006.

Barbarea vulgaris R. Br.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 13988, 01 V 2007.

Cardamine bulbifera (L.) Crantz.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 13989, Euro.-Sib., 09 V 2007.

C. uliginosa Bieb.

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 15477,27 III 2006.

C. impatiens L. var. ***pectinata*** (Pallas) Trautv.

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 15478, Euro.-Sib., 25 VII 2006.

C. hirsuta L.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 13990, 26 VII 2006.

Aubrieta deltoidea (L.) DC.

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 13991, 10 IV 2008.

A. canescens (Boiss.) Bornm. subsp. ***canescens***

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 15479, End- LC, 08 V 2008.

Chorispora syriaca Boiss.

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 13992, Ir.-Tur., 26 V 2006.

Matthiola longipetale (Vent) DC. subsp. ***bicornis*** (Sibth&Smith) P. W. Ball

N 40°17'25.7"-E 030°07'15.7", 266m, OUFE: 13993, 10 IV 2006.

Hesperis pendula DC.

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 13994, 26 V 2006.

H. kotschyii Boiss.

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 15480, End- LC-Ir.-Tur. El., 03 VII 2009.

Malcolmia africana (L.) R. Br.

N 40°24'58.7"-E 030° 01'51.5", 93m, OUFE: 13995, 01 V 2007.

Erysimum lycaonicum (Hand.-Mazz.) Hub.-Mor.

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 13996, 08 V 2008.

E. crassipes Fisch.&Mey.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 13997, 09 V 2007.

E. repandum L.

N 40° 21'49.8"-E 029°57'03.8", 107m, OUFE: 13998, 10 IV 2008.

Alliaria petiolota (Bieb.) Cavara&Grande

N 40° 21'18.5"-E 029°54'45.0", 117m, OUFE: 15481, 15 IV 2009.

Sisymbrium officinale (L.) Scop

N 40° 14'48.1"-E 030° 01'48.4", 147m, OUFE: 13999, 22 V 2008.

S. altissimum L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14000, 10 IV 2006.

S. orientale L.

N 40°23'05.5"-E 029°56'09.9", 204m, OUFE: 14001, 09 V 2007.

S. loeselii L.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14002, 27 III 2006.

Arabidopsis thaliana (L.) Heynhold

N40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14003, 01 V 2007.

Camelina rumelica Vel.

N 40°24' 58.7"-E 030°01' 1.5", 93m, OUFE: 14004, 01 V 2007.

C. microcarpa

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 15482,30 IV 2009.

Descurainia sophia (L.) Webb

N40°22'15.2"-E 029°58'22.8" , 147m, OUFE: 14005, 27 III 2006.

CAPPARACEAE

Capparis ovata Desf. var. ***canescens*** (Coss.) Heywood

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 14006, 01 V 2006.

RESEDACEAE

Reseda inodora Reichb. var. ***anatolica*** Boiss.

N 40° 24'36.5"-E 030° 01'34.5", 100m, OUFE: 14007, 26 V 2006.

R. lutea L. var. ***lutea***

N 40°15'33.8"-E 030° 05'06.2", 101m, OUFE: 14008, 01 V 2006.

R. luteola L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14009., 25 VII 2006.

CISTACEAE

Cistus creticus L.

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 14010, Medit., 26 V 2006.

C. laurifolius L.

N 40°17'39.3"-E 029°56'27.6", 784m, OUFE: 14011, Medit., 09 V 2007.

Helianthemum nummularium (L.) Miller subsp. ***nummularium***

N 40°18'24.3"-E 030° 07'18.0", 242m, OUFE: 14012, 22 V 2008.

H. nummularium (L.) Miller subsp. ***lycaonicum*** Coode&Cullen

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 14013, End-LC, 26 V 2006.

H. canum (L.) Baumg.

N 40° 17'25.7"-E 030° 07'15.7", 266m, OUFE: 14014, 10 IV 2006.

H. salicifolium (L.) Miller

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14015., 22 V 2008.

Fumana Spach

F. arabica (L.) Spach var. ***arabica***

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14016, 22 V 2008.

F. procumbens (Dun.) Gren&Godr.

N 40° 17'39.3"-E 029°56'27.6", 784m, OUFE: 14017, 09 V 2007.

F. paphlagonicum Bornm.&Janchen

N 40° 22'15.2"-E 029° 57'21.7", 147m, OUFE: 14018, End-LC, Ir.-Tur., 27 III 2006.

F. thymifolia (L.) Verlot var. ***viridis*** (Ten) Boiss.

N 40°16'40.6"-E 030°11'19.4", 589m, OUFE: 14019, 21 III 2007.

VIOLACEAE

Viola odorata L.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14020, 01 V 2006.

V. suavis Bieb.

N 40°20'58.0"-E 030°00'03.1", 363m, OUFE: 15483,04 IV 2007.

V. alba Besser

N 40°21'18.5"-E 029°54'45.0", 117m, OUFE: 15484, 15 IV 2009.

V. sieheana Becker

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 16489, 17 IV 2006.

V. occulta Lehm.

N 40°17'25.7"-E 030° 07'15.7", 266m, OUFE: 14011, 01 V 2006.

V. kitaibeliana Roem.&Schult.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14022, 26 V 2006.

POLYGALACEAE

Polygala supina Schrep.

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14023, 25 VII 2006.

P. pruinosa Boiss. subsp. ***pruinosa***

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 14024, 10 IV 2008.

P. anatolica Boiss.&Heldr.

N 40°25'15.3"-E 030°08'52.9", 517m, OUFE: 14025, 26 IX 2006.

P. vulgaris L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14026, 26 V 2006.

PORTULACACEAE

Portulaca oleraceae L.

N 40°18'48.5"-E 030° 07'14.1", 109m, OUFE: 14027, 16 X 2008.

CARYOPHYLLACEAE

Arenaria rotundufolia subsp. ***rotundufolia***

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14028, 15 VIII 2008.

A. serpyllifolia L.

N 40°27'07.5"-E 030° 08'35.0", 87m, OUFE: 14029, 26 V 2006.

A. leptoclados (Reichb.) Guss

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 14030, 10 IV 2008.

Minuartia hirsuta (Bieb.) Handz.-Mazz. subsp. ***falcata*** (Gris.) Mattf.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14031, 09 V 2007.

M. juniperina (L.) Marie et Petitm.

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14032, 08 V 2008.

M. hamata (Hausskn.) Mattf.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14033, 01 V 2007.

M. anatolica (Boiss.) Woron var. ***polimorpha*** McNeill

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14034, End-LC, 22 V 2008.

M. mesoginata (Boiss.) Handz.-Mazz. subsp. ***mesoginata***

N 40°24'58.7"-E 030°01'51.5", 93m, OUFE: 14035, 01 V 2007.

M. mesoginata(Boiss.) Handz.-Mazz. subsp***. kotschyana*** (Boiss.) McNeill

N 40°23'05.5"-E 029°56'09.9", 204m, OUFE: 14036, 09 V 2007.

M. urumiensis (Bornm.) Bornm.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14037, 26 V 2006.

Stellaria media (L.) Vill. subsp. ***media***

N 40°20'42.4"-E 030°03'58.0", 156m, OUFE: 14038, 26 V 2006.

S. media (L.) Vill. subsp. ***pallida*** (Dumort.) Aschers.&Graebn.

N 40°14'43.4"-E 029°58'44.6", 361m, OUFE: 15485, 02 IV 2009.

S. holostea L.

N 40°18'58.2"-E 029°51'26.1", 215m, OUFE: 14039, 26 V 2006.

Cerastium perfoliatum L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14041, 01 V 2006.

C. banaticum (Roch.) Heuffel

N 40°20"42.1"-E 029°52'50.1", 174m, OUFE: 14040, 15 VIII 2008.

Holosteum umbellatum L. var. ***umbellatum***

N 40°15'33.8"-E 030°05'06.2", 101m, OUFE: 14042, 01 V 2006.

H. umbellatum L. var. ***glutinosum***

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14043, 10 IV 2008.

Moenchia mantica (L.) Bartl. subsp. ***mantica***

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14044, 10 IV 2006.

Telephium imperati L. subsp. ***orientale*** (Boiss.) Nyman

N 40°23'42.5"-E 030°15'26.3", 688m, OUFE: 14045, 01 V 2006.

Dianthus micranthus Boiss.&Heldr

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14046, 22 V 2008.

D. leucophaeus (Sibth.&Sm. var. ***leucophaeus***

N 40°20'52.3"-E 030° 05'56.4", 290m, OUFE: 14047, 25 VII 2006.

D. crinitus Sm. var. ***crinitus***

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14048, 15 VIII 2008.

D. zonatus Fenzl. var. ***zonatus***

N 40°19'07.5"-E 029°54'14.3", 613m, OUFE: 14049, 25 VII 2006.

D. calocephalus Boiss.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14050, 15 VIII 2008.

D. lydius Boiss.

N 40°20'42.4"-E 030°03'58.0", 156m, OUFE: 14051, End-LC, 26 V 2006.

D. cibrarius

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 15486, 03 VII 2009.

Saponaria glutinosa Bieb.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 15487,17 IV 2006.

S. mesoginata Boiss.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 15488, E. Medit., 17 IV 2006.

S. kotschyi Boiss.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14052, End- LC, 26 V 2006.

Gypsophila pilosa Hudson

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14053, Ir.-Tur., 25 VII 2006.

Vaccaria pyramidata Medik. var. ***grandiflora*** (Fisch. ex DC.) Cullen

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14054, 26 V 2006.

Silene italica (L.) Pers.

N 40° 16'06.6"-E030°06'39.2", 167m, OUFE: 14055, 24 IV 2006.

S. vulgaris (Moench) Garcke subsp. ***vulgaris***

N 40°17'25.7"-E 030°07'15.7", 266m, OUFE: 14056, 01 V 2006.

S. compacta Fischer

N 40°19'07.5"-E 029°54'14.3", 613m, OUFE: 14057, 25 VII 2006.

S. alba (Miller) subsp. ***divaricata*** (Reichb.)

N 40°26'19.5"-E 030°00'36.4", 294m, 21 VII 2008.

S. subconica L.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14058, 26 V 2006.

S. supina subsp. ***pruinosa***

N 40°23'21.1"-E 030°09'57.8", 515m, OUFE: 15490, 06 VIII 2009.

S.otites

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 15663, 03 VII 2009

S. lydia

N 40°21'51.3"-E 029°57'06.9", 114m, OUFE: 15491, E. Medit., 03 VI 2009.

S. conoidea

N 40°17'31.9"-E 029°53'44.9", 449m, OUFE: 15492, 29 X 2009.

Velezia rigida

N 40°18'22.5"-E 030°06'36.4", 168m, OUFE: 15493, 06 VIII 2009.

Agrostemma githago L.

N 40°23'19.5"-E 030°14'10.7", 491m, OUFE: 14059, 01 V 2006.

ILLECEBRACEAE

Herniaria incana Lam.

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14060, 15 V 2008.

Paronychia kurdica Boiss. subsp. ***kurdica*** var. ***kurdica***

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14061, 01 V 2006.

P. carica Chaudhri

N 40°14'45.0"-E 030°00'04.5", 307m, OUFE: 15494, End, 29 X 2009.

Scleranthus annuus L. subsp. ***annuus***

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15496, 06 VIII 2009.

POLYGONACEAE

Polygonum bistorta L. subsp. ***bistorta***

N 40°20'44.6"-E 030°12'23.7", 186m, , OUFE: 14062, Euro.-Sib. ,01 V 2006.

P. lapathifolium L.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14063, 15 VIII 2008.

P. cognatum Meissn

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 14064, 10 V 2006.

P. bellardii All.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14065, 24 VII 2006.

Rumex acetocella L.

N 40°14'37.8"-E 029°59'35.8", 378m, OUFE: 14066, 15 V 2008.

R. tuberosus L. subsp. ***tuberosus***

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14067, 08 V 2008.

R. crispus L.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 14068, 25 VII 2006.

R. pulcher L.

N 40°24'58.7"-E 030°01'51.5", 93m, OUFE: 14069, 01 V 2007.

CHENOPODIACEAE

Beta triginia Walds et Kit

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15497, 06 VIII 2009.

Chenopodium botrys L.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14070, 10 V 2006.

C. foliosum (Moench) Aschers.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14071, 16 X 2008.

C. album L.subsp. ***album*** var. ***album***

N 40°20'42.4"-E 030°03'58.0", 156m, OUFE: 14072, 26 V 2006.

Atriplex. hortensis L.

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15498,03 VI 2009.

A. lasiantha Boiss.

N 39°40'47.8"-E 029°56'51.4", 539, OUFE: 15499, 03 VII 2009.

AMARANTHACEAE

Amaranthus retroflexus L.

N 40°21'54.8"-E 030°14'03.4", 218m, OUFE: 14073, 01 V 2006.

A. lasiantha Boiss.

N 39°40'47,8"- E 029°56'51,4", 539m, OUFE:15499, 03 VII 2009.

A. blitoides

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15500, 30 IV 2009.

PHYTOLACCACEAE

Phytolacca americana L.

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 14074, 10 V 2006.

TAMARICACEAE

Tamarix smyrnensis Bunge

N 40°20'49.9"-E 030°17'50.4", 621m, OUFE: 14075, 24 IV 2006.

Reaumuria alternifolia

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15501, Ir.-Tur., 23 IV 2009.

HYPERICACEAE

Hypericum atomarium Boiss.

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 15502, E. Medit., 24 IV 2006.

H. perfoliatum L.

N 40°21'15.3"-E 029°54'06.8", 108m, OUFE: 15503, Medit., 18 V 2006.

H. montbretii Spach

N 40°20'40.7"-E 030°04'19.2", 170m, OUFE: 14076, 01 V 2007.

H. origanifolium Willd.

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14077, 15 V 2008.

H. aviculariifolium Jaub.&Spach subsp. ***depilatum*** (Freyn&Bornm.) Robson var. ***depilatum***

N40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14078, End-LC-Ir.-Tur., 10 V 2006.

H. avicularifolium Jaub.&Spach subsp. ***byzantium*** (Azn.)

N 40°22'29.5"-E 029°58'24.5", 108m, , End-LC-E. Medit, 01 V 2006.

H. perforatum L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14079, 26 V 2006.

MALVACEAE

Hibiscus trionum L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14080, 18 V 2006.

Malva sylvestris L.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14081, 16 X 2008.

M. neglecta Wallr.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14082, 15 VIII 2008.

Lavatera. huringiaca

N 40°17'31.9"-E 029°53'44.9", 449m, OUFE: 15505, 29 X 2009.

Alcea apterocarpa (Fenzl) Boiss.

N 40°20'49.9"-E 030°17'50.4", 621m, OUFE: 14083, End-LC, 25 VII 2006.

A. rosea L.

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14084, 18 V 2006.

A.pallida Waldst.&Kit.

N 40°20'14.5"-E 030°05'42.9", 197m, OUFE: 14085, 16 X 2008.

Althaea cannabina L.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 14086, 25 VII 2006.

A. officinalis L.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14087, 25 VII 2006.

A. hirsuta L.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 15506, 26 V 2006.

TILIACEAE

Tilia rubra DC. subsp. ***caucasica*** (Rupr.) V. Engler

N 40°19'07.5"-E 029°54'14.3", 613m, OUFE: 14088, Euxine,25 VII 2006.

LINACEAE

Linum nodiflorum L.

N 40°23'10.4"-E 029°56'46.4", 128m, OUFE: 15507, Medit., 15 V 2007.

L. hirsutum L. subsp. ***anatolicum*** (Boiss.) Hayek var. ***anatolicum***

N 40°17'26.7"-E 029° 55'59.2", 753m, OUFE: 14089, End- LC-Ir.-Tur , 15 V 2008.

L. bienne Miller

N 40°19'62.7"-E 029°53'57.5", 713m, OUFE: 14090, Medit., 27 III 2006.

L. corymbulosum L.

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15508, Medit., 06 VIII 2009.

L. cariense

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 15509, End-LC-Ir-Tur., 03 VII 2009.

GERANIACEAE

Geranium lucidium L.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14091, 10 IV 2006.

G. tuberosum L. subsp. ***tuberosum.***

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14092, 10 IV 2008.

G. sylvaticum L.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14093, Euro.-Sib, 26 V 2006.

G. pupureum

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15510, 30 IV 2009.

G. asphodeloides subsp. ***asphodeloides***

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15511, Euro.-Sib., 03 VI 2009.

Erodium ciconium (L.) L'Hérit.

N 40°14'37.8"'-E 029°59'35.8", 378m, OUFE: 14094, 15 V 2008.

E. cicutarium (L.) L'Hérit. subsp. ***cicutarium***

N 40°20'49.9"-E 030°17'50.4", 621m, 24 IV 2006, OUFE: 14095.

E. sibthorpianum Boiss. subsp***. sibthorpianum***

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 15512, End-EN., 30 IV 2009.

ZYGOPHYLLACEAE

Tribulus. terrestris

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15513, 30 IV 2009.

Peganum harmala L.

N40°20'42.4"-E 030° 03" 58.0", 156m, , OUFE: 14096,25 VII 2006.

RUTACEAE

Ruta montana (L.) L.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14097, 15 VIII 2008.

Haplophyllum thesioides (Fisch. Ex DC.) G. Don

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14098, 26 V 2006.

SIMAROUBACEAE

Ailanthus altissima (Miller) Swingle

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14099, 25 VII 2006.

ACERACEAE

Acer platanoides L.

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14100, Euro.-Sib., 26 V 2006.

A. campestre L. subsp. ***campestre***

N 40°20'49.9"-E 030°17'50.4", 621m, OUFE: 14101, Euro.-Sib., 25 VII 2006.

RHAMNACEAE

Paliurus spina-christi Miller

N 40°20'31.5"-E 029°51'39.1", 422m, OUFE: 14102, 17 IV 2006.

Frangula

F. alnus subsp. ***alnus***

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15514, Euro.-Sib., 03 VII 2009.

Rhamnus thymifolius Bornm.

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15515, 06 VIII 2009.

ANACARDIACEAE

Rhus coriaria L.

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15516,30 IV 2009.

Pistacia terebinthus L. subsp. ***palaestina*** (Boiss.) Engler

N 40°19'41.9"-E 029°51'35.7", 335m, OUFE: 14103,Medit., 17 X 2006.

CELASTRACEAE

Euonymus verrucosus Scop.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14104, 18 V 2006.

FABACEAE

Cercis siliquastrum L.

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15517, 23 IV 2009.

Chamaecytisus hirsutus (L.) Link

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14105,01 V 2006.

C. austriacus

N 40°15'11.4"-E 029°59'41.3", 362m, OUFE: 15518, Euro.-Sib. 30 IV 2009.

Genista tinctoria L.

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14106, Euro.-Sib., 11 IV 2007.

G. lydia Boiss. var. ***lydia***

N 40°22'10.5"-E 029°49'25.2", 337m, OUFE: 14107, Medit., 10 IV 2006.

G. albida Willd.

N 40°14'37.8"-E 029°59'35.8", 378m, OUFE: 14108, 15 V 2008.

G. aucherii Boiss.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14109, End-LC-Ir.-Tur., 10 IV 2006.

G. sessilifolia

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15519, Ir.-Tur., 03 VI 2009.

G. januensis

N 40°21'51.3"-E 029°57'06.9", 114m, OUFE: 16490, 03 VI 2009.

Spartium junceum L.

N 40°13'51.5"-E 030°04'35.7", 115m, OUFE: 15520, Medit., 14.11.2008.

Lotononis genistoides (Fenzl.) Benth.

N 40°16'14.4"-E 030° 07'00.9", 202m, OUFE: 14110, Ir.-Tur., 15 VIII 2008.

Lupinus angustifolius L. subsp. ***angustifolius***

N 40°20'40.7"-E 030° 04'19.2", 170m, OUFE: 14111. 01 V 2007.

Galega officinalis L.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14112, Euro.-Sib., 15 VIII 2008.

Colutea cilicica Boiss.&Bal.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14113, 10 IV 2006.

Astragalus glycyphyllos L. subsp. ***glycyphyllos***

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 14115, Euro.-Sib., 25 VII 2006.

A. angustiflorus C. Koch subsp. ***anatolicus*** (Boiss.) Chamberlain

N 40°14'37.8"-E 029°59'35.8", 378m, OUFE: 14116, End-LC-E. Medit., 15 V 2008.

A. angustifolius subsp. ***pungens***

N 40°17'31.9"-E 029°53'44.9", 449m, OUFE: 15527, 29 X 2009.

A. microcephalus Willd.

N 40°16'39.8"-E 029° 57'51.4", 480m, OUFE: 14117, Ir.-Tur., 25 VII 2006.

A. sterocalyx Bornm.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14118, End-LC-Ir.-Tur., 26 V 2006.

A. ponticus Pall.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14119, 26 VII 2006.

A. macrocephalus Willd. subsp. ***macrocephalus***

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14114, End-LC-Ir.-Tur., 15 VIII 2008.

A. cadmicus Boiss.

N 40°20'40.7"-E 030°04'19.2", 170m, OUFE: 14120, End-LC,01 V 2007.

A. campylosema subsp. ***campylosema***

N 40°21'18.5"-E 029°54'45.0", 117m, OUFE: 15521, End-LC-Ir.-Tur., 15 IV 2009.

A. vulnerariae DC.

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 14121, End-LC, 01 V 2006.

A. densifolius subsp. ***densifolius***

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15522, End-LC-Ir.-Tur., 03 VII 2009.

A. melanophrurius

N 40°21' 07.4"-E 029°59'55.2", 386m, OUFE: 15523, End-LC-Ir.-Tur., 23 IV 2009.

A. micropterus

N 40°20'53.7"-E 02958'13.7", 568m, OUFE: 15524, End-LC-Ir.-Tur., 30 IV 2009.

A. mesoginatus

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15525, End-LC., 03 VI 2009.

A. hirsutus

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 15526, End-LC, 03 VII 2009.

A. glycyphylos subsp. ***glycyphylos***

N 40°13'39.2"-E 029°57'18.7", 331m, 29 X 2009.

A. lydius

N 40°13'39.2"-E 029°57'18.7", 331m, OUFE: 15528, End-LC-Ir.-Tur., 29 X 2009.

A. ornithopodioides

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15529, 03 VII 2009.

A. parnassi subsp. ***parnassi***

N 40°24'22.8"-E 030°10'22.7", 615m, OUFE: 15530, E. Medit. 06 VIII 2009.

A. zederbaueri

N 40°19'06.7"-E 030°07'36.9", 123m, OUFE: 15531, End-LC-Ir.-Tur., 06 VIII 2009.

Psoralea bituminosa L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14122, Medit., 25 VII 2006.

Cicer anatolicum Alef.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14123, Ir.-Tur., 15 VIII 2008.

Vicia cracca L. subsp. ***stenophylla*** Vel

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14124, 10 IV 2006.

V. peregrina L.

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 14125, 08 V 2008.

V. grandiflora Scop. var. ***grandiflora***

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14126, 22 V 2008.

V. sativa L. subsp. ***sativa***

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 14127. 27 III 2006.

V. narbonense L. var. ***narbonense***

N 40°20'40.7"-E 030°04'19.2", 170m, OUFE: 14128, 01 V 2007.

V. faba L.

N 40°14'37.8"-E 029°59'35.8", 378m, OUFE: 14129. 15 V 2008.

V. pannonica var. ***purpurescens***

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15532, 06 VIII 2009.

Lathyrus aureus (Stev.) Brandza

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14130, Euxine, 22 V 2008.

L. digitatus **(**Bieb.) Fiori

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14131, E. Medit., 26 V 2006.

L. pratensis L.

N 40°22'15.2"-E 029°57'21.7", 147m, , OUFE: 14132, Euro.-Sib., 27 III 2006.

L. laxiflorus (Desf.) O. Kuntze ***laxiflorus***

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14133, 01 V 2006.

L. cicera L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14134, 26 V 2006.

Pisum sativum L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14135, 10 V 2006.

Ononis spinosa L. subsp. ***leiosperma*** (Boiss.) Sirj.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14136, 21 VII 2008.

O. pusilla L.

N 40°22'33.7"-E 029°54'59", 151m, OUFE: 14137, Medit., 01 V 2006.

Trifolium repens L. var. ***repens***

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14138, 15 VIII 2008.

T. hybridum L. var. ***hybridum***

N 40°22'33.1"-E 029°50'26.9", 573m, OUFE: 14139, 15 VIII 2008.

T. campestre Schreber

N 40°23'38.0"-E 030°04'05.3", 264m, OUFE: 14140, 10 IV 2006.

T. pratense L. var. ***pratense***

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 14141, 27 III 2006.

T. arvense L. var. ***arvense***

N 40°14'04.8"-E 030°04'37.4", 123m, OUFE: 14142, 24 IV 2006.

T. angustifolium L. var. ***angustifolium***

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14143, 01 V 2007.

T. purpureum Lois. var. ***purpureum***

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14144. 27 III 2006.

T. ochroleucum

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15533, 03 VI 2009.

T. medium var. ***medium***

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15534, 03 VII 2009.

Melilotus officinalis (L.) Desr.

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14145, 12 VII 2008.

M. alba (L.) Desr.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14146, 21 VII 2008.

Trigonella cretica (L.) Boiss.

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 14147, End-NT-E. Medit., 08 V 2008.

T. lunata Boiss.

N 40°20'10.1"-E 030° 05'37.7", 208m, OUFE: 14148, Ir.-Tur., 01 V 2007.

T. spruneriana Boiss. var. ***spruneriana***

N 40°18'08.8"-E 030°06'11.9", 185m, OUFE: 14149., 01 V 2006.

T. tenuis Fisch.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14150, Ir.-Tur., 09 VI 2008.

T. aurantiaca

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 16491, 03 VII 2009.

T. rhytilocarpa Boiss. et Bal.

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15535, End-NT- Ir.-Tur., 06 VIII 2009.

Medicago orbicularis (L.) Bart.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 15536, 24 IV 2006.

M. lupulina L.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14151, 01 V 2006.

M. sativa L. subsp. ***sativa***

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14152, 10 IV 2006.

M. minima (L.) Bart. var. ***minima***

N 40°24'23.4"-E 030°10'23.9", 640m, OUFE: 14153, 26 IX 2006.

M. rigidula (L.) All. var. ***rigidula***

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14154, 08 V 2008.

Dorycnium graecum (L.) Ser.

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14155, Euxine, 25 VII 2006

Lotus corniculatus L. var. ***corniculatus***

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14156, 25 VII 2006.

L. aegaeus (Gris.) Boiss.

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14157, Ir.-Tur., 22 V 2008.

Tetragonolobus maritimus (L.) Roth

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14158, 09 VI 2008.

Coronilla scorpoides (L.) Koch.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14159, 27 III 2006.

C. varia L. subsp. ***varia***

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 14160, 01 V 2006.

Hippocrepis unisiliquosa L.subsp. ***unisiliquosa***

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 15537, 08 V 2008.

Hedysarum varium Willd.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14161, 24 VI 2008.

Onobrychis oxyodonta Boiss.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14162, 26 V 2006.

O. sativa L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14163, 24 IV 2006.

O. aequidentata (Sibht. etSm.)

N 40°21'40.3"-E 030°01'11.3", 95m, Medit., 06 VIII 2009.

O. armena

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15539, End-LC, 03 VII 2009.

O. argyrea subsp. ***argyrea***

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15540, End-LR-Ir.-Tur. 03 VI 2009.

O. hypargyrea Boiss

N 40°22'11.2"-E 029°54'419.9, 672m, OUFE: 15541, 03 VI 2009.

Ebenus hirsuta Jaub.&Spach

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14164, End-LR-Ir.-Tur., 09 VI 2008.

Alhagi pseudoalhagi (Bieb.) Desv.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14165, Ir.-Tur., 15 VIII 2008.

ROSACEAE

Laurocerasus officinalis Roemer

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14166, 25 VII 2006.

Prunus spinosa L.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14167, Euro.-Sib., 10 IV 2006.

Amygdalus orientalis Mill.

N 40°20'17.7"-E 029°52'17.9", 280m, OUFE: 14168, Ir.-Tur., 17 IV 2006.

Filipendula vulgaris Moench

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14169, Euro.-Sib., 22 V 2008.

F. ulmaria (L.) Maxim

N 40°23'10.4"-E 029°56'46.4", 128m, OUFE: 14170, Euro.-Sib., 15 V 2007.

Rubus idaeus

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15542, 06 VIII 2009.

R. sanctus Schreber

N 40°13' 43.7"-E 029°56'59.1", 260m, OUFE: 14171, 16 X 2008.

R. canescens DC. var. ***canescens***

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14172, Euro.-Sib., 25 VII 2006.

Potentilla recta L.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14173, 24 VI 2008.

P. reptans L.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14174, 24 IV 2006.

Fragaria vesca L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14175, 24 IV 2006.

Geum urbanum L.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14176, Euro.-Sib., 01 V 2006.

Agrimonia eupatoria

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15543, 23 IV 2009.

Sanguisorbia minor Scop. subsp. ***muricata*** (Spach) Briq

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14177, 25 VII 2006.

Rosa pulverulenta Bieb.

N 40°22'10.5"-E 029°49'25.2", 337m, OUFE: 14178, 25 VII 2006.

R. horrida Fischer

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14179, 25 VII 2006.

R. canina L.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14180, 16 X 2008.

R. foedita

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 15544, Ir.-Tur., 30 IV 2009.

Pyracantha coccinea Roemer

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14181, 09 VI 2008.

Crataegus microphylla C. Koch.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14182, Hyrc.-Euxine,24 VI 2008.

C. monogyna Jacq. subsp. ***mongyna***

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14183, 12 VII 2008.

Sorbus torminalis (L.) Crantz var. ***torminalis***

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14184, 01 V 2006.

Cydonia oblonga Miller

N 40°14' 48.1"-E 030°01'48.4", 147m,OUFE: 14185, 22 V 2008.

Malus sylvestris (L.) Miller subsp. ***orientalis*** (A. Uglitzkich) Browicz var. ***orientalis***

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 14186, 10 IV 2008.

LYTRACEAE

Lytrum salicaria L.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14187, Euro.-Sib., 16 X 2008.

ONAGRACEAE

Epilobium angustifolium L.

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14188, 12 VII 2008.

E. hirsutum L.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14189, 15 VIII 2008.

E. parviflorum Schreber

N 40°14'35.3"-E 030°00'14.9", 260m, OUFE: 15545, 16 X 2008.

CUCURBITACEAE

Ecballium elaterium (L.) A. Rich.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14190, Medit., 16 X 2008.

CACTACEAE

Opuntia ficus-indica (L.) Miller

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14191, 26 V 2006.

CRASSULARIACEAE

Umbilicus erectus DC.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14192, 09 VI 2008.

Sedum acre L.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14193, 21 VII 2008.

S. album L.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14194, 15 VIII 2008.

S. sempervivoides Bieb.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14195, 15 VIII 2008.

S. litoreum Guss.

N 40°17'17.2"-E 029°50'08.6", 213m, Medit. 26 V 2006.

S. hispanicum L. var. ***hispanicum***

N 40°23'10.4"-E 029°56'46.4", 128m, OUFE: 14196, Ir.-Tur., 15 V 2007.

S. pallidum Bieb. var. ***pallidum***

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14197, 12 VII 2008.

S. sediforme

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15547, Medit., 03 VI 2009.

Sempervivum. armenum

N 40°26'19.5"- E030°00'36.4", 294m, OUFE:15548, 21 VII 2008.

SAXIFRAGACEAE

Saxifraga hederaceae L. var. ***hederacea***

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 14198, 01 V 2006.

APIACEAE

Astranthia maxima subsp. ***maxima***

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15549, 03 VII 2009.

Myrrhoides nodosa (L.) Cannon

N 40°17'31.9"-E 029°53'44.9", 449m, OUFE: 15550,29 X 2009.

Hippomarathum cristatum

N 40°15'51.5"-E 029°56'54.7", 537m, OUFE: 16492, E. Medit. 29 X 2009.

Eryngium giganteum Bieb.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14199, Euxine,15 VIII 2008

E. creticum Lam.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 15552, E. Medit., 15 VIII 2008.

E. bithynicum Boiss.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14200, End-LC-Ir.-Tur., 21 VII 2008.

E. campestre L. var. ***campestre***

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14201, 24 VI 2008.

Echinophora tournefortii Jaub&Spach

N 40°21'43.4"-E 030°02'43.7", 110m, OUFE: 14202, 16 X 2008.

E. tenuifolia L. subsp. ***sibthorbiana*** (Guss.) Tutin

N 40°18'48.5"-E 030°07'14.1", 109m, OUFE: 14203, Ir.-Tur.,16 X 2008.

Chaerophyllum byzantinum Boiss.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14204, Euxine,26 V 2006.

Anthriscus numerosa (Bieb.) Sprengel

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14205, 15 V 2008.

Scandix stellata Banks&Sol.

N 40°20'10.1"-E 030°05'37.7", 208m, OUFE: 14206, 01 V 2007.

S. iberica Bieb.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14207, 01 V 2007.

S. pecten-veneris L.

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 14208, 27 III 2006.

S. australis L. subsp. ***grandiflora*** (L.) Thell.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 15553, 10 IV 2006.

Bifora radians Bieb.

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14209, 22 V 2008.

Smyrnium olusatrum L.

N 40°21'39.0"-E 030°30'21.0", 170m, OUFE: 15554, Medit., 10 IV 2006.

S. perfoliatum L.

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 14210, 08 V 2008.

Pimpinella tragium Vill. subsp. ***lithophila*** (Schischkin) Tutin

N40°20'35.3"-E 030° 04'34.9", 223m, OUFE: 14211, 26 IX 2006.

P. saxifraga L.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 14212, 16 X 2008.

P. anisum

N 40°13'39.2"-E 029°57'18.7", 331m, OUFE: 15555, 29 X 2009.

Sium sisarium L. var. ***lancifolium*** (Bieb.) Thell.

N 40°22'33.1"-E 029°50'26.9", 573m, OUFE: 14213,15 VIII 2008.

Berula erecta (Huds.) Coville

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15556, 06 VIII 2009.

Seseli tortuosum L.

N 40°26'19.5"-E 030°00'36.4", 294m, , OUFE: 14214, 21 VII 2008.

S. campestre Beser

N 40°20'42.4"-E 030° 03'58.0", 156m, OUFE: 15557, 25 VII 2006.

Oenanthe fistulosa L.

N 40°20' 08.6"-E 030°12'46.1", 218m, OUFE: 14215,17 VII 2008.

Oe. pimpinelloides L.

N 40°20'10.1"-E 030°05'37.7", 208m, OUFE: 14216, 01 V 2007.

Oe. ilaifolia Bieb.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14217, 10 IV 2006.

Foeniculum vulgare Miller

N 40°14'35.1"-E 030°06'30.1", 143m, OUFE: 15558, 14.11.2008.

Anethum graviolens L.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14218,14 VI 2008.

Conium maculatum L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14219, 01 V 2006.

Prangos meliocarpoides var. ***meliocarpoides***

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15559, End-LC-Ir.-Tur., 06 VIII 2009.

Bupleurum rotundifolium L.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14220, 14 VI 2008.

B. intermedium Poiret

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14221. 08 V 2008.

B. flavum Forssk.

N 40°14'31.4"-E 030° 02'25.4", 211m, OUFE: 14222, E. Medit. 12 VII 2008.

B. sulphureum Boiss. et Bal.

N 40°21'04.9"-E 029°59'56.3", 330m, OUFE: 16564, End-LR-Ir.-Tur.,30 IV 2009.

Ammi visnaga (L.) Lam.

N 40°16'14.4"-E 030° 07'00.9", 202m, OUFE: 16493, Medit., 15 VIII 2008.

A. majus L.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 15562, Medit., 25 VII 2006.

Falcaria vulgaris Bernh.

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15563, 03 VI 2009.

Ferulago galbanifera (Miller) W. Koch

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14223, Euro.-Sib., 14 VI 2008.

F. macrosciadia Boiss.&Bal.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14224, End-LR-Euro.-Sib., 01 V 2007.

Pastinaca sativa L.

N 40°22'33.1"-E 029°50'26.9",573m, 15 VIII 2008, OUFE: 14225.

Malabaila secacul Banks&Sol.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 15564, 15 VIII 2008.

Heracleum sphondylium L.subsp. ***ternatum*** (Velen) Brummitt

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14226, Euro.-Sib., 22 V 2008.

H. humile Sm.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14227, E. Medit., 15 VIII 2008.

H. platytaenium Boiss.

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15565, End-LR, 03 VII 2009.

Tordylium apulum L.

N 40°20'15.2"-E 030° 09'20.3", 130m, OUFE: 14228, Medit., 18 V 2006.

T. maximum L.

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15566,03 VII 2009.

Laser trilobum (L.) Borkh.

N 40°21'28.4"-E 029° 54'44.9", 122m, OUFE: 14229, 24 VI 2008.

Torilis nodosa (L.) Gaertner

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14230. 01 V 2007.

T. arvensis (Huds.) Link var. ***arvensis***

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14231. 21 VII 2008.

T. leptophylla (L.) Reichb.

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14232, 15 V 2008.

Caucalis platycarpos L.

N 40°21'09.4"-E 029°55' 46.8", 161m, OUFE: 15567, 26 V 2006.

Turgenia latifolia (L.) Hoffm.

N 40°18'35.8"-E 029°53'54.4", 756m, OUFE: 14233, 09 V 2007.

Daucus carota L.

N 40°20' 08.6"-E 030°12'46.1", 218m, OUFE: 14234, 17 VII 2008.

D. broteri Ten.

N 40°16'14.4"-E 030° 07'00.9", 202m, OUFE: 14235, Medit., 15 VIII 2008.

D. guttatus Sm.

N 40°13'39.2"-E 029°57'18.7", 331m, OUFE: 15568, 29 X 2009.

Artedia squamata L.

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14236, 22 V 2008.

ARALIACEAE

Hedera helix L.

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14237, 16 X 2008.

CORNACEAE

Cornus mas L.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14238, Euro.-Sib., 26 V 2006.

CAPRIFOLIACEAE

Sambucus ebulus L.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14239, Euro.-Sib., 25 VII 2006.

S. nigra L.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14240, Euro.-Sib., 10 IV 2008.

Vibirnum opulus L.

N 40°22'27.4"-E 029°52' 00.4",343m, OUFE: 14241, Euro.-Sib., 14 VI 2008.

Lonicera etrusca Santi var. ***etrusca***

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14243, Medit., 01 V 2006.

VALERIANACEAE

Valeriana dioscoridis Sm.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14244, E. Medit., 27 III 2006.

Centranthus longiflorus Stev.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14245, Ir.-Tur., 18 V 2006.

Valerianella echinata (L.) DC.

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 15569, Medit., 10 IV 2006.

V. carinata Lois.

N 40°22'21.5"-E 030° 03'58.1", 141m, OUFE: 15570, 10 IV 2006.

V. turgida (Stev.) Betcke

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 14246.,10 IV 2008.

V. pumila (L.) DC.

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14247, 08 V 2008.

V. coronata (L.) DC.

N 40°20'05.9"-E 029°51'54.7", 504m, OUFE: 14248, 18 V 2006.

V. kotschyi Boiss.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14249, Ir.-Tur., 01 V 2007.

V. discoidea (L.) Lois.

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 14250, Medit., 27 III 2006.

V. lasiocarpa (Stev.) Betck

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 15571, Ir.-Tur., 08 V 2008.

MORINACEAE

Morina persica L. var. ***persica***

N 40°14'31.4"-E 030° 02'25.4", 211m, OUFE: 14251, Ir.-Tur., 12 VII 2008.

DIPSACACEAE

Dipsacus laciniatus L.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14252, 15 VIII 2008.

Cephalaria transsylvanica (L.) Schrader

N 40°21'43.4"-E 030°02'43.7", 110m, OUFE: 14253, LC,16 X 2008.

C. syriaca (L.) Schrader

N 40°20'08.6"-E 030°12'46.1", 218m, OUFE: 14254. 17 VII 2008.

Scabiosa atropurpurea L. subsp. ***maritima*** (L.) Arc.

N 40°17'35.5"-E 029° 53'40.2", 700m, OUFE: 14255, Ir.-Tur., 16 X 2008.

S. argentea L.

N 40°21' 43.4"-E 030°02'43.7", 110m, OUFE: 14256, 16 X 2008.

S. calocephala

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 16565, 03 VII 2009.

S. rotata

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15572, Ir.-Tur., 06 VIII 2009.

Tremastelma palaestinum (L.) Janchen

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 15573, E. Medit., 15 V 2008.

Knautia orientalis

N 40°21'40.3"-E 030°01'11.3", 95m, OUFE: 15574, 06 VIII 2009.

ASTERACEAE

Bidens tripartida L.

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14257, 15 VIII 2008.

Xanthium spinosum L.

N 40°24' 23.4"-E 030°10'23.9", 640m, OUFE: 14258, 26 IX 2006.

X. strumarium L. subsp. ***strumarium***

N 40°20'15.2"-E 030°09'20.3", 130m, OUFE: 14259, 18 V 2006.

Inula oculus-christi L.

N 40°20'15.2"-E 030°10'49.1",146m, OUFE: 14260, Euro.-Sib., 26 V 2006.

I. viscosa (L.) Aiton

N 40°20'15.2"-E 030°10'49.1",146m, OUFE: 14261, Medit. 26 V 2006.

I. aschersoniana

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15575, 06 VIII 2009.

I. vulgaris

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 15576, Euro.-Sib., 03 VII 2009.

Pulicaria dysenterica

N 40°21' 30.3"-E 030°07'48.9", 248m, OUFE: 15577, 06 VIII 2009.

Helichrysum grveolens

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15578, 03 VI 2009.

Filago pyramidata L.

N 40°23'59.8"-E 030°17'12.6", 566m, OUFE: 14262, 01 V 2006.

Logfia arvensis (L.) Holub

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14263, 15 V 2008.

Erigeron acer L. subsp. ***acer***

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14264, Euro.-Sib., 26 V 2006.

Conyza canadensis (L.) Cronquist

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14265, 25 VII 2006.

Bellis perennis L.

N 40°20'17.7"-E 029°52'17.9", 280m, OUFE: 14266, Euro.-Sib., 17 IV 2006.

Doronicum orientale Hoffm.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14267, 25 VII 2006.

Seneico vernalis Waldst&Kit

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14268, 25 VII 2006.

S. viscosus

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15579,06 VIII 2009.

Tussilago farfara L.

N 40°21' 49.8"-E 029°57'03.8", 107m, OUFE: 14269, Euro.-Sib., 10 IV 2008.

Calendula officinalis L.

N 40°22'49.8"-E 029°55'27.1", 156m, OUFE: 14270, 17 IV 2006.

Eupatorium cannabinum L.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14271, Euro.-Sib., 15 VIII 2008.

Anthemis cretica L. subsp. ***anatolica*** (Boiss.) Grierson

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14272, 25 VII 2006.

A. tinctoria L. var. ***tinctoria***

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 14273, 25 VII 2006.

A. tinctoria var. ***pallida***

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15580, 06 VIII 2009.

A. auriculata

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 15582, E. Medit., 03 VII 2009.

Achillea wilhelmsii C. Koch

N 40°25'13.5"-E 030°01'25.2", 160m, 18 V 2006, OUFE: 14274, Ir.-Tur.

A. nobilis L. subsp. ***neilreichii*** (Kerner) Formanek

N 40°20'15.2"-E 030°10'49.1",146m, 26 V 2006, OUFE: 14275.

A. biebersitenii Afan.

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 16566, 30 IV 2009, Ir.-Tur.

A. milleifolium L. subsp. ***milleifolium***

N 40°21'16.6"-E 030°02'52.3", 189m, OUFE: 15583, Euro.-Sib., 03 VI 2009.

Tanacetum parthenium (L.) Schultz

N 40°21'39.0"-E 030°30'21.0", 170m, OUFE: 14276, 13 VII 2007.

Tripleurospermum sevanense (Manden.) Pobed

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14277, 12 VI 2008.

Artemisia scoparia Waldst. et. Kit

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15584, 03 VI 2009.

Arctium minus (Hill.)Bernh**.** subsp. ***pubens***(Babington) Arenes

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15585, 06 VIII 2009.

Onopordum tauricum Willd

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14278, 25 VII 2006.

Cirsium vulgare (Savi) Ten.

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 14279, 25 VII 2006.

C. hypoleucum DC.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14280, Euxine, 25 VII 2006.

C. arvense (L.) Scop. subsp. ***vestitum*** (Wimmer&Grab.) Petrak

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14281, 26 V 2006.

C.creticum(Lam.)D'urv. subsp***. creticum***

N 40°21'04.9"-E 029°59'56.3", 330m, OUFE: 15586,30 IV 2009.

Picnomon acarna (L.) Cass.

N 40°21'41.1"-E 029°55'22.2", 138m, OUFE: 14282, Medit., 25 VII 2006.

Carduus nutans L.

N 40°24'13.3"-E 030°00'19.8", 96m, OUFE: 14283. 26 V 2006.

C. pycnocephalus subsp. ***albidus***

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15587,23 IV 2009.

Jurinea consanguinea DC.

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14284, 25 VII 2006.

J. pontica Hausskn. Et freyn ex Hausskn.

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 16567, End-LR-Ir.-Tur., 03 VI 2009.

Tyrimnus lucographus (L.) Cass.

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 15589, Medit., 30 IV 2009.

Acroptilon repens (L.) DC.

N 40°20'15,2"-E 030°10'49.1", 146m, OUFE: 14285, Ir.-Tur., 26 V 2006.

Centaurea wiedemanniana Fisch.&Mey.

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 15590, End-VU, 26 V 2006.

C. virgata Lam.

N 40° 22'15.2"-E 029°57'21.7", 147m, OUFE: 14286, Ir.-Tur. 25 VII 2006.

C. solstitialis L. subsp. ***solstitialis***

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14287, 13 VII 2008.

C. iberica Trev. ex Sprengel

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14288, 12 VI 2008.

C. urvillei DC. subsp. ***urvillei***

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 14289, E. Medit., 03 VII 2009.

C. urvillei DC. subsp. ***stepposa*** Wagenitz

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14289, End-LR-Ir.-Tur., 25 VII 2006.

C. triumfettii All.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 14290, 10 IV 2006.

C. thirkei Schultz

N 40°14'04.8"-E 030° 04'37.4", 123m, OUFE: 14291, E. Medit., 24 IV 2006.

C. cyanus L.

N 40°25'13.5''-E 030°01'25.2", 160m, OUFE: 15592, 01 V 2007.

C. thracica (Janka)Hayek

N 40°14'28.3"-E 030°00'40.1", 296m, OUFE: 15593, 30 IV 2009.

C. diffusa Lam.

N 40°21'07.4"-E 029°59'55.2", 386m, OUFE: 15594, Medit., 23 IV 2009.

C. depressa Bieb.

N 40°13' 39.2"-E 029°57'18.7", 331m, OUFE: 15595, 29 X 2009.

Chardinia orientalis (L.) O. Kuntze

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15596, Ir.-Tur., 30 IV 2009.

Crupina crupinastrum (Moris) Vis.

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 14292, 18 V 2006.

C. vulgaris Cass.

N 40°21'09.4"-E 029°55'46.8", 161m, OUFE: 15597, 26 V 2006.

Carthamus lanatus L

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 16494, 15 VIII 2008.

C. dentatus Vahl

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14293, 25 VII 2006.

Xeranthemum annuum

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15598, 06 VIII 2009.

Echinops ritro L.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14294, 25 VII 2006.

E. microcephalus Sm.

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 15599, Medit., 25 VII 2006.

E. viscosus DC. subsp. ***bithynicus*** (Boiss.) Rech.

N 40°23'59.8"-E 030°17'12.6", 566m, 01 V 2006, OUFE: 14295.

Scolymus hispanicus L.

N 40°20'22.5"-E 030°14'46.6", 452m, OUFE: 14296, Medit., 18 V 2006.

Cichorium intybus L.

N 40°21'39.0"-E 030°30'21.0", 170m, OUFE: 14297, 26 V 2006.

Koelpinia linearis Pallas

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 16495, Ir.-Tur., 03 VII 2009.

Scorzonera laciniata L. subsp. ***laciniata***

N 40°20'49.9"-E 030°17'50.4", 621m, OUFE: 14298, 24 IV 2006.

S. suberosa C. Koch. subsp. ***suberosa***

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14299, Ir.-Tur., 24 IV 2006.

S. eriophora

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 15601, End-LR, 03 VI 2009.

Tragopogon longirostris Bisch. ex Schultz subsp. ***abbreviatus*** Boiss.

N 40°20'04.1"-E 030°12'57.9", 238m, OUFE: 14300, 24 IV 2006.

T. dubius Scop.

N 40°25'53.5"-E 029°56'44.8", 381m, OUFE: 14301, 18 V 2006.

Leontodon crispus Vill. subsp. ***asper*** (Waldst.&Kit.) Rohl. var. ***asper***

N 40°23'10.4"-E 029°56'46.4", 128m, OUFE: 15602, 15 V 2007.

Picris hieracioides L.

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 14302, Euro.-Sib., 25 VII 2006.

P. strigosa Bieb.

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 15603, Ir.-Tur. 22 V 2008.

P. pauciflora

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15604,06 VIII 2009.

Hedynopsis cretica (L.) Dum.-Cours.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 15605, Medit. 26 V 2006.

Sonchus asper (L.) Hill. subsp. ***glaucescens*** (Jordan) Ball

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 14303, 26 V 2006.

Pilosella hoppeana (Schultes) C.H.&F.W. Schultz subsp. ***troica*** **(**Zahn) Sell&West

N 40°24'23.4"-E 030°10'23.9", 640m, OUFE: 14304, 26 IX 2006.

Lactuca saligina L.

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14305, 24 IV 2006.

L. serriola L.

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 14306, 18 V 2006.

Lapsana communis subsp. adenophora (Boiss.) Rech. Fil.

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15606, 03 VI 2009.

Taraxacum serotinum (Waldst.&Kit.) Poiret

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14307, 22 V 2008.

T. officinale Weber

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14308, 25 VII 2006.

Chondrilla juncea var***. latifolia***

N 40°20'53.7"-E 029°58'13.7", 568m, OUFE: 15607, 30 IV 2009.

Crepis sancta (L.) Babcock

N 40°22'15.2"-E 029° 57'21.7", 147m, OUFE: 14309, 25 VII 2006.

C. foedita subsp. ***commutata***

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15608, 03 VI 2009.

C. neglecta

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 15609, 03 VII 2009.

CAMPANULACEAE

Campanula lyrata Lam. subsp. ***lyrata***

N 40°14'37.8"-E 029°59'35.8", 378m, OUFE: 14310, End-LR, 15 V 2008.

C. rapunculoides L. subsp. ***cordifolia*** (C. Koch) Damboldt

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14311.

C. persicifolia L.

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 14312, Euro.-Sib., 25 VII 2006.

C. latiloba D.C. subsp. ***latiloba***

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14313, End-LR-Euxine, 03 VIII 2008.

C. olympica Boiss.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14314, 01 V 2006.

C. glomerata subsp. ***hispida***

N 40°13'39.2"-E 029°57'18.7", 331m, OUFE: 15610, Euro.-Sib., 29 X 2009.

C. cymbalaria

N 40°15'11.4"-E 029°59'41.3", 362m, OUFE:15611, E. Medit., 30 IV 2009.

Asyneuma limonifolium (L.) Janchen subsp. ***limonifolium***

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14315, 25 VII 2006.

A. lobelioides (Willd.)Hand.-Mazz

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14316, 22 V 2008.

A. linifolium subsp. ***linifolium***

N 40°15'11.4"-E 029°59'41.3", 362m, OUFE: 15612, End-LR- E. Medit., 30 IV 2009.

Legousia speculum-veneris (L.) Chaix

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14317, E. Medit., 01 V 2006.

L. falcata (Ten.) Fritsch.

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 15613, E. Medit., 25 VII 2006.

L. pentagonia (L.) Thellung

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 15614,E. Medit., 03 VII 2009.

ERICACEAE

Rhododendron ponticum L. subsp. ***ponticum***

N 40°25'00.6"-E 029°54'57.1", 452m, OUFE: 14318, 18 V 2006.

Arbutus unedo L.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14319, 13.11.2008.

PRIMULACEAE

Primula vulgaris (Lam.) Huds. subsp. ***vulgaris***

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 14320, Euro.-Sib., 10 IV 2006.

Androsace maxima L.

N 40°24'13.2"- E 029°52'04.8", 608m, OUFE: 14321, 17 IV 2006.

Cyclamencoum Miller var. ***coum***

N 40°20'44.6"-E 030°12'23.7", 186m, OUFE: 14322, 01 V 2006.

Lysimachia vulgaris L.

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14323, 26 IX 2006.

L. atropurpurea L.

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 14324, E. Medit, 01 V 2006.

Anagallis arvensis L. var. ***arvensis***

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14325, 01 V 2006.

A. foemina Miller.

N 40°20'40.7"-E 029°55'04.3", 331m, OUFE: 14326, Medit., 28.02.2007.

OLEACEAE

Jasminum fruticans L.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14327, Medit,10 V 2006.

Fraxinus angustifolia Vahl. subsp. ***oxycarpa*** (Bieb. ex Willd.) Franco&Rocha

N 40°22'44.2"-E 029°51'08.1", 528m, OUFE: 14328, 17 IV 2006.

Olea europaea L. var. ***sylvestris*** (Miller) Lehr.

N 40°22'10.5"-E 029°49'25.2", 337m, OUFE: 14329, Medit., 10 IV 2006.

Phillyrea latifolia L.

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14330, Medit., 01 V 2006.

Ligustrum vulgare L.

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 15615, Euro.-Sib., 06 VIII 2009.

APOCYNACEAE

Vinca herbacea Waldst et Kit.

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14331, Medit., 26 IX 2006.

V. major L. subsp. ***major***

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14332, 19 III 2008.

ASCLEPIADACEAE

Periploca graeca L. var. ***graeca***

N 40°24'22.4"-E 029°53'39.4", 610m, OUFE: 14333, E. Medit., 18 V 2006.

Cynanchum acutum L. subsp. ***acutum***

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15616, 06 VIII 2009.

Vincetoxicum fuscatum (Hornem.) Reichb. fil. subsp. ***fuscatum***

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 15617, 26 V 2006.

Cionura erecta (L.) Griseb

N 40°24'49.6"-E 030°13'23.9", 539m, OUFE: 14334, Medit., 26 IX 2006.

GENTIANACEAE

Centaurium erythraea subsp. ***erythraea***

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 15618, Euro.-Sib., 06 VIII 2009.

Gentiana asclepiadae L.

N 40°22'32.9"-E 029°53'38.9", 257m, OUFE: 14335, 17 IV 2006.

G. lutea L. subsp. ***lutea***

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15619, EN- Euro.-Sib., 03 VI 2009.

CONVOLVULACEAE

Convolvulus cantabrica L.

N 40°25'53.5"-E 029°56'44.8", 381m, OUFE: 14336, 18 V 2006.

C. lineatus L.

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 14337, 10 V 2006.

C. arvensis L.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14338., 01 V 2006.

C. galaticus Rotsan ex Coisy

N 40°21'54.8",E 030°14'03.4", 218m, OUFE: 14339, End-LR-Ir.-Tur., 18 V 2006.

C. betonicifolius Miller ***subsp. betonicifolius***

N 40°15'11.4"-E 029°59'41.3", 362m, OUFE:15620, 30 IV 2009.

C. holosericeus Bieb**.** subsp. ***holosericeus***

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE:15621, 03 VI 2009.

Calystegia sepium (L.) R. Br.

N 40°18'36.3"-E 030°03'16.1", 156m, OUFE: 14340, 26 IX 2006.

Ipomea purpurea (L.) Roth

N 40°20'04.1"-E 030°12'57.9", 238m, OUFE: 14341, 24 IV 2006.

CUSCUTACEAE

Cuscuta campestris Yuncker

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14342, 25 VII 2006.

C. europaea L.

N 40°18'48.5"-E 030° 07'14.1", 109m, OUFE: 14343, 16 X 2008.

BORAGINACEAE

Heliotropium europaeum L.

N 40°27'13.4"-E 030°05'45.0", 72m, OUFE: 14344, Medit., 10 IV 2006.

H. dolosum De Not.

N 40°22'14.1"-E 029°57'14.6", 92m, OUFE: 15622, 25 VII 2006.

H. hirsutissimum Grauer

N 40°20'35.3"-E 030°04'34.9", 223m, OUFE: 15623, E. Medit., 26 IX 2006.

Lappula barbata (Bieb.) Gürke

N 40°21'41.1"-E 029°55'22.2", 138m, OUFE: 15624, Ir.-Tur., 26 V 2006.

Asperugo procumbens L.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 15625, Euro.-Sib., 09 V 2007.

Myosotis incrassata Guss.

N 40°23' 08.8"-E 029°57'11.7", 116m, OUFE: 15626, E. Medit., 15 IV 2009.

M. ramosissima Rochel ex Schultes subsp. ***ramosissima***

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 15627, 24 IV 2006.

M. arvensis (L.) Hill subsp. ***arvensis***

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 14345, Euro.-Sib., 10 IV 2006.

M. sicula Guss.

N 40°20'10.7"-E 029°51'57.5", 502m, OUFE: 14346, 17 IV 2006.

M. sylvatica Ehrh. Ex Hoffm subsp. ***cyanea*** Vestergren

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 15628, 06 VIII 2009.

Paracaryum paphlagonicum (Bornm.) R. Mill.

N 40°17'39.3"-E 029°56'27.6", 784m, OUFE: 15629, 09 V 2007.

Cynoglossum creticum Miller

N 40°22'44.2"-E 029°51'08.1", 528m, OUFE: 14347, 17 IV 2006.

C. montanum L.

N 40°20'16.2"-E 029°48'50.6", 336m, OUFE: 14348, 26 V 2006.

Arnebia densiflora (Nordm.) Ledeb.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14349, 13 VII 2008.

Lithospermum purpurocaeruleum L.

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 16496, Euro.-Sib., 08 V 2008.

Buglossoides arvensis (L.) Johnston

N 40°20'40.7"-E 029°55'04.3", 331m, OUFE: 14350, 28.02.2007.

Echium italicum L.

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14351, Medit. 26 IX 2006.

E. angustifolium Miller

N 40°22'10.5"-E 029°49'25.2", 337m, OUFE: 14352, E. Medit., 25 VII 2006.

Moltkia coerulea (Willd.) Lehm.

N 40°24'49.6"-E 030°13'23.9", 539m, OUFE: 14353, Ir.-Tur., 26 IX 2006.

M. aurea Boiss.

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 14354, End-LC-Ir.-Tur., 26 V 2006.

Onosma isauricum Boiss&Heldr.

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14355, End-LC-Ir.-Tur., 25 VII 2006.

O. tauricum Pallas ex Willd. var. ***tauricum***

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14356, 12 VI 2008.

O. bornmuelleri Hausskn.

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14357, End-LC-Ir.-Tur., 18 V 2006.

O. armenum DC.

N 40°25'47.8"-E 030°03'34,4", OUFE: 15631, 116m, End-LC, 06 VIII 2009.

O. aucheranum DC.

N 40°21"16.6"-030° 02" 52.3", OUFE: 15632, 03 VI 2009, E. Medit.

O. bracteosum Hauskn. Et Bornm.

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 15633, End-LC-Ir.-Tur., 03 VI 2009

O. microcarpum

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 16568, 06 VIII 2009.

Cerinthe minor L. subsp. ***auriculata*** (Ten.) Domac

N 40°24'36.5"-E 030°01'34.5", 100m, OUFE: 14358, 26 V 2006.

Symphytum orientale L.

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 16497, Euro.-Sib., 15 V 2008.

Anchusa leptophylla Roemer&Schultes subsp. ***incana*** (Ledeb) Chamb

N 40°18'12.2"-E 029°59'41.2", 377m, OUFE: 14359, End-LC-Ir.-Tur., 13 VII 2008.

A. officinalis L.

N 40°20'42.1"-E 029°52'50.1", 174m, 15 VIII 2008.

A. azurea Miller var. ***azurea***

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14360, 28.02.2007.

A. stylosa Bieb.

N 40°14'04.8"-E 030°04'37.4", 123m, OUFE: 16498, 24 IV 2006.

A. undulata subsp***. hybrida***

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 16499, Medit., 06 VIII 2009.

Nonea pulla (L.) DC. subsp. ***monticola*** Rech. fil.

N 40°26'39.1"-E 030°03'48.3", 215m, OUFE: 16500, End-LC, 24 IV 2006.

N. ventricosa (Sm.) Griseb.

N 40°23'08.8"-E 029°57'11.7", 116m, OUFE: 16501, Medit. 15 IV 2009.

Alkanna orientalis (L.) Boiss. var. ***orientalis***

N 40°18'57.5"-E 029°51'26.1", 215m, OUFE: 14361, 26 V 2006.

A. tinctoria (L.) Tausch subsp. ***tinctoria***

N 40°24'58.7"-E 030°01'51.5", 93m, OUFE: 16502, E. Medit., 01 V 2007.

A. tinctoria (L.) Tausch subsp. ***anatolica***

N 40°17'17.2"-E 029°50'08.6", 213m, OUFE: 14362, 26 V 2006.

A. areolata Boiss. var. ***areolata***

N 40°20'40.1"-E 030°03'47.0", 148m, OUFE:14363, End-LR- E. Medit., 15 IV 2009.

SOLANACEAE

Solanum nigrum L. subsp. ***schultesii*** (Opiz) Wessely

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14363, 16 X 2008.

S. dulcamara L.

N 40°20'31.5"-E 029°51'39.1", 422m, OUFE: 14364, Euro.-Sib., 17 IV 2006.

Lycium barbarum

N 40°22'17.8"-E 030°05'12.7", 250m, OUFE: 16503, 03 VII 2009.

Physalis alkekengi L.

N 40°20'35.3"-E 030°04'34.9", 223m, OUFE: 16504, 26 IX 2006.

Datura tramonium L.

N 40°20'16.2"-E 029°48'50.6", 336m, OUFE: 14365, 26 V 2006.

Hyoscyamus niger L.

N 40°14'45.1"-E 030°01'14.7", 238m, OUFE: 14366, 08 V 2008.

Atropa belladona

N 40°25'47.8"-E 030°03'344", 116m, OUFE:15644, 06 VIII 2009.

SCROPHULARIACEAE

Verbascum flavidum (Boiss.) Freyn&Bornm

N 40°19'41.9"-E 029°51'35.7", 335m, OUFE: 14367, Euro.-Sib., 28.02.2007.

V. lasianthum Boiss. Ex Bentham

N 40°24'13.3"-E 030°00'19.8", 96m, OUFE: 14368.

V. cheiranthifolium Boiss. var. ***cheiranthifolium***

N 40°24'49.6"-E 030°13'23.9", 539m, OUFE: 14369, 03 VIII 2008.

V. biledschikianum

N 40°23'21.1"-E 030°09'57.8", 515m, OUFE: 16505, End-VU-E. Medit., 06 VIII 2009.

V. glomeratum

N 40°21'30.3"-E 030°07'48.9", 248m, OUFE: 16506, Ir.-Tur., 06 VIII 2009.

V. lachnopus

N 40°23'21.6"-E 030°09'56.2", 539m, OUFE: 16507, End-EN-Euxine, 03 VII 2009.

V. orientale

N 40°14'45.0"-E 030°00'04.5", 307m, OUFE: 16508, LC- E. Medit., 29 X 2009.

Scrophularia cryptophylla Boiss.&Heldr.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 16509, End-LC-E. Medit., 21 VII 2008.

S. scopolii (Hoppe ex) Pers. var. ***scopolii***

N 40°22'10.5"-E 029°49'25.2", 337m, OUFE: 14370, 25 VII 2006.

S. xanthoglossa Boiss. var. ***decipiens***

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 16510, 06 VIII 2009.

Linaria genistifolia (L.) Miller subsp. ***genistifolia***

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14371, Euro.-Sib., 26 IX 2006.

L. corifolia Desf.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14372, End-LC- Ir.-Tur., 17 IV 2006.

L. simplex (Willd.) DC.

N 40°20'40.1"-E 030°03'47.0", 148m, Medit., 15 IV 2009.

Digitalis ferruginea L. subsp. ***ferruginea***

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14373, Euro.-Sib., 18 V 2006.

D. lamarckii Ivan

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14374, End-LC-Ir.-Tur., 10 IV 2006.

Veronica grisebachii S. M.

N 40°20'40.1"-E 030°03'47.0", 148m, OUFE: 16511, E. Medit., 15 IV 2009.

V. persica Poiret

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 16512, 10 IV 2006.

V. hederifolia L.

N 40°20'17.7"-E 029°52'17.9", 280m, OUFE: 14375, 17 IV 2006.

V. chamaedrys L.

N 40°21'54.8"-E 030°14'03.4", 218m, OUFE: 14376, Euro.-Sib., 01 V 2006.

V. pectinata L. var. ***pectinata***

N 40°18'36.3"-E 030°03'16.1", 156m, OUFE: 14377, 01 V 2006.

V. multifida L.

N 40°20'40.1"-E 030°03'47.0", 148m, OUFE: 16513, End- LC-Ir.-Tur., 15 IV 2009.

V. anagalis-aquatica L.

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 16514, 06 VIII 2009

V. bozakmanii M.A. Fischer

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 16515, Ir.-Tur.,30 IV 2009.

V. jacquinii Baumg.

N 40°19'06.7"-E 030°07'36.9", 123m, OUFE: 16516, Euro.-Sib., 06 VIII 2009.

Euphrasia pectinata Ten

N 40°23'21.6"-E 030°09'56.2", 539m, OUFE: 16517, Euro.-Sib.,03 VII 2009.

Parentucelia latifolia (L.) Caruel subsp. ***latifolia***

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 16518, Medit., 03 VI 2009

Bellardia trixago (L.) All.

N 40°23'21.1"-E 030°09'57.8", 515m, OUFE: 16519, 06 VIII 2009.

Pedicularis comosa L. var. ***sibthorpii*** (Boiss.) Boiss

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14378, 28.02.2007.

Rhinanthus angustifolius C. C. Gmelin subsp. ***grandiflorus*** (Wallr.) D.A. Webb

N 40°22'27.4"-E 029°52'00.4",343m, 17 IV 2006, OUFE: 14379.

Lathrea squamaria L.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14380, Euro.-Sib., 17 IV 2006.

OROBANCHACEAE

Orobanche ramosa L.

N 40°20'08.6"-E 030°12'46.1", 218m, OUFE: 14381, 26 V 2006.

O. alba Stephan

N 40°21'15.3"-EV029°54'06.8", 108m, OUFE: 14382, 18 V 2006.

O. minor Sm.

N 40°19'41.9"-E 029°51'35.7", 335m, OUFE: 14383, 17 IV 2006.

O. elatior Sutton

N 40°21'15.3"-E 029°54'06.8", 108m, OUFE: 14384, 12 VI 2008.

O. anatolica Boiss&Reuter

N 40°14'48.1"-E 030°01'48.4", 147m, OUFE: 14385, 22 V 2008.

ACANTHACEAE

Acanthus hirsutus Boiss.

N 40°24'07.1"-E 030°08'15.3", 558m, OUFE: 14386, End-LC, 25 VII 2006.

GLOBULARIACEAE

Globularia orientalis L.

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14387, Ir.-Tur., 11 IV 2007.

G. trichosanchta Fisch.&Mey.

N 40°20'10.1"-E 030°05'37.7", 208m, OUFE: 14388, Ir.-Tur., 26 V 2006.

VERBENACEAE

Verbena officinalis L.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14389, 14 VI 2008.

Vitex agnus-castus L.

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14390, Medit., 12 VII 2008.

LAMIACEAE

Ajuga orientalis L.

N 40°22'29.5"-E 029°58'24.5", 108m, OUFE: 14391, 18 V 2006.

A. chamaepitys (L.) Schreber subsp. ***chia*** (Schreber) Arcangeli var. ***chia***

N 40°22'06.0"-E 030°01'44.7", 105m, OUFE: 14392, 10 IV 2008.

A. laxmanii (L.) Benth.

N 40°14'45.0"-E 030°00'04.5", 307m, Euro.-Sib., 29 X 2009.

Teucrium orientale L. var. ***orientale***

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14394, Ir.-Tur., 21 VII 2008.

T. parviflorum Schreber

N 40°20'15.,2"-E 030°10'49.1",146m, OUFE: 14395, Ir.-Tur., 25 VII 2006.

T. chamaedrys L. subsp. ***chamaedrys***

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14396, Euro.-Sib., 15 VIII 2008.

T. polium L.

N 40°24'49.6"-E 030°13'23.9", 539m, OUFE: 14397., 26 IX 2006.

Scutellaria albida L. subsp. ***albida***

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14398, E. Medit., 24 VI 2008.

S. salviifolia Bentham

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14399, End-LC, 10 IV 2008.

S. orientalis L. subsp. ***pectinata*** (Bentham) Edm.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14400, End-LR-Ir.-Tur., 15 VIII 2008.

S. orientalis L. subsp. ***alpina*** (Boiss.) O. Schwarz var. ***alpina***

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14401, 15 VIII 2008.

Phlomis pungens Willd. var. ***pungens***

N 40°21'39.0"-E 030°30'21.0", 170m, OUFE: 14402, 26 V 2006.

P. russeliana (Sims) Bentham

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14403, End-LC-Hyrc.-Euxine, 12 VII 2008

P. armeniaca Willd.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14404, End- LC-Ir.-Tur., 24 VI 2008.

Lamium garganicum subsp. ***laevigatum*** Arganceli

N 40°24'49.6"-E 030°13'23.9", 539m, OUFE: 14405, Euxine, 12 VI 2008.

L. amplexicaule L.

N 40°21'39.0"-E 030°30'21.0", 170m, OUFE: 14406, Euro.-Sib., 25 VII 2006.

L. purpureum L. var. ***purpureum***

N 40°20'42.1"-E 029°52'50.1", 174m, OUFE: 14407, Euro.-Sib., 17 IV 2006.

Wiedemannia orientalis Fisch&Mey.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14408, End-LC-Ir.-Tur., 10 IV 2008.

Ballota nigra L. subsp. ***anatolica*** P. H. Davis

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14409, End-LC-Ir.-Tur., 25 VII 2006.

Marrubium vulgare L.

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14410, 11 IV 2007.

M. parviflorum Fisch&Mey. subsp. ***parviflorum***

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14411, Ir.-Tur., 24 VII 2006.

M. peregrinum **L**.

N 40°21'43.4"-E 030°02'43.7", 110m, 16 X 2008.

Sideritis montana L. subsp. ***montana***

N 40°18'36.3"-E 030°03'16.1", 156m, OUFE: 14412, Medit., 25 VII 2006.

S. germanicopolitana Bornm. subsp. ***germanipoliticana***

N 40°20'08.6"-E 030°12'46.1", 218m, OUFE: 14413, End-LC, 17 VII 2008.

S. galatica Bornm.

N 40°21'16.6"-E 030°02'52.3", 189m, End-LC, 03 VI 2009.

S. lanata

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 16520, Medit., 03 VI 2009.

Stachys tmolea Boiss.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14414, End-LC-E. Medit., 15 VIII 2008.

S. byzantina C. Koch

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14415, Euro.-Sib., 26 IX 2006.

S. annua (L.) L. subsp. ***annua*** var. ***lycaonica*** Battacharjee

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14416, Ir.-Tur., 08 V 2008.

S. annua (L.) L. subsp. ***annua*** var. ***annua***

N 40°22'22.8"-E 029°54'32.4", 156m, OUFE: 14417, 17 IV 2006.

S. cretica subsp. ***anatolica*** Rech. fil.

N 40°19'06.7"-E 030°07'36.9", 123m, End-LC-Ir.-Tur., 06 VIII 2009.

Melissa officinalis L. subsp. ***officinalis***

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14418, 24 VI 2008.

Nepeta italica L.

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14419, 12 VII 2008.

N. nuda L. subsp. ***albiflora*** (Boiss.) Gams

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14420, 21 VII 2008.

Prunella vulgaris L.

N 40°23'19.5"-E 030°14'10.7", 491m, OUFE: 14421, Euro.-Sib., 01 V 2006.

P. laciniata (L.) L.

N 40°14'28.3"-E 030°00'40.1", 296m, OUFE: 16569, 30 IV 2009.

Origanum sipyleum L.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14422, End-LC-E. Medit., 15 VIII 2008.

O. vulgare L. subsp. ***hirtum*** (Link) Ietsw.

N 40°18'48.5"-E 030°07'14.1", 109m, 16 X 2008, OUFE: 14423, E. Medit.

Satureja hortensis L.

N 40°20'35.3"-E 030°04'34.9", 223m, OUFE: 14424, 26 IX 2006.

Clinopodium vulgare L.subsp. ***arundanum*** (Boiss.) Nyman

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14425, 11 IX 2008.

Acinos rotundifolius Pers.

N 40°14'31.4"-E 030° 02'25.4", 211m, OUFE: 14426, 12 VII 2008.

Micromeria myrtifolia Boiss.&Hohen.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 14427, E. Medit., 24 VI 2008.

Thymus sipyleus Boiss. var. ***sipyleus***

N 40°18'24.3"-E 030° 07'18.0", 242m, OUFE: 14428, 22 V 2008.

T. sipyleus Boiss. var. ***rosulans*** (Borbas) Jalas

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14429, 21 VII 2008.

T. leucostomus Hausskn.&Velen. var. ***leucostomus***

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14430, End-NT-Ir.-Tur., 15 VIII 2008.

T. longicaulis C. Presl subsp. ***longicaulis*** var. ***subisophyllus*** (Borbas) Jalas

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14431, 01 V 2006.

T. roegneri C. Koch.

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 16521, 03 VI 2009.

Thymbra spicata L. var. ***spicata***

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14432, E. Medit., 21 VII 2008.

Mentha pulegium (Miller) DC.

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14433, 11 IX 2008.

M. aquatica L.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14434, 27 IX 2008.

M. longifolia (L.) Hudson subsp. ***typhoides*** (Briq.) Harley var. ***typhoides***

N 40°14'31.4"-E 030°02'25.4", 211m, OUFE: 14435, 12 VII 2008.

M. spicata L. subsp. ***tomentosa*** (Briq.) Harley

N 40°19'39.1"-E 029°54'48.4", 622m, OUFE: 14436, 16 X 2008.

Lycopus europaeus L.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14437, 27 IX 2008.

Ziziphora capitata L.

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 14438, Ir.-Tur., 15 VIII 2008.

Z. taurica Bieb. subsp. ***taurica***

N 40°22'33.1"-E 029°50'26.9", 573m, OUFE: 14439, Euro-Sib., 25 VII 2006.

Z. tenuior

N 40°16'02.3"-E 030°00'31.1", 589m, OUFE: 16570, Ir.-Tur., 30 IV 2009.

Salvia tomentosa Miller

N 40°21'41.1"-E 029°55'22.2", 138m, OUFE: 14441, Medit., 13 VII 2007.

S. pinnata L.

N 40°16'19.9"-E 029°54'51.3", 690m, OUFE: 16522, Medit., 02 IV 2009.

S. wiedemannii Boiss.

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14440, End-LC-Ir.-Tur., 22 V 2008.

S. viridis L.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14442, Medit., 10 IV 2008.

S. sclarea L.

N 40°22'27.4"-E 029°52'00.4",343m, OUFE: 14444, 14 VI 2008.

S. aethiopis L.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14445, 21 VII 2008.

S. argentea L.

N 40°21'28.4"-E 029°54'44.9", 122m, OUFE: 16523, Medit., 24 VI 2008.

S. candidissima Vahl subsp. ***candidissima***

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14446, Ir.-Tur., 26 V 2006.

S. virgata Jacq.

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14447, Ir.-Tur., 18 V 2006.

S. verticillata L. subsp. ***verticillata***

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 16524, 03 VI 2009, Euro.-Sib.

S. bracteata Banks& Sol

N 40°19'06.7"-E 030°07'36.9", 123m, OUFE: 16525, 06 VIII 2009.

S. cadmica Boiss.

N 40°21'04.9"-E 029°59'56.3", 330m, OUFE: 16526, End-LC, 30 IV 2009.

PLUMBAGINACEAE

Limonium angustifolium (Tausch) Turrill

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 16527, Medit., 26 IX 2006.

Acantholimon acerosum (Willd.) Boiss. subsp. ***acerosum***

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14448, Ir.-Tur., 13 VII 2007.

A. puberulum Boiss. et Bal. var. ***puberulum***

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 16571, Ir.-Tur., 06 VIII 2009.

PLANTAGINACEAE

Plantago major L. subsp. ***intermedia*** (Gilib.) Lange

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14449, 26 IX 2006.

P. lanceolata L.

N 40°22'33.7"-E 029°54'59", 151m, OUFE: 14450. 10 IV 2006.

P. scabra Moench

N 40°19'06.7" –E 030°07'36.9", 123m, OUFE: 16528, 06 VIII 2009.

THYMELAEACEAE

Daphne pontica L.

N 40°22'15.2" –E 029°57'21.7", 147m, OUFE: 14451, Euxine, 12 VI 2008.

D. serieca Vahl.

N 40°21'49.8" –E 029°57'03.8", 107m, OUFE: 14452, E. Medit., 10 IV 2008.

D. oleoides Schreber. subp. ***oleoides***

N 40° 22'15.2" –E 029°57'21.7", 147m, OUFE: 16529, 27 III 2006.

ELAEAGNACEAE

Elaeagnus angustifolia L. var. ***orientalis*** (L.) Kuntze

N 40°23'42.5" –E 030°15'26.3", 688m, OUFE: 14453, 01 V 2006.

LORANTHACEAE

Viscum album L. subsp. ***album***

N 40°21'41.1" –E 029°55'22.2", 138m, OUFE: 14454, 27 III 2006.

RAFFLESIACEAE

Cytinus hypocistis L.subsp. ***kermesinus*** (Guss.) Wettst.

N 40°14'37.8" –E 029°59'35.8", 378m, OUFE: 14455, Medit., 15 V 2008.

ARISTOLOCHIACEAE

Asarum europeum L.

N 40°24'13.3" –E 030°00'19.8", 96m, OUFE: 14456, Euro.-Sib., 10 IV 2006.

Aristolochia clematitis L.

N 40°23'25.3" –E 029°59'38.5", 89m, OUFE: 16530, Euro.-Sib., 08 V 2008.

A. pallida Willd.

N 40°21'49.8" –E 029°57'03.8", 107m, OUFE: 14457, 22 V 2008.

A. bodamae Dingler

N 40°22'33.7" –E 029°54'59", 151m, OUFE: 14458, 12 VI 2008.

EUPHORBIACEAE

Andrachne telephioides L.

N 40°23'42.5" –E 030°15'26.3", 688m, OUFE: 14459, 01 V 2006.

Chrozophora tinctoria (L.) A. Juss.

N 40°20'42.1" –E 029°52'50.1", 174m, OUFE: 14460, 15 VIII 2008.

Mercurialis annua L.

N 40°22'06.0" –E 030° 01'44.7", 105m, OUFE: 14461, Euro.-Sib., 10 IV 2008.

M. perennis L.

N 40°26'31.5" –E 030°03'30.3", 92m, OUFE: 14462, 19 III 2008.

Euphorbia peplis L.

N 40°16'39.8" –E 029°57'51.4", 480m, OUFE: 14463, Medit., 11 IX 2008.

***E. apios* L.**

N 40°20'56.2" –E 030°03'05.8", 103m, OUFE: 16572, E Medit., 28 III 2009.

E. palustris L.

N 40°25'15.3" –E 030°08'52.9", 517m, OUFE: 14464, Euro.-Sib., 21 IV 2007.

E. helioscopia L.

N 40°22'21.5" –E 030° 03'58.1", 141m, OUFE: 14465, 26 V 2006.

E. aleppica L.

N 40°20'42.1" –E 029°52'50.1", 174m, OUFE: 16573, 15 VIII 2008.

E. taurinensis All.

N 40°23'08.8" –E 029°57'11.7", 116m, OUFE: 16574, 15 IV 2009.

E. falcata L. subsp. ***falcata*** var. ***galilaea*** (Boiss.)Boiss.

N 40°23'21.1" –E 030°11'40.7", 584m, OUFE: 14466, 13 VII 2007.

E. anacampseros Boiss. var. ***anacampseros***

N 40°21'07.4" –E 029°59'55.2", 386m, OUFE: 16531, End-LC, 23 IV 2009.

E. myrisitines L.

N 40°21'18.5" –E 029°54'45.0", 117m, OUFE: 16532, 15 IV 2009.

URTICACEAE

Urtica dioica L.

N 40°20'35.3" –E 030°04'34.9", 223m, OUFE: 14467, Euro.-Sib., 03 VIII 2008.

Parietaria judaica L.

N 40°26'31.5"–E 030°03'30.3", 92m, OUFE: 14468, 10 IV 2006.

ULMACEAE

Celtis australis

N 40°18'22.5" –E 030°06'36.4", 168m, OUFE: 16533, 06 VIII 2009.

MORACEAE

Morus alba L.

N 40°23'42.5" –E 030°15'26.3", 688m, OUFE: 14469, 01 V 2006.

M. nigra L.

N 40°23'42.5" –E 030°15'26.3", 688m, OUFE: 14470, 01 V 2006.

Ficus carica L. subsp. ***carica***

N 40°23'21.1" –E 030°11'40.7", 584m, OUFE: 14471, 26 IX 2006.

JUGLANDACEAE

Juglans regia L.

N 40°24'23.4" –E 030°10'23.9", 640m, OUFE: 14472, 26 IX 2006.

PLATANACEAE

Platanus orientalis L.

N 40°24'49.6" –E 030°13'23.9", 539m, OUFE: 14473, 26 IX 2006.

FAGACEAE

Fagus orientalis Lipsky

N 40°20'35.3" –E 030°04'34.9", 223m, OUFE: 14474, Euro.-Sib., 26 IX 2006.

Castanea sativa Miller

N 40°20'15.,2" –E 030°10'49.1",146m, OUFE: 14475, Euro.-Sib., 25 VII 2006.

Quercus robur L.subsp. ***robur***

N 40°20'52.3" –E 030°05'56.4", 290m, OUFE: 14476, Euro.-Sib., 25 VII 2006.

Q. petraea (Mattschka) Liebl. subsp. ***iberica*** (Steven ex Bieb.) Krassiln.

N 40°24'13.3" –E 030°00'19.8", 96m, OUFE: 14477, 16 X 2008.

Q. infectoria Olivier subsp. ***boissieri*** (Reuter) O. Schwarz

N 40°19'39.1" –E 029°54'48.4", 622m, OUFE: 14478, Euro.-Sib., 16 X 2008.

Q. pubescens Willd.

N 40°20'42.1" –E 029°52'50.1", 174m, OUFE: 14479., 17 IV 2006.

CORYLACEAE

Carpinus betulus L.

N 40°23'59.8" –E 030°17'12.6", 566m, OUFE: 14480, Euro.-Sib., 13 VII 2007.

SALICACEAE

Salix alba L.

N 40°17'30.0" –E 029°50'35.0", 194m, OUFE: 14481, Euro.-Sib., 21 IV 2007.

S. cinerea L.

N 40°21'41.1" –E 029°55'22.2", 138m, OUFE: 14482, Euro.-Sib., 21 IV 2007.

Populus alba *L.*

N 40°23'42.5" –E 030°15'26.3", 688m, OUFE: 14483, Euro.-Sib., 19 III 2008.

P. tremula *L.*

N 40°22'22.8" –E 029°54'32.4", 156m, OUFE: 14484, Euro.-Sib., 17 IV 2006.

P. nigra L. subsp. ***nigra***

N 40°20'10.1" –E 030°05'37.7", 208m, OUFE: 14485, 26 V 2006.

RUBIACEAE

Asperula lilaciflora Boiss. subsp. ***phrygia*** (Bornm.) Schönb

N 40°24'23.4" –E 030°10'23.9", 640m, OUFE: 14486, End-LC, 12 VI 2008.

A. pestalozzae Boiss.

N 40°22'15.2" –E 029°57'21.7", 147m, OUFE: 14487, End-LC-Euxine, 24 VII 2006.

A. arvensis L.

N 40°25'58.5"–E 030°03'08.9", 94m, OUFE: 14488, Medit., 10 IV 2006.

A. rumelica

N 40°14'28.3"–E 030°00'40.1", 296m, 30 IV 2009.

Callipetis cucullaria (L.) Steven

N 40°21'16.6"–E 030°02'52.3", 189m, Ir.-Tur., 03 VI 2009.

Galium rivale (Sm.) Griseb.

N 40°22'15.2"–E 029°57'21.7", 147m, OUFE: 14489, Euro.-Sib., 25 VII 2006.

G. odoratum (L.) Scop.

N 40°20'52.3" –E 030°05'56.4", 290m, OUFE: 14490, Euro.-Sib., 26 V 2006.

G. verum L. subsp. ***verum***

N 40°21'39.0" –E 030°30'21.0", 170m, OUFE: 14491, Euro.-Sib., 18 V 2006.

G. incanum Sm. subsp. ***elatius*** (Boiss.) Ehrend.

N 40°20'08.3" –E 030°12'46.0", 217m, OUFE: 14492, Ir.-Tur., 11 IV 2007.

G. spurium L. subsp. ***spurium***

N 40°22'06.0" –E 030°01'44.7", 105m, OUFE: 14493, Euro.-Sib., 10 IV 2008.

G. floribundum subsp***. floribundum***

N 40°19'38.4" –E 029°54'48.1", 672m, OUFE: 16534, 03 VI 2009.

Cruciata taurica (Palas ex Willd.) Ehrend.

N 40°24'49.6" –E 030°13'23.9", 539m, OUFE: 14494, Ir.-Tur., 13 VII 2007.

Rubia peregrina L.

N 40°23'21.1" –E 030°11'40.7", 584m, OUFE: 14495, Medit., 12 VI 2008.

R. tinctorium L.

N 40°14'31.4" –E 030°02'25.4", 211m, OUFE: 14496, Ir.-Tur., 12 VII 2008.

MONOCOTYLEDONAE

ARACEAE

Arum maculatum L.

N 40°20'35.3" –E 030°04'34.9", 223m, OUFE: 14497, 26 V 2006.

A. elongatum Steven. subsp. ***elongatum***

N 40°27'07.5" –E 030°08'35.0", 87m, OUFE: 14498, 10 IV 2006.

Dracunculus vulgaris Schott 5-6

N 40°22'21.5"–E 030°03'58.1", 141m, OUFE: 14499, E.Medit., 26 V 2006.

LILIACAEAE

Ruscus aculeatus L. var. ***angustifolius*** Boiss.

N 40°13'43.7" –E 029°56'59.1", 260m, OUFE: 14500, 08 V 2008.

Asparagus acutifolius L.

N 40°16'39.8" –E 029°57'51.4", 480m, OUFE: 14501, Medit., 11 IX 2008.

A. tenuifolius Lam

N 40°23'21.6" –E 030°09'56.2", 539m, OUFE: 16535, Euro.-Sib., 03 VII 2009.

A. officinale L.

N 40°20'35.3" –E 030°04'34.9", 223m, OUFE: 16575, 26 V 2006.

Polygonatum orientale Desf.

N 40°27'07.5" –E 030°08'35.0", 87m, OUFE: 14502, Euxine, 01 V 2006.

Asphodeline lutea (L.) Reichb.

N 40°14'45.1" –E 030°01'14.7", 238m, OUFE: 14503, Medit., 08 V 2008.

A. damascena (Boiss.) Baker subsp. ***damascena***

N 40°18'43.1" -E 030°07'09.4",135m, OUFE: 14504, Ir.-Tur., 01 V 2006.

Allium sieheanum (L. (Hausskn. Ex) Kollmann

N 40°21'38.4" –E 030°13'55.8", 195m, OUFE: 14505, Ir.-Tur., 25 VII 2006.

A. myrianthum Boiss.

N 40°18'12.2" –E 029°59'41.2", 377m, OUFE: 16536, Ir.-Tur., 18 V 2006.

A. ampeloprasum L.

N 40°14'48.1" –E 030°01'48.4", 147m, OUFE: 14506, Medit., 22 V 2008.

A. atroviolaceum Boiss.

N 40°20'49.9" –E 030°17'50.4", 621m, OUFE: 14507, 25 VII 2006.

A. scorodoprasum L.Stearn subsp. ***rotundum*** (L.) Stearn

N 40°18'36.3" –E 030°03'16.1", 156m, OUFE: 14508, Euxine, 25 VII 2006.

A. jubatum Macbride

N 40°18'24.3" –E 030°07'18.0", 242m, OUFE: 16537, Euxine, 22 V 2008.

A. atropurpureum Waldst.&Kit.

N 40°17'26.7" –E 029°55'59.2", 753m, OUFE: 16538, Euro.-Sib., 15 V 2008.

A. orientale Boiss.

N 40°18'12.2" –E 029°59'41.2", 377m, OUFE: 16539, E. Medit., 18 V 2006.

A. lycaonicum Siehe ex Hayek

N 40°14'48.1" –E 030°01'48.4", 147m, OUFE: 14509, 22 V 2008.

A. guttatum subsp. ***sardoum***

N 40°19'06.7" –E 030°07'36.9", 123m, OUFE: 16540, Medit., 06 VIII 2009.

A. paniculatum subsp. ***paniculatum***

N 40°20'50.6" –E 029°54'49.8", 367m,Medit., 03 VI 2009.

Scilla bifolia L.

N 40°20'15.,2" –E 030°10'49.1",146m, OUFE: 14510, Medit., 10 IV 2006.

S. autumnalis L.

N 40°21'07.2" –E 029°54'08.4", 96m, OUFE: 14511, Medit., 25 VII 2006.

Ornithogalum pyrenaicum L.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14512, 01 V 2006.

O. sphaerocarpum Kerner

N 40°22'21.5"-E 030°03'58.1", 141m, OUFE: 14513, 10 IV 2006.

O. oligophyllum E.D. Clarke

N 40°25'58.5"-E 030°03'08.9", 94m, OUFE: 14514, 10 IV 2006.

O. fimbriatum Willd.

N 40°16'14.4"-E 030°07'00.9", 202m, OUFE: 14515, E. Medit., 01 V 2006.

O. sigmoideum Freyn&Sint.

N 40°21'49.8"-E 029°57'03.8", 107m, OUFE: 14516, Euro.-Sib., 10 IV 2008.

O. comosum L.

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14517, 08 V 2008.

O. umbellatum L.

N 40°23'05.5"-E 029°56'09.9", 204m, OUFE: 16541, 09 V 2007.

O. alpigenum Stapf

N 40°22'22.8"-E 029°54'32.4", 156m, OUFE: 14518. End-LC- Medit., 17 IV 2006.

Muscari comosum (L.) Miller

N 40°26'45.4"-E 030°07'48.4",189m, OUFE: 14519, Medit., 27 III 2006.

M. tenuifolium Tausch

N 40°22'15.2"-E 029°58'22.8", 147m, OUFE: 14520, 10 IV 2006.

M. neglectum Guss.

N 40°25'58.5"-E 030°03'08.9", 94m, OUFE: 14521, 10 IV 2006.

M. armeniacum Leichtlin ex Baker

N 40°27'13.4"-E 030°05'45.0", 72m, OUFE: 14522., 10 IV 2006.

Fritillaria pontica Wahlenb.

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14523, Euro-Sib., 11 IV 2007.

F. fleischeriana Steudel&Hochst

N 40°22'22.8"-E 029°54'32.4", 156m, OUFE: 14524, End-LC-Ir.-Tur., 17 IV 2006.

F. pinardii Boiss.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14525, Ir.-Tur., 10 IV 2006.

Tulipa sylvestris L.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14526, 10 IV 2006.

T. armena Boiss. var. ***lycica*** (Baker) Marais

N 40°20'04.1"-E 030°12'57.9", 238m, OUFE: 14527, End-LC, 24 IV 2006.

Gagea bithynica Pascher

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14528, End-LC-E. Medit., 28.02.2007.

G. villosa (Bieb.) Duby var. ***villosa***

N 40°19'62.7"-E 029°53'57.5", 713m, OUFE: 14529, Medit., 28.02.2007.

Colchicum szovitsii Fisch.& Mey.

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14530, Ir.-Tur., 11 IV 2007.

C. triphyllum G. Kunze

N 40°27'13.4"-E 030°05'45.0", 72m, OUFE: 14532, Medit., 10 IV 2006.

C. bornmuelleri Freyn.

N 40°22'11.2"-E 029°54'19.9", 678m, OUFE: 14533, End-LC-Euxine,17 X 2006.

C. bivonae Guss.

N 40°21'51.3"-E 029°57'06.9", 114m, OUFE: 16576, 03 VI 2009.

Merendera attica (Spruner) Boiss.&Spruner

N 40°21'06.5"-E 029°59'58.5", 318m, OUFE: 14535, E. Medit., 11 IV 2007.

AMARYLLIDACEAE

Galanthus gracilis Celak

N 40°25'58.5"-E 030°03'08.9", 94m, OUFE: 14536, 10 IV 2006.

IRIDACEAE

Iris orientalis Mill.

N 40°26"45.4"-030°07'48.4",189m, OUFE: 14537, E. Medit., 10 IV 2006.

I. schachtii Markgraf

N 40°20'08.3"-E 030°12'46.0", 217m, OUFE: 14538, End-LR-Ir.-Tur., 11 IV 2007.

I. kerneriana Ascherson&Sint. Ex Baker

N 40°21' 04.9"-E 029°59'56.3", 330m, OUFE: 16542, End-LC, 30 IV 2009.

I. attica Boiss.& Heldr.

N 40°14'28.3"-E 030°00'40.1", 296m, OUFE: 16543, VU, 30 IV 2009.

Crocus ancyrensis (Herbert) Maw

N 40°20'58.0"-E 030° 00'03.1", 363m, OUFE: 14539, End-LR-Ir.-Tur., 04 IV 2007.

C. chrysanthus (Herbert) Herbert

N 40°21'52.9"-E 030° 03'36.2", 177m, OUFE: 14540, 04 IV 2007.

C. danfordiae Maw

N 40°22'33.7"-E 029°54'59", 151m, OUFE: 14541, End-LC, 17 IV 2006.

C. flavus Weston subsp. ***flavus***

N 40°16'19.9"-E 029°54'51.3", 690m, OUFE: 16544, Euro.-Sib., 02 IV 2009.

C. olivieri Gay subsp. ***olivieri***

N 40°23'44.2-E 030° 04'05.0", 279m, OUFE: 14542, 21 III 2007.

C. pallasii Goldb. subp. ***pallasii***

N 40°20'32.7"-E 030°04'32.3", 203m, OUFE: 14543.

Gladiolus illyricus W. Koch

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14544, Medit., 01 V 2007.

G. atroviolaceus Boiss.

N 40°20'40.7"-E 029°55'04.3", 331m, OUFE: 14545, Ir.-Tur., 27 III 2006.

ORCHIDACEAE

Cephalanthera epipactoides Fisch.&Mey.

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 16577, E. Medit., 18 V 2006.

C. rubra (L.) L. C. M. Richard

N 40°17'39.3"-E 029° 56'27.6", 784m, OUFE: 14546, 09 V 2007.

C. longifolia (L.) Fritsch

N 40°23'25.3"-E 029°59'38.5", 89m, OUFE: 14547, Euro.-Sib, 08 V 2008.

C. damasonium (Miller) Druche

N 40°21'15.3"-E 029°54'06.8", 108m, OUFE: 16545, Euro.-Sib., 18 V 2006.

Epipactis condensata Boiss. ex D. P.

N 40°18'24.3"-E 030°07'18.0", 242m, OUFE: 14548, 22 V 2008.

E. helleborine

N 40°19'06.7"-E 030°07'36.9", 123m, OUFE: 16546, 06 VIII 2009.

E. persica

N 40°23'21.6"-E 030°09'56.2", 539m, OUFE: 16547, 03 VII 2009.

Limodorum abortivum (L.) Swartz

N 40°22'22.8"-E 029°54'32.4", 156m, OUFE: 14549, 17 IV 2006.

P. chlorantha (Custer) Reiche. subsp. chlorantha

N 40°22'15.2"-E 029°57'21.7", 147m, OUFE: 14550, Euro.-Sib., 25 VII 2006.

Orphrys fusca Link.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14551, Medit., 10 IV 2006.

O. lutea Cav. subsp. ***minor*** (Guss.) O.&E. Danesch,

N 40°18' 09.4"-E 029°57'18.4", 767m, OUFE: 16548, E. Medit., 02 IV 2009.

O. mammosa Desf.

N 40°21'38.4"-E 030°13'55.8", 195m, OUFE: 14552, E. Medit., 01 V 2006.

O. pseudomammosa

N 40°19'38.4"-E 029°54'48.1", 672m, OUFE: 16549, 03 VI 2009.

O. oestrifera Bieb. subsp***. oestrifera***

N 40°20'40.7"-E 30°02'12.3", 331m, OUFE:14588., 12 VI 2008.

Serapias bergonii E.G. Camus, Bergon&A. Camus subsp***. bergonii***

N 40°23'08.8"-E 29°57'11.7", 116m, D. Akd. El, OUFE:14590, E. Medit., 15 IV 2009.

Himantoglossum caprinum (M. Bieb.) Spreng. Subsp. ***caprinum***

N 40°14'31.4"-E 30°02'25.4", 211m, OUFE:14591, Euxine, 12 VII 2008.

Anacamptis pyramidalis (L.) L.C.M. Richard

N 40°17'26.7"-E 029°55'59.2", 753m, OUFE: 14553., 15 V 2008.

Orchis tridentata Scop.

N 40°25'13.5"-E 030°01'25.2", 160m, OUFE: 16550, Medit., 01 V 2007.

O. purpurea Hudson

N 40°16'39.8"-E 029°57'51.4", 480m, OUFE: 14554, Euro.-Sib., 08 V 2008.

O. simia Lam.

N 40°18' 43.1"-E 030° 07'09.4",135m, OUFE: 14555, Medit., 01 V 2006.

O. anatolica Boiss.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14556, Medit., 01 V 2007.

O. mascula (L.) subsp. ***pinetorum*** (Boiss.&Kotschy) G. Camus

N 40°13'37.2"-E 029°57'44.9", 287m, OUFE: 14557, E. Medit., 08 V 2008.

O. pallens L.

N 40°13'37.2"-E 029° 57'44.9",287m, OUFE: 14594, E. Medit, 08 V 2008.

Dactylorhiza romana (Seb.) Soo subsp. ***romana***

N 40°17'41.3"-E 030°06'33.6", 291m, OUFE: 14558, Medit., 24 IV 2006.

D. incarnata

N 40°20'50.6"-E 029°54'49.8", 367m, OUFE: 16551, 03 VI 2009

DIOSCOREACEAE

Tamus communis L. subsp. ***communis***

N 40°13'43.7"-E 029°56'59.1", 260m, OUFE: 14559., 16 X 2008.

TYPHACEAE

Typha latifolia L.

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 14560., 27 IX 2008.

T. angustifolia

N 40°25'47.8"-E 030°03'34,4", 116m, OUFE: 16552, 06 VIII 2009.

JUNCACEAE

Juncus heldreichianus Marsson ex Parl**.** subsp**. *heldreichianus***

N 40°18'25.8"-E 029°59'58.9", 589m, OUFE: 16553, E. Medit., 03 VII 2009.

J. inflexus L.

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14561., 09 VI 2008.

J. buffonius L.

N: 40°22'24.4"- E 029°45'34.6", 430m, OUFE:15689, 17 IV 2006.

CYPERACEAE

Eleocharis palustris (L.) Roemer&Schultes

N 40°22'22.8"-E 029°54'32.4", 156m, OUFE: 14562., 17 IV 2006.

Carex pendula Hudson

N 40°17'30.0"-E 029°50'35.0", 194m, OUFE: 14563, Euro.-Sib., 27 III 2006.

POACEAE

Elymus elongatus **(**Host**)** Runemark subsp**. *elongatus***

N 40°26'31.5"-E 030°03'30.3", 92m, OUFE: 16554., 27 IX 2008.

E. hispidus **(**Opiz**)** Melderıs subsp**. *hispidus***

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 16555., 25 VII 2006.

Aegilops umbellulata Zhuk**.** subsp**. *umbellulata***

N 40°18'22.5"-E 030°06'36.4", 168m, OUFE: 16556, 06 VIII 2009.

Ae. triuncialis (L.) subsp. ***triuncialis***

N 40°21'07.2"-E 029°54'08.4", 96m, OUFE: 14564., 09 VI 2008.

Triticum L.

T. aestivum L.

N 40°26'45.4"-E 030°07'48.4",189m, OUFE: 14565., 10 IV 2006.

Hordeum murinum L.subs. ***glaucum*** (Steudel) Tzvelev

N 40°18'36.3"-E 030°03'16.1", 156m, OUFE: 14566., 25 VII 2006.

H. bulbosum L.

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14567., 25 VII 2006.

Bromus hordeaceus subsp. ***hordeaceus*** L.

N 40°23'21.1"-E 030°11'40.7", 584m, OUFE: 14568., 26 IX 2006.

B. tectorum L.

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14569,17 IV 2006.

B. sterilis **L.**

N 40°18'22.5"-E 030°06'36.4", 168m, OUFE: 16578, 06 VIII 2009.

Avena barbata Pott subsp. ***barbata***

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14570, 25 VII 2006.

Arrhenatherum P.Beauv.

A. palaestinum Boiss.

N 40°24'23.4"-E 030°10'23.9", 640m, OUFE: 16557, 26 IX 2006.

Alopecurus myosuroides HUDS. var. ***myosuroides***

N 40°22'24.4"-E 029°45'34.6",430m, OUFE: 14571., 25 VII 2006.

Phleum pratense L.

N 40°21'38.4"-E 030°13'55.8", 195m,OUFE: 14572, 25 VII 2006.

P. montanum C.KOCH **subs.** ***montanum***

N 39°40'47.8"-E 029°56'51.4", 539m, OUFE: 16558, 03 VII 2009.

Lolium perenne L.

N 40°27'07.5"-E 030°08'35.0", 87m, OUFE: 14573, 25 VII 2006.

L. multiflorum Lam**.**

N 40°21'51.3"-E 029°57'06.9", 114m, OUFE: 16559, 03 VI 2009.

Vulpia cliata Dumort. subsp. ***cliata***

N 40°22'33.1"-E 029°50'26.9",573m, OUFE: 16560, 15 VIII 2008.

Poa annua L.

N 40°17'25.7"-E 030°07'15.7", 266m, OUFE: 1457410, IV 2006.

P. trivialis L.

N 40°20'10.1"-E 030°05'37.7", 208m, OUFE: 14575., 26 V 2006.

P. bulbosa L.

N 40°26'19.5"-E 030°00'36.4", 294m, OUFE: 14576., 01 V 2007.

Dactylis glomerata **L. subs.** hispanica

Melica ciliata L. subsp. ***ciliata***

N 40°21'07.2"-E 029°54'08.4", 96m,OUFE: 14577, 09 VI 2008.

Stipa bromoides (L.) Dörfler

N 40°20'08.6"-E 030°12'46.1", 218m, OUFE: 14578, Medit., 25 VII 2006.

S. holosericea Trin.

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 16561., 25 VII 2006.

Pitatherum miliaceum (L.) Cosson subsp. ***thomasii***

N 40°15'28.5"-E 029°54'37.4", 622m, OUFE: 16562, 16 X 2008.

Phragmites australis (Cav.) Trin. ex Steudel

N 40°26'31.5"-E 030° 03'30.3", 92m, OUFE: 14579, Euro.-Sib., 27 IX 2008.

Cynodon dactylon (L.) Pers *var*. ***dactylon***

N 40°26'45.4"-E 030°07'48.4",189m, OUFE: 14580, 10 IV 2006.

Setaria viridis (L.) P. Beauv

N 40°19'46.9"-E 030°06'30.1", 117m, OUFE: 14581, 26 V 2006.

Chrysopogon gryllus (L.) Trin

N 40°17'26.7"-E 029°55'59.2", 753m, , OUFE: 14582. 15 V 2008.

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Human Thermal Comfort Situation in the City of Sakarya, Turkey

Yuksel Guclu,PhD
Sakarya University, Faculty of Education,
Department of Social Studies Education,
Hendek, Sakarya, Turkey.
E-Mail:yguclu@sakarya.edu.tr

Abstract

In this study, the determination of the human thermal comfort situation in the city of Sakarya has been aimed. In the direction of the aim, the temperature and relative humidity data of Sakarya Meteorology station have been examined according to The Thermo-hygrometric Index (Thom Index) (THI) and the New Summer Simmer Index (SSI). According to this, it has been determined that the thermal comfort conditions are not appropriate in the period of November-May on average monthly. The June and September are the months which can be accepted as the most comfortable in terms of both THI and SSI.

Keywords: Thermal comfort; Human health; The Thermo-Hygrometric Index; The Summer Simmer Index; Sakarya city; Turkey

1. Introduction

The climate which is one and leading of many components of the inhabited environment forms direct and indirect effects on the human life and activities (Bahadir and Karagulle,1983). For the people to continue their lives in a comfortable environment, the climate conditions are also required to be appropriate to this. In this context, the human thermal comfort has a big importance.

"Human thermal comfort is defined as the condition of mind which expresses satisfaction with the thermal environment, absence of thermal discomfort. Variables of thermal comfort are the air temperature, radiant temperature, air velocity, relative humidity, activity and clothing" (From ASHREA 55,2004,(Yilmaz et al.,2007). It is known that the comfort feeling is subjective and there are different psychological and physical factors affecting this feeling. However, such kind of a study made on the human thermal comfort is interesting as it shows to what extent the climate conditions of the inhabited environment show average or optimum values in terms of climate conditions and it is also interesting in terms of determining the deviation measure from the average (Kocman,1993). On the other hand, when it is considered that the human activities cannot be always limited to the spaces which are equipped air-conditioning systems such as buildings and vehicles, the importance of this situation is clearly understood (Ozguc,1998).

In this study, with reference to the above mentioned issues, it has been aimed to find an answer to the question of "How is the thermal comfort situation for human in the city of Sakarya which is one of rapidly developing cities of Turkey?"

2. Methodology

Study Area

Sakarya city which is the study area constitutes the Centrum of the city which is called with its name (Fig. 1).

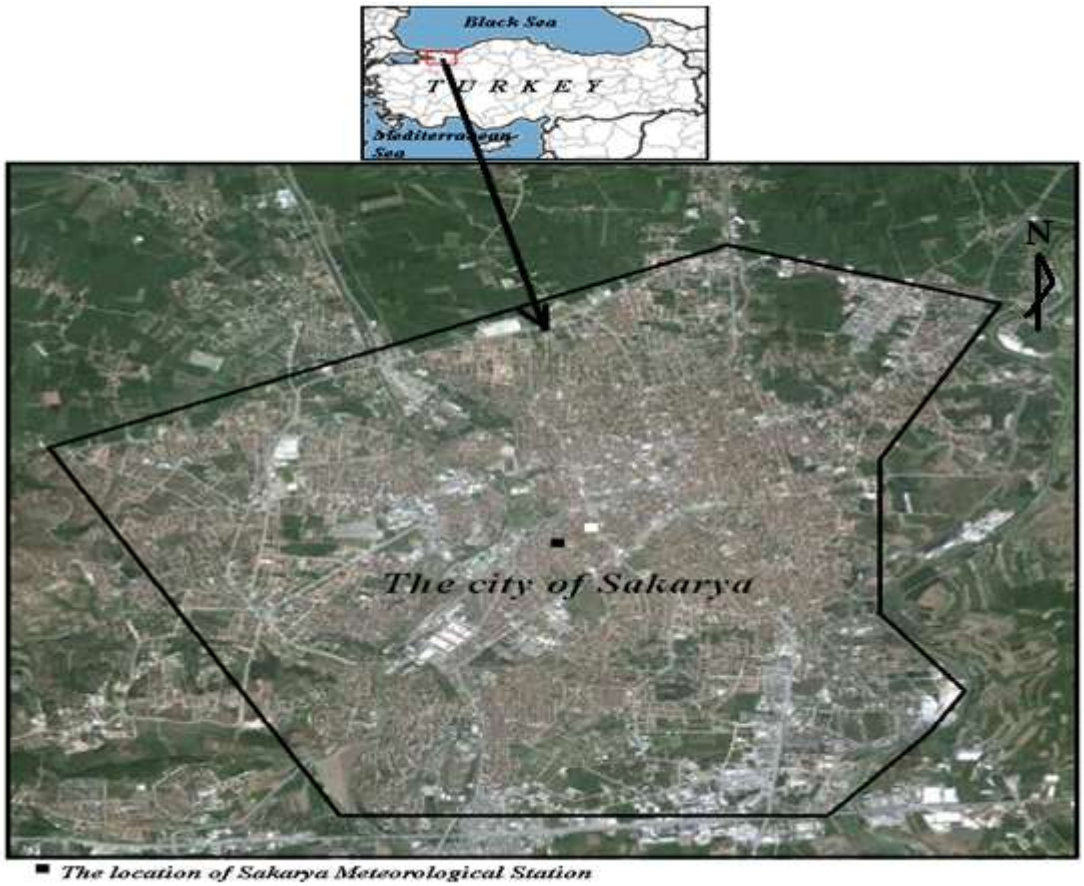


Fig. 1.The location of the study area

Data Collection and Analyses

In the study, the average temperature and relative humidity data belonging to the Sakarya Meteorology Station and covering the period of 1970-2011 have been used. Because, although many factors are effective on the human thermal comfort, the temperature and humidity among them are effective in their wide areas (www.bom.gov.au ,2012) and have effects on everybody. The obtained data have been analysed by using The Thermo-Hygrometric Index (Thom Index) (THI) (Tzenkova et al., 2007) and The Summer Simmer Index (SSI) (Pepi,1999; Tzenkova et al.,2007) which has been calculated by considering the simultaneous effect of the temperature and relative humidity and commonly used by many researchers.

3.Results

The Thermo-Hygrometric Index (Thom Index) (THI): THI values have been determined in Sakarya city on average monthly in months of May, September and October; in the period of June- September as of 07.00 o'clock; in the months of April and October as of 14.00 o'clock; in the months of May, June and September as of 21.00 o'clock in the "Comfortable" category (Table 1). As of 07.00 o'clock, THI values are not observed in the "Hot" category. As of 14.00 o'clock in the period of May- September; as of 21.00 o'clock in the months of July and August and according to the monthly averages

in the months of June, July and August THI values are observed in the "Hot" category (Table 1).

Table 1: Monthly status of THI (Thom Index) categories in the city of Sakarya (according to Besansenot classification scheme) (period of 1970-2011)

THI values	THI categories and values according to months and calculation hours											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XI
THI value at 07.00 o'clock	5,48	5,54	6,76	10,43	14,5	18,16	19,79	19,15	15,53	12,34	9,04	7,18
THI value at 14.00 o'clock	9,66	10,47	12,96	16,83	20,32	23,33	24,78	24,69	22,38	18,88	14,89	11,21
THI value at 21.00 o'clock	6,94	7,22	8,81	12,27	15,96	19,62	21,53	21,35	18,32	14,68	10,94	8,53
Monthly *average THI* value	7,24	7,71	9,52	13,16	16,84	20,29	21,97	21,80	18,86	15,28	11,57	8,89

Cold | Cool | Comfortable | Hot

The THI values qualified as "Cool" in the city of Sakarya have been determined in the month of April as monthly average; in the month of May as of 07.00 o'clock; in the month of November as of 14.00 o'clock; in the month of October as of 21.00 o'clock (Table 1). As its degree changing, THI values take place in the "Cold" category in October - April period (7 months) as of 07.00 o'clock; December-March period (4 months) as of 14.00 o'clock; November - April period (4 months) as of 21.00 o'clock and November -March period (5 months) on monthly average (Table 1).

The New Summer Simmer Index (SSI): According to the monthly averages, in Sakarya city, "Zone 2" is dominant in the month of June and "Zone 3" is dominant in the months of July and August and "Zone 1" is dominant in the month of September (Table 2).

Table 2: Monthly situation of SSI categories in the city of Sakarya (period of 1970-2011)

SSI values	SSI categories and values according to months and calculation hours											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XI
SSI value at 07.00 o'clock	26,03	26,25	30,68	43,69	58,19	71,25	77,05	74,77	61,88	50,50	38,75	32,10
SSI value at 14.00 o'clock	33,77	43,79	52,69	66,46	78,89	89,63	94,81	94,49	86,24	73,79	59,57	46,47
SSI value at 21.00 o'clock	31,23	29,60	37,89	50,22	63,39	76,42	83,22	82,60	71,79	58,83	45,49	36,90
Monthly average SSI value	32,30	33,99	40,44	53,40	66,53	78,83	84,82	84,21	73,73	60,97	47,76	38,20

Out of classification | Zone 1 | Zone 2 | Zone 3 | Zone 4

The thermal comfort conditions have been determined in the category of "Zone 1" in the summer months as of 07.00 o'clock; in the category of "Zone 1" in the month of May as of 14.00 o'clock; in the category of "Zone 3" in the months of June and September; in the category of "Zone 4" in the months of July and August and in the category of "Zone 1" in the month of October; in the category of "Zone 1" in the months of June and September as of 21.00 o'clock, in the category of "Zone 2" in the months of July and august. Although the period degree remaining "Out of classification" category according to SSI data changes, it covers whole year (nine months) excluding the summer

months as of 07.00 o'clock (Table 2). This period corresponds to the period of November-April (six months) as of 14.00 o'clock and to the period of October-May (8 months) on monthly average (Table 2).

4.Discussion and Conclusion

07.00 o'clock: It shows inappropriate human thermal comfort conditions in the city of Sakarya according to both indices. As of this time, the summer months are appropriate to all kinds of human activities in thermal comfort terms. 14.00 o'clock: In city of Sakarya, it shows inappropriate thermal comfort conditions in the period of November-march according to both indices. As of this time, the month of November shows appropriate thermal comfort conditions and the months of May, June and September show "Acceptable" category thermal comfort conditions. The months of July and August are the months in which the human thermal comfort significantly decreases due to the high temperature as of 14.00 o'clock. 21.00 o'clock: It shows inappropriate thermal comfort conditions in the period of October-May. The months of June and September are appropriate to almost all kinds of human activities in thermal comfort terms for this time. The months of July and August are generally appropriate to the human health and activities as of this time. Monthly average: It shows inappropriate thermal comfort conditions in the period of October-May. In the city of Sakarya, the most appropriate month is September according to both indices and the month of May can be considered as appropriate in terms of human thermal comfort. These months are appropriate to all kinds of human activities. The months of July and August are the months in which the human thermal comfort significantly decreases due to the high temperature.

As a result, in the city of Sakarya the months of June, July and August have the most convenient conditions in terms of human thermal comfort as of 07.00 o'clock; the months of May, June, and September and mainly October have the most convenient conditions in terms of human thermal comfort as of 14.00 o'clock; the months of June and September have the most convenient conditions in terms of human thermal comfort as of 21.00 o'clock; and the months of may and September have the most convenient conditions in terms of human thermal comfort as monthly average. The human thermal comfort significantly decreases in the months of July and August due to the high temperature and relative humidity as of 14.00 o'clock, 21.00 o'clock and on monthly average. At these times, it is recommended that the ones in the risk group such as mainly the ones having health problem, old persons, and children should care the type, level of the activities in the open areas and dresses as health problems can happen and they should avoid the heavy activities which will force especially the body. Also, it will be beneficial that the arising thermal comfort conditions should be announced to the persons living in the city by using the appropriate and common communication tools and especially the ones in the risk group should be warned. On the other hand, the fact that the external environment temperatures are higher than 22^{o}C reveals the need of cooling in the closed spaces in these months for the human thermal comfort.

The human thermal comfort significantly decreases due to the low temperature and high relative humidity in the period of October-May as of 07.00 o'clock; in the period of November-March as of 14.00 o'clock, in the period of October-May as of 21.00 o'clock and in the period of November -May as monthly average. In these periods, people should be provident against the situations which can threaten the human health. Especially the clothing should be cared and the activities which will compel the body should be avoided.

On the other hand, as the external environment temperatures are below 15^{o}C in this period, there is a need for heating in the closed environments for providing thermal comfort.

References

Bahadir A., Karagulle Z. Climate types in bio-meteorological terms and its physiological-pathological-therapeutic effects. In, Proceedings Book of Medical Biometeorology Seminar, Ankara. pp.15,1983 [in Turkish].

Yilmaz S., Toy T., Yilmaz H. Human thermal comfort over three different land surfaces during summer in the city of Erzurum, Turkey. Atmosfera 20(3), 289-297, 2007.

Kocman A. Climate of Aegean plains in terms of their effects on the human activities and environment. Publications of Aegean University Faculty of Letters:73,İzmir, 1993 [in Turkish].

Ozguc N. Tourism Geography. Characteristics. Regions. Cantay Publishing, İstanbul, 1998 [in Turkish].

Australian Government Bureau of Meteorology. Thermal comfort observations. http://www.bom.gov.au/info/thermal_stress/ **(25.05.2012).**

Tzenkova A., Ivancheva J., Koleva E.,Videnov P. The human comfort conditions at Bulgarian Black Seaside. In, Developments in Tourism Climatology (Edit. A.

Matzarakis, C. R. de Freitas, D. Scott), 2007:150-157, (http://www.mif.uni-freiburg.de/ISB /ws3/report /dTcl_ 2007 _ didaskalouetal _.pdf,15.05.2012).

Pepi J. W. The New Summer Simmer Index - A comfort index for the new millennium.1999, (http:// www. Summersimmer .com / home.htm, 15.05.2012).

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Economic Study of the Asian Region

Owen Tang
owen.tang@inet.polyu.edu.hk
Instructor, Department of Logistics and Maritime Studies

Po-wan SUN
brian.pw.sun@polyu.edu.hk
Teaching Fellow, Department of Logistics and Maritime Studies

Yui Yip Lau
josephlau627@hotmail.com
Department of Logistics and Maritime Studies

Abstract

Since two-thirds of the exports (on a value-added basis) from the Asian region are linked to demand from Europe and the United States, there is a high likelihood of transmitting a European crisis through the trade link. Although the fundamentals of the Euro area crisis have not been improved, shipping-industry observers have collective some encouraging data indicating growth in export activities in the Asian region. This paper investigates whether the performance of the economic indicators could support the positive views from that of the shipping-industry observers. The authors submit that growth in Asian region will continue if the European and U.S. policymakers fully deliver on their commitments keeping the European debt crisis under control.

Key words: Asian region, Financial crisis, Food price, Inflation, Trade linkage, Transmission of a European crisis

Introduction

After the 2008 global financial crisis, economists have begun to pay high attention on how the Western economies will operate in a world of high government debt. Tharman Shanmugaratnam, the IMFC Chair and Singapore Finance Minister, believed that a good economic analysis involved knowing how things are moving across different sectors in different countries, and then connecting these dots (Pickford et al., 2011). In order to understand how the economies in Asian region operate under a world of high government debt, the authors of this paper submit that the researchers have to investigate whether the global debt crisis would be transmitted to the Asian economies through the trade links. Economists have conducted a large empirical body of research to document how emerging economies could be affected by change of economic factors in advanced economies. For instance, (i.e., Edwards (1984); Cline (1995); Cline and Barnes (1997)) find that GDP growth and export activities can be significant determinants of corresponding macroeconomic volatility in the emerging economies.

Economic performance in the Asian region has been highly correlated with its export performance. Exports have played a central role in the rapid industrialization in the region. Historical data showed that the unprecedented growth in the region has coincided with the development of a regional trading bloc. The regional interdependence of the Asian economies has been reflected by the facts that most of their exports were ended up in similar countries. Cook and Devereux (2006) observed that the majority of exports from the newly industrializing economies of East Asia went to OECD countries during the early 1980s; however, by the late 1990s, exports to other Asian (excluding Japan) countries were almost as large as exports to developed economies (including Japan).

In addition, some aspects of the export pattern make the Asian region highly affected by the global economy. Cespedes et al. (2004) observed that one of the unique features of the East Asian trading bloc is that intra-regional trade has been denominated in currencies which are external to the region, principally the US dollar. McKinnon and Schnabl (2004) also observed that the economies in the Asian region tend to share a common attitude - fear of currency floating, which reflect their emphasis on keeping US dollar to play a central role in both Asian goods and Asian financial markets.

The authors of this paper submit that although global trade with the advanced economies would enhance the chance of the market economies in the Asian region to benefit from specialization, but it also place the region in vulnerable position in absorbing the economic fluctuations of its trading partners. The debt problems of the GIIPS countries (Greece, Ireland, Italy, Portugal, and Spain) have remained the major source of causing European economic contraction in 2012 to 13, and it is expected that worldwide trade linkage would bring the negative impacts in a global scale. When economic contraction first takes place in Europe due to the debt problems of the GIIPS, it will lower the income of all its trading partners, who will then spend less and thus import less. Eventually, it will decrease all their trading partners' incomes, even for those are far away from the European orbit.

And in the process of investigation, the researchers also need to consider the various economic policies undertook in the Asian region which aim at reducing the worldwide trade interlinkage. For example, after the 2008 global financial crisis, the International Monetary Fund (IMF) have repeatedly marked down its global growth

projections; and as a policy response, emerging market economies, such as India and China, have adopted policies to shift from external to domestic sources of growth, and it seems the Asian economies will soon follow such a direction (Todaro, 2004; Lun et al., 2006).

However, a number of shipping-industry observers discerned that U.S. demands for products from China were increasing in the third quarter of 2012. Since the global financial crisis, economic indicators showed that weak exports to Europe and to the U.S. have exacerbated a slowdown in China's domestic economy in the first and second quarters. In the third quarter, however, exports grew 7.4% from a year earlier. Colum Murphy from Wall Street Journal reported that Chinese officials released the exports figures of September 2012, which showed a strong rise of 9.9% compares with the figures from a year earlier (Murphy, 2012). The results make some economists opined that the third quarter marked the bottom for China's slowdown.

This paper conducts an economic study to see whether these positive views from shipping-industry observers were supported by other economic indicators.

Overall Macroeconomic Performance of the Asian Region

After the 2008 global financial crisis, growth in the Asia-Pacific region has slowed, mainly caused by the setbacks of the recovery in advanced economies. The authors select the four most commonly used economic indicators to conduct the analysis in this paper, namely the (1) Real GDP, (2) Consumer Prices, (3) Current Account Balance, and (4) Unemployment. Since the full negative impacts of the 2008 global financial crisis were reflected in the year of 2009, the authors use the summary statistics of the four indicators in 2009, and compare with that in 2011 (see Table 1 to Table 4).

For Asia as a whole, although GDP growth fell to its lowest rate during the first and second quarters of 2012, capital inflows have started to resume in the third quarter. Economic indicators show that growth is projected to pick up very gradually, and the Asian region is likely to be the global growth leader. IMF predicted that the Asia and Pacific region will expand about 2 percentage points faster than the world average in 2013.

Table 1: Advanced Asia (2011)

Real GDP, Consumer Prices, Current Account Balance, and Unemployment

(Annual percent change unless noted otherwise)

	Real GDP		Consumer Prices		Current Account Balance		Unemployment	
	2009	2011	2009	2011	2009	2011	2009	2011
Japan	-5.2	-0.8	-1.4	-0.3	2.8	2.0	5.1	4.6
Australia	1.2	2.1	1.8	3.4	-4.4	-2.3	5.6	5.1
New Zealand	-1.6	1.3	2.1	4.0	-3.0	-4.2	6.2	6.5

- Movements in consumer prices are shown as annual averages.
- Current Account Balance is indicated by percent of GDP.
- Unemployment is indicated by percentage, and national definitions of unemployment may differ.

Table 2: Newly Industrialized Asian Economies (2011)

Real GDP, Consumer Prices, Current Account Balance, and Unemployment

(Annual percent change unless noted otherwise)

	Real GDP		Consumer Prices		Current Account Balance		Unemployment	
	2009	2011	2009	2011	2009	2011	2009	2011
Korea	0.2	3.6	2.8	4.0	5.1	2.4	3.7	3.4
Taiwan	-1.9	4.0	-0.9	1.4	11.3	8.9	5.8	4.4
Hong Kong	-2.8	5.0	0.5	5.3	8.7	5.3	5.1	3.4
Singapore	-1.3	4.9	0.6	5.2	17.8	21.9	3.0	2.0

- Movements in consumer prices are shown as annual averages.
- Current Account Balance is indicated by percent of GDP.
- Unemployment is indicated by percentage, and national definitions of unemployment may differ.

Table 3: Developing Asia (2011)

Real GDP, Consumer Prices, Current Account Balance, and Unemployment

(Annual percent change unless noted otherwise)

	Real GDP		Consumer Prices		Current Account Balance		Unemployment	
	2009	2011	2009	2011	2009	2011	2009	2011
China	9.1	9.2	-0.7	5.4	6.0	2.8	4.3	4.1
India	5.7	6.8	10.9	8.9	-2.9	-3.4	NIL	NIL

- Movements in consumer prices are shown as annual averages.
- Current Account Balance is indicated by percent of GDP.
- Unemployment is indicated by percentage, and national definitions of unemployment may differ.

Table 4: ASEAN-5 (2011)

Real GDP, Consumer Prices, Current Account Balance, and Unemployment

(Annual percent change unless noted otherwise)

	Real GDP		Consumer Prices		Current Account Balance		Unemployment	
	2009	2011	2009	2011	2009	2011	2009	2011
Indonesia	4.5	6.5	4.8	5.4	2.0	0.2	8.0	6.6
Thailand	-2.2	0.1	-0.8	3.8	7.7	3.4	1.4	0.7
Malaysia	1.1	5.1	3.2	3.2	5.3	11.0	7.5	3.1
Philippines	-1.7	3.9	0.6	4.7	16.5	3.1	3.7	7.0
Vietnam	5.3	5.9	6.7	18.7	-8.0	0.2	6.0	4.5

- Movements in consumer prices are shown as annual averages.
- Current Account Balance is indicated by percent of GDP.
- Unemployment is indicated by percentage, and national definitions of unemployment may differ.

Real GDP Growth and various Domestic Constraint Factors

Nominal GDP figures show the total value of the products and services generated in a country during a particular year. Since the current paper involves the comparison of GDP in one year with past years for reading the pattern of trends in economic growth, the authors use real GDP as the measuring tool. For Asia as a whole, real GDP growth averaged 5.5 percent (year over year) in the first half of 2012, well above the global average, but the lowest rate since the 2008 global financial crisis. Looking at the economic performance of each individual country in the Asia and Pacific region, beside the adverse trade spillovers from weakness in the Euro area which acted as a negative

factor to their export performance, there also exist the following domestic constraint factors:

The slowdown in China caused the governmental efforts to engineer a soft landing (Chou, 2000); and in India, the weakening investor sentiment has led to supply constraints. In Japan, the positive impacts of the policy-driven pickup in early 2012 have been slowly withered, which evidenced by a slowdown in consumption and a recent deceleration in growth.

For Indonesia, Malaysia, and Thailand, with the support from public investment, these countries achieve growth close to their potential. For example, growth in Thailand has bounced back sharply, which was led by reconstruction and investment after the devastating floods occurred in October 2011.

In Australia, although the mining-related investment recorded a strong performance, it faces the domestic constraint factor of insufficient working population. In advance economies, it is well recognized that aging is likely to have a negative impact on private saving rates. For every 1 percent decline in the working-age population, it is assumed that saving declines by 0.7 percent.[1]

Unemployment

Unemployment is good economic indicator to evaluate whether an economy is moving in or out of a recession. Some economists make their judgment even look further into the subsets of unemployment, such as, the cyclical behavior of equilibrium unemployment (Shimer, 2005) and the direction and extent of unemployment flows (Hall, 2005). The researches bring important insights on how to construe economic data. For example, (Shimer, 2007) opined that the elevated rates of inflow in time of recession appear not to be a relic of past downturns, but rather a distinctive feature of severe recessions, both old and modern (Hall, 2005). The behavior of the outflow rate also mirrors that observed in past deep recessions: as the wave of inflows receded in the latter stages of the 2007 recession, the outflow rate continued to fall (Shimer, 2007).

For the economic indicator of unemployment rate, all countries locate in Advanced Asia and Newly Industrialized Asian Economies have reduced unemployment when compared with the figures in 2009. However, Japan, Australia, and New Zealand have not yet fully recovered to its 2008 level. Some economists observed that the historic decline in unemployment outflow rates would likely to be accompanied by a substantial rise in long-term unemployment, and research findings showed that this is likely to result in a persistent residue of long-term unemployed workers with relatively weak search effectiveness, depressing the strength of the recovery (Elsby et al, 2010). The data on unemployment collected in the Asian region were encouraging, and for the four economies located in Newly Industrialized Asian Economies, both Hong Kong and Singapore have successfully reduced their unemployment level lower than that of 2008 – the pre-global financial crisis level. See Table 5 below:

[1] Olivier Blanchard, the Director of Research in IMF.

Table 5: Compare Unemployment level between Advanced Asia & Newly Industrialized Asian Economies

	Unemployment		
Advanced Asia	**2008**	**2009**	**2011**
Japan	.0	.1	.6
Australia	4.2	5.6	5.1
New Zealand	4.2	6.2	6.5

	Unemployment		
Newly Industrialized Asian Economies	**2008**	**2009**	**2011**
Korea	.2	.7	.4
Taiwan	.1	.8	.4
Hong Kong	.5	.1	.4
Singapore	.2	.0	.0

Inflation

Inflation in the Asia region was within its comfort zone, mainly because of the declining global commodity prices caused by reduced consumption from the Western economies. From the policy perspective, with real lending rates on average are about 150 basis points below the pre-2008 levels, this gives the central banks in the region a margin to cut interest rates for promoting a stable non-inflationary economic growth through encouraging domestic demand. In China, for example, retail sales growth moves at double-digit rates, and the Chinese government must adopt at least two macro-prudential measures: (1) to rein in real estate lending, and (2) to control local government financing activities, as essential complements to its monetary policy for address financial stability.

In Japan, the early 2012 monetary easing measures support economic growth and help to provide an exit from deflation. However, it seems that Japan needs to further easing its monetary policy to achieve the Bank of Japan's inflation goal of 1 percent.

Elsewhere in the Asian region, we notice high inflation occurs in India and Vietnam, which challenge the governments in using monetary measure (interest rate cutting) to achieve non-inflationary economic growth. For countries with strong past credit growth, such as Indonesia, the government may have limited room for policy maneuver (Fama, 1981).

Food Price and Inflation

A failure to keep food price under careful control may limit the positive effects of a good monetary policy in promoting non-inflationary economic growth. The experience of the 2007-08 spike of global food prices told the economists that a sudden rise in food prices could cut down disposable income of the general population, and limit the scope for monetary policies to support growth. In most of Asia, inflation remains within a comfort zone, helped by relatively stable local rice prices. However, the 2007-28 experience warned economists that food price frustrations mostly affected those countries

where the population spends a high share of food and fuel in (Consumer Price Index) CPI baskets, including in India and Asia's low-income economies. It is quite difficult to estimate which regions are most vulnerable to food price surge from the data collected by the U.S. Department of Agriculture.[2] However, based on the 2007-08 experience, IMF observed that high global food prices could contribute to CPI inflation for many economies in the Asia-Pacific region at about 10 to 20 percent a year after the shock.

The question is how likely another global food price surge may come. Since the 2007-08 food crisis, the supply side has improved in terms of higher acreage and yields, as well as productivity gains. When the authors measure the global inventory buffer in terms of stock-to-use ratios, the 2012 performance has improved significantly, especially for rice and wheat (Amihud and Mendelson, 1989).

How about the likelihood of a food price spike caused by a rise in energy price? The experience of the 2007-08 food crisis shows that energy-intensive inputs such as ammonia-based nitrogen fertilizers and power provide a transmission mechanism, transferring high energy prices to high food prices.

Moreover, advance technology makes possible to make crops from as fuel production, for example, corn and sugar have been increasingly used for ethanol production. Besides, soybeans and other oilseeds could be used for bio-diesel production. When there is an energy price spike, farms may sell the crops to the energy market rather than the food market, which lowers the total supply for food.

In 2007-08, energy prices surged along with the high food prices, which intensified the spillover effects. However, economic indicators show that energy prices have recently declined, limiting the spillover to food prices. Although China depends on the global market to satisfy a large portion of its domestic soybean demand, but China has accumulated a substantial inventory as buffer. On the global level, the current stock-to-use ratio for soybeans is lower than it was during 2007–08.

Limitations

In writing this paper, the authors have adopted a number of assumptions. It is because the authors carried out their analysis based on the economic data published by IMF, which have adopt similar assumptions as well. First, it is assumed that real effective exchange rates remained constant at their average levels. For the currencies participating in the European exchange rate mechanism II (ERM II), it is assumed that they maintain a constant rate in nominal terms relative to the euro. It further assumes that the average price of oil will be about $105.64 a barrel over the medium term. Finally, it also assumes the six-month Japanese yen deposit rate will yield on average in a range of 0.4 percent to 0.3 percent in 2012 to 2013. The uncertainties surrounding these assumptions will add to the margin of error of the observations mentioned in this paper.

Conclusion

The authors of this paper predicted that the performance of the economic indicators of the last quarter in 2012 supports the positive views from shipping-industry observers. Although the fundamentals of the Euro area crisis have not been improved,

[2] For data supplied by the U.S. Department of Agriculture, it groups North America to include Mexico, and Oceania includes Australia and New Zealand. Pacific island nations, which are vulnerable to food price shocks, could not be disaggregated from Oceania due to data limitations.

growth in Asian region will continue if the European and U.S. policymakers fully deliver on their commitments (Baldwin, 2006; Fajonyomi et al., 2012).

It is true that about two-thirds of emerging Asia's exports (on a value-added basis) are linked to demand from Europe and the United States alone, and in the event of a severe global slowdown resulting from a further escalation of the Euro area crisis, it would like to create a powerful downward drag on Asia's most open economies. However, the relatively strong economic and policy fundamentals are there to buffer Asian economies against the possible deleveraging actions by Euro area banks.

Finally, although IMF is quite conservative in its estimating of the 2013 global growth projection, when it uses financial and commodity market data to gauge risks to the Asian region, the result suggests that there is only a one in seven chance of Asia's growth falling below 4% in 2013.

References

Amihud, Y. and Mendelson, H. (1989) "The effect of Beta, Bid-Ask Spread, Residual Risk and Size of Stock Returns", Journal of Finance 44: 479-486.

Baldwin, R. (2006) "In or out Does it matter An evidence – Based Analysis of the Euro's Trade Effects". Centre for Economic Policy Research, London

Cespedes, M., Chang, R., Velasco, A. (2004) "Balance sheets and exchange rate policy", American Economic Review 94: 1183– 1193.

Chou, W.L. (2000) "Exchange rate variability and China's Exports", Journal of Comparative Economics 28: 61-79

Cline, W.R. (1995) "International Debt Reexamined". Institute for International Finance. Washington, DC

Cline, W.R. and Barnes, K.S. (1997) "Spreads and Risk in Emerging Market Lending". Research Paper, Vol. 97-1, Institute for International Finance, Washington, DC.

Cook, D. and Devereux, M.B. (2006) "External currency pricing and the East Asian crisis", Journal of International Economics 69: 37–63

Edwards, S. (1984) "LDC Foreign borrowing and default risk: an empirical investigation", American Economic Review 74: 726-734.

Elsby, M.W., Hobijn, B. and Sahin, A. (2010) "The Labor Market in the Great Recession", Brookings Papers on Economic Activity.

Fama, E.F. (1981) "Stock returns, real activity, inflation, and money", American Economic Review 71: 545-564.

Fajonyomi, S.O., Ashamu, S.O. and Abiola, J.O. (2012) "A comparative analysis of the impact of exchange rate volatility on the export of Ghana and Nigeria", Scottish Journal of Arts, Social Sciences and Scientific Studies 5: 67-80

Hall, R.E. (2005) "Employment efficiency and sticky wages: evidence from flows in the labor market", Review of Economics and Statistics 87: 397–407.

Lun, Y.H.V., Lai, K.H. and Cheng, T.C.E. (2006) "Shipping and Transport

Logistics". McGraw-Hill, Singapore

McKinnon, R., Schnabl, G. (2004) "The East Asian dollar standard, fear of floating, and original sin", Review of Development Economics 8: 331– 360.

Murphy, C. (2012) "U.S. Shoppers Return to China". Wall Street Journal.

Pickford, S., Pisani-Ferry, J., Stiglitz and Shanmugaratnam, T. (2011) "Lessons from a Time of Crisis".

Shimer, R. (2005) "The cyclical behavior of equilibrium unemployment and vacancies", American Economic Review 95: 25–49.

Shimer, R (2007) "Reassessing the ins and outs of unemployment", Working Paper no. 13421, National Bureau of Economic Research, Cambridge, Mass.

Todaro, M. (2004) "The theory of Economic development". McGraw Publishers, New York (19th Edition).

Scottish Journal of Arts, Social Sciences and Scientific Studies - ISSN 2047-1278
http://scottishjournal.co.uk

Optimization of Machining Parameters in Turning Operation Using PSO and AIS Algorithms: A Survey

Adnan, J.A.
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka, Durian Tunggal, 76100 Melaka, Malaysia
Phone: +606-3316002, Fax: +606-3316411,

Mohamad, B.M.
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka, Durian Tunggal, 76100 Melaka, Malaysia
Phone: +606-3316002, Fax: +606-3316411,

Md.Nizam, A.R.
Faculty of Manufacturing Engineering
Universiti Teknikal Malaysia Melaka, Durian Tunggal, 76100 Melaka, Malaysia
Phone: +606-3316002, Fax: +606-3316411,

Abstract:-
In recent manufacturing, the optimization of turning processes is one of important problems which aim to increase competitiveness and product quality. However, the choice of optimal machining parameters is difficult and complex. Traditionally, the selections is heavily relies on trial and error methods which is tedious and unreliable. Metaheuristics methods have been proposed over the last decade to overcome these problems. This paper presents a survey for optimizing the parameters of turning operation using Particle Swarm Optimization (PSO) and Artificial Immune System (AIS). This study deals with different machining performance in turning operation like surface roughness, material removal rate , tool wear , tool life, production cost, machining time and cutting temperature. Most papers in the field of turning parameters optimization are based on (PSO) algorithms, but only a few efforts that are using (AIS) algorithms. In addition, there is a gap of several machining operation parameters especially for cutting temperature optimization in turning operation using PSO and AIS.

Keywords:- Metaheuristics methods. Particle swarm optimization; Artificial immune system; Turning process optimization; Optimal machining parameters.

1. Introduction

Studies on evolutionary algorithms have shown that these methods can be efficiently used to eliminate most of difficulties of classical methods**.** In turning operation, it is important task to select cutting parameters for achieving high cutting performance. The traditional methods such as linear programming used for solving this kind of optimization problems include calculus based and gradient methods and cannot presents a multi-objective optimization problem and finding local optimum due to complexity of the optimization problem especially in multipass turnings because plenty of practical constraints have to be considered [1], [2],[3],[4],[5],[6]. Modern heuristics methods include artificial neural network, Lagrangian relaxation, approaches and simulated annealing and have power in global searching [6],[7]. Some of these methods are successful in finding the optimal solutions, but they are usually slow in convergence and require much computing time. Other methods may risk being trapped at a local optimum which fails to give best solution.

Generally, there are many studies dependent upon the handbook recommendations or human experience to select the machine parameters in manufacturing industry. These may be not guarantee finding the optimum parameters and avoid the problems. Also, because of the complexity of the optimization problem there have not been many studies done in the field of machining conditions optimization. Artificial intelligence (AI) defines as "the study and design of intelligent agents" where an intelligent agent is a system that represents its environment and takes actions that maximize its opportunities of success. AI research is highly technical and specialized, but the main problems include such specifications as reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects. So, AI is still among the field's long term goals.

In today's manufacturing, optimization of turning processes is one of animated problems which aim to increase competitiveness and product quality. In fact, the choice of optimal machining parameters is despotic and complex. Traditionally, the selections is heavily relies on trial and error methods which is tedious and unreliable. Metaheuristics methods such as PSO, AIS have been proposed over the last decade to improve many solutions of optimization complex problems in many applications [8]. PSO technique is simple and needs to a few lines of programming code only [9]. It consists of a swarm of particles and then particle will fly through a many dimensional search space to find better solution in the search space [10]. On the other hand, AIS are a class of computationally intelligent systems taken from the processes of the vertebrate immune system. The algorithms typically take advantage of the immune system's characteristics of learning and memory of immune basics. Generally, AIS includes three basic mechanisms; proliferation of cells to make antibodies against the antigen, generation of diverse antibodies to achieve affinity maturation through somatic hyper mutation process, and antigenic receptors handling which has low affinity. Many studies have been done in the field of turning operation parameters optimization , however very little fields such as cutting temperature optimization as well as for machining operation optimization such as turning , milling , drilling , grinding. The use of PSO and AIS algorithms in turning operation optimization is reviewed in this study.

2. Optimization of turning parameters using PSO.

Particle swarm optimization is a simple biologically computational search and optimization method. It describes an active particles working together for travelling towards the optimum solution through the D-dimensional search-space directed by the best previous positions. According to the value of the objective function, each particle keeps track of its best-achieved position (personal best, pbesti) and the best position ever achieved in the group (group best, gbesti) among all personal bests. A number of its variants have been developed to improve the speed of concourse and quality of solution [10]. The use of PSO algorithms in turning operation optimization is described in the following sections:-

2.1 Optimization of surface roughness, tool life, material removal rate and tool wear.

Tamizharasan et al. [3] studied the operation of finding optimal process parameters in turning operation to minimize the flank wear and improve the surface finish of the manufactured component. The parameters used are material hardness, cutting speed, feed rate, and depth of cut. The flank wear is selected as performance quality characteristic and the surface roughness as constraint. The mathematical measurments of quality called S/N ratio is applied to determine the effect of product and process parameters on flank wear. Lower ratio is used in this study to minimize the flank wear is shown as equation (1):-

$$S/N \text{ ratio for flank wear } = -\frac{1}{N} 10 \log_{10} \sum \bar{y}^{-2} \quad Eq.\ (1)$$

Whereas:-

N: number of experiments.

$\bar{y}$: measured data.

The S/N ratio of flank wear value is obtained using PSO and non linear regression model. The results were better in comparison to linear regression model.

Karpat and Ozel [11] used the Dynamic Neighborhood Particle Swarm Optimization (DN-PSO) methodology to treat the multi-objective optimization problems with opposite objectives in turning process planning. Neural networks used to obtain the non-linear relations between the machining parameters such as tool geometry and the performance using experimental data. In this work minimizing the surface roughness, machining induced stresses on the surface and maximizing the productivity, tool life and material removal rate are taken as a case study. The proposed system is active, efficient and provides intelligence form for production planning in multi-parameter turning processes.

Karpat and Ozel [12] used a neural network (NN) to model and estimate the surface roughness and tool wear for multi-objective optimization of hard turning. Particle swarm optimization PSO is used in this work to obtain optimum cutting parameters for many operation performances at the same time. Two approaches are used to solve multi objective problems, the first is by combining several objectives into a single objective through the use of “weights” or utility functions. However the method has limitation is largely depends on numerical weights that are difficult to select in practical. The second way is because of a pareto-optimal set of non-dominated variable settings. The second way abolishes the problem in first method but has another problem due to many possible

solutions. The objective function used in this work is to minimize the tool wear as equation (2):-

$$\min \quad f = w_1 \times (\min(0, VB_{\lim} - VB_{pred}))^2 + w_2 \times \left(\sum_{l=l_1}^{l_2} \min(0, Ra_{\lim} - Ra_{pred}) \right)^2 + w_3 \times \frac{1}{x_1 x_2} \qquad \textit{Eq. (2)}$$

Whereas:-

VB_{lim}: limit of tool flank wear after given cutting distance.

VB_{pred}: predicted tool wear at that point by neural network model.

Ra_{lim}: limited surface roughness.

Ra_{pred}: prediction of neural network model.

The third term in the objective function represents productivity and has a penalty coefficient w_3. The authors concluded that minimum function in the fitness function will punish these solutions by multiplying them with penalty coefficients w_1 and w_2.

Karpat and Ozel [13] used the multi-objective particle swarm optimization (MOPSO) methodology to optimize machining parameters in hard turning process. The relationships between machining parameters and the performance measures are obtained by using experimental data and swarm intelligent neural network systems (SINNS). This methodology is used to compare pareto optimal solutions while the neural networks are used in forming the effects of decision variables on the performance. Dynamic neighborhood-particle swarm optimization (DN-PSO) is also used for the whole population. In this method, global best for each particle are found. Two case studies were taken; the first one is for maximizing the cutting tool life as equating (3):-

$$T = \frac{A}{V^3 + B \times V^2 + C \times V} \qquad \textit{Eq.} (3)$$

Whereas:-

T: tool life time.

V: cutting velocity.

A, B, C: calculated experimentally.

The second case study for minimizing material removal rate as equating(4):-

$$Mrr = v \times f \times d \qquad \textit{Eq. (4)}$$

Whereas:-

Mrr: material removal rate.

v:- cutting velocity.

f:- feed rate.

d:- depth of cut.

The constraints used are v, f, and d.

Adam A. Cardi [14] studied the effects of chatter on the quality of a machined part in turning operations. A Neural network (NN) trained with Particle swarm optimization (PSO) is used to transform a radial displacement measurement made at the cutting tool to an estimation of the radial displacement of the work piece. In the PSO used to train the ANN network, 1500 particles and 1500 generations were used. It was found that larger population sizes and more iteration had little improvement on the fitness of the

final solution. The root mean square error (RMSE) over the 1500 generations used in training. The work piece displacement was predicted with an average RMSE of 1.41 and 1.70 mm for the two testing datasets. It should be noted that the two testing datasets had better performance than the single training dataset. The control effort could be exerted through a peizoactuated toolholder such that the cutting tool tracks the workpiece. In this way, there would be theoretically zero relative tool–workpiece displacement and chatter would be rapidly eliminated because chip thickness variation would not occur.

2.2 Optimization of production cost.

Srinivas et al. [15] used PSO for selecting optimum machining parameters that minimize unit production cost in multi-pass turning. Dynamic objective function is used in this study to resolve a complex, multi-constrained, nonlinear turning model as a single, unconstrained objective problem. Best solution in each generation is obtained by comparing the unit production cost and the total non-dimensional constraint wrong among all of the particles.

Zheng and Ponnambalam [16] used (PSO) algorithm to optimize the unit production cost in multi pass turning process. Two operations used, rough machining and then a finish machining. The performance evaluated by comparing it with genetic algorithm (GA) and simulated annealing (SA) algorithm.

Costa et al. [17] Used a novel hybrid (PSO) algorithm to select the optimal cutting parameters for minimizing the production cost in multi-pass turning problems. The optimal parameters subjected to a set of technological constraints. A simulated annealing (SA) methodology is embedded to enhance the PSO search mechanism and to avoid PSO from being trapped into local optima. Two strategies have been applied to manage the constraint between the provided total depth of cut and the number of passes to be performed. Five different test cases based on the multi-pass turning have been achieved. The comparison between the performances of the proposed technique and other existing methods was accomplished.

2.3 Optimization of machining time.

Tang et al. [18] proposed a system to optimize the process parameters for minimizing the machining time in single and multi pass turning operations. Two-tool parallel turning operations were used. Heuristics algorithm based on particle swarm optimization (PSO) is used. The simulation results of the proposed algorithm are evaluated in terms of total machining time and required computational time.

Bharathi and Baskar [19] posit (PSO) methodology to find the optimal machining parameters for minimizing machining time in CNC turning operation. The experiments were achieved on brass, aluminum, copper, and mild steel materials. The constraints used are cutting speed, feed, depth of cut, and surface roughness. The results showed that PSO is capable to select correct machining parameters for the turning operation.

Kusum and Jagdish [20] studied PSO technique of CNC turning operation to find the optimal cutting parameters such as cutting speed and feed rate and minimizing the total production time. The constraints such as cutting force, power, tool-chip interface temperature and surface roughness of the product are used. The results are compared with those obtained by Nelder Mead Simplex (NMS) method, Boundary Search Method (BS), Genetic Algorithm (GA) and Simulated Annealing (SA).

2.4 Optimization of cutting temperature.

2.4.1 Cutting temperature measurement in turning.

Measuring and prediction the temperature in the cutting zone is highly complex work due to a limit shear region, chip obstacles, and the nature of the contact phenomena between the tool and chip. [21] , [22].

Many researchers showed that most of the energy of cutting process is converted into heat in the main zone of plastic deformation (shearing plane), and secondary zone of plastic deformation (where chips slides on the rake face). Some heat grow on the tertiary zone where the tool relief face slides on the newly machined surface but this heat is not considered in most cases either for simplicity or because the heat is very small when using sharp cutting edges [23] , [24] , [25].

Aneiro et al. [23] studied the turning process on hardened steel work piece using multilayer coated carbide tools at high cutting speeds. The effect of cutting parameters are considerable such as cutting speed, feed and depth of cut on tool temperature, cutting forces, tool wear and surface roughness. The temperature was measured using a thermocouple positioned at the lowest insert face. The gradient method is used to calculate the values of temperature near the cutting tool rake face. The tool wear measurements showed the capability of these tools in turning this type of work piece with optimal tool life. The authors concluded that the depth of cut has the greatest influence on temperature. However, some results are low compared to other previous works within the same range.

Luke et al. [24] showed the effect of cutting parameters by the controlled contact length, and how to design an experiment to explain the functions of a controlled contact length of the tool/chip interface. To obtain a successful cutting operation, the tool material must be harder than the work material and able to keep the hardness at elevated temperatures. Although (60%) of heat is generated in the shear region and 80% of the total heat goes to the chips, the temperature increases in the tool because it remains constant in the work piece.

The development of temperature in cutting tools is a very difficult task due to the large number of connected parameters affect on the cutting tool such as cutting speed, feed rate ,depth of cut , tool wear, chemical and physical characteristics of machined part, cutting tool coating type. The temperature in the primary and secondary shear zones are usually very high, therefore it affect the cutting operation. During the cutting process, the mechanical energy due to the plastic deformation progressing at the primary shear plane and at the chip–tool interface. This energy usually converted into heat. In manufacturing process, temperature has critical effect on machining because it accelerates tool wear, shortening tool life and causes thermal deformation of the work-piece, cutting tool and machine tool, which degrades the machining accuracy performance [26].

Colak [26] studied estimation the cutting temperature in high pressure jet assisted turning of Ti6Al-V4. Finite difference method is used to know the temperature distribution. Chip and tool temperatures are calculated using different cutting parameters such as cutting speed, feed and high pressure jet. Calculated cutting coefficient information from cutting force measurement and cutting conditions were carried out for

temperature estimation of the tool-chip interface. The author concluded that the temperature is consistent with spindle speed and feed rate.

Amritkar et al. [27] studied the relationship between obtained electromotive force (e.m.f) during machining and the cutting temperature using tool-work thermocouple. The performance of the setup is evaluated for the different material like EN19, EN31, mild steel, SS 304 and SAE 8620. Regression analysis method is used to establish the relationship between temperature and the generated voltage. Microcontroller is used to obtain the relationship between temperature and voltage. The benefits of using the tool work thermocouple are its ease of implementation and its low cost as compared to other temperature measurement techniques.

Abhang and Hameedullah [28] measured the temperature generated on the cutting tool and work piece junction during metal cutting using tool- work thermocouple method. With this method, the output of the thermocouple is in the mill volt range and measured by a digital milli-voltmeter. The average temperature at the tool-chip interface is interest parameter.

Lazard and Corvisier [29] studied estimating the fleeting temperature and the heat flux at the tip of a tool in turning process using an inverse approach. This way is used to prevent and avoid the tool damage. In this method, two thermocouples are located at two different positions in the insert tool. The heat transfer that is described with a model-depending upon the quadrupole formulation. The simulations performed with numerical code based on the finite volume method fluent for different temperatures profiles such as Heaviside and exponential solicitations.

Mahdavinejad and Sharifi [30] showed a combination of artificial neural networks and fuzzy logic methods to predict the roughness of machined surfaces in dry turning. The fitness function used as equating (5):-

$$Ra = 0.0321f^{2} / r \qquad \textit{Eq. (5)}$$

Whereas:-

Ra:-Surface roughness.

f:-feed rate.

r:- Radius of tool tip.

The chips shape changes from discrete to continue when the cutting speed is increased and the machine chatter is decreased, which leads to the machined surface quality. In addition, the quality of machined surface is proportional with the feeding rates and depth of cut.

Ueda et al. [31] developed a new type of pyrometer which used two optical fibers to accept and transmit the infrared energy. The two fibers are connected using a non-contact fiber coupler. In turning, the face of one optical fiber which is embedded in a rotating work piece accepts the infrared rays radiated from the cutting tool and emits it to other face. The infrared energy is received by the other optical fiber which is stable at the pyrometer and leads to the two color detectors.

Carvalho et al. [32] Showed that the direct temperature measurements at the chip–tool interface are very complex. The estimation of the temperature from heat flux at the chip–tool interface is studied using the inverse heat conduction problem technique. The thermal model is obtained by a numerical solution of the transient three-dimensional heat diffusion equation that considers both the tool and the tool holder assembly. Many

cutting tests using cemented carbide tools were performed in order to check the model and to verify the influence of the cutting parameters on the temperature field.

Abdulla et al. [33] used an artificial neural network (ANN) model in turning steel for predicting chip tool interface temperature. The cutting parameters used are cutting speed, feed rate and depth of cut. A feed-forward back propagation network with ten hidden neurons has been selected as the optimum network by trial and error method. The coefficient of determination (R2) between model prediction and experimental value is found 0.9965. The author concluded that the system has been successfully applied for estimation the chip tool interface temperature in response to the cutting parameters.

Jurković [34] used Taguchi's method for minimizing the tool-chip interface temperature when cutting Č1730 (EN C60) steel work piece by cemented carbide inserts in turning process using a tool-work thermocouple technique. The author concluded that cutting temperature is important factor which directly affects cutting tool and work piece properties, also the cutting speed is the most worthy parameter on cutting temperature.

Salihu et al. [35] measured the temperature using the thermocouple method during the CNC turning on steel C45 work piece and ceramic cutting plates MC2 cutting tool. The cutting parameters used: cutting velocity (v), feed (s), depth of cut (a) and nose radius (r). There are three zones of cutting temperature: primary shear zone, secondary shear zone (chip-tool interface) and shear zone due to scrub between the tool and work piece. The authors concluded that cutting speed and feed have a great influence on temperature , on the other hand, when the cutting angle increases, the cutting forces also increase and then the temperature increase.

Zuperl and Cus [36] used the feed forward and radial basis neural networks to study a complex optimization of cutting parameters. The methods produces accurate and reliable results but require more time for training and testing also the precision of results is worse. The authors suggested implementation of the proposed approach to real-world problems and extension of the proposed approach to adaptive control of machining operations or on-line adjustment of cutting parameters based on information from sensors.

Dolinšek [37] posists that the tool wear is generally considered to be a result of mechanical thermo dynamic wear such as abrasion and chemical thermo chemical wear such as diffusion interactions between the cutting tool and work piece. At high temperature reaches to 1000C$^{\circ}$ or more , the appearance of the chemical wear becomes visible and clear which enhances the diffusion and oxidation processes.

2.4.2 Cutting temperature optimization of turning using PSO.

Liu Yi et al. [38] Proposed PSO algorithm for estimating the parameters based on nonlinear regressive curve of cutting tool temperature. The empirical model used as equating (6):-

$$Tr = K * a_p * f * v \qquad \textit{Eq. (6)}$$

Whereas:-

Tr = Output of temperature (C^{o}).

K = coefficient depending on work piece material.

a_p = Depth of cut(mm).

f = feed rate (mm/rev).
v = cutting speed (m/min).

The objective function aims to minimize the model simulation output temperature and actual temperature. The results showed that the PSO algorithm is an active approach.

3. Using AIS in turning parameters optimization.

The artificial immune systems (AIS) are based on the clonal selection and affinity maturation principles of the immune system [10]. The use of this system in turning operation optimization is shown as:-

3.1 Optimization of production cost.

Yildiz [39] used a hybrid optimization approach for minimization of the unit production cost in multipass turning operation. The proposed approach includes differential evolution algorithm and receptor editing property (DERE) of an immune system. This approach provides best computed solutions for the turning optimization problem compared to ABC (artificial bee colony algorithm), DE (differential evolution algorithm), PSRE (particle swarm-receptor editing optimization algorithm), HTHS(hybrid Taguchi harmony search algorithm), HIHC(hybrid artificial immune-hill climbing optimization algorithm), HRGA (hybrid robust genetic algorithm), SS (scatter search), FEGA (float encoding GA) and SA/PS (Simulated Annealing and Hooke–Jeeves pattern search). This approach can be taken into account as a tough technique for optimizing manufacturing optimization problems.

Riza [40] used a hybrid method combining immune algorithm with a hill climbing algorithm for solving complex optimization problems of machining parameters in turning. The fitness function used is for minimizing a unit production cost in multi-pass turning operations. The constraints used are depth of cut, cutting speed, feed, tool life, cutting force, power, stable cutting region, chip-tool interface temperature and surface finish. The method is applied in many applications such as single benchmark problem, multi-objective disc brake problem, shape design optimization problem and also optimization of machining parameters in multi-pass turning operation. This method is active optimization method in finding better solutions compared to other previous approaches.

4. Hybrid PSO and AIS in turning optimization.

Riza [40] used a hybrid optimization approach based on PSO and receptor editing property of artificial immune system (AIS) in both design and manufacturing fields for multi-pass turning operation. A single-objective test problem, tension spring problem, pressure vessel design optimization problem taken from the literature and two case studies for multi-pass turning operations are solved by the proposed new hybrid approach to evaluate its performance.

Discussions and conclusions

In many real applications the makers face the problem of simultaneous optimization of several conflicting and incomparable objectives. From the reviewed studies, generally, it is clearly visible that particle swarm optimization techniques are more popular in comparison to artificial immune system techniques for turning processes optimization. Where many efforts are concentrated on optimization of surface roughness, production costs, material removal rate, machining time and tool wear. The reason is

because of PSO-based algorithms is simple and effective. However, there is lack of studies for other turning processes parameters such as cutting temperature, torque, geometrical accuracy and heat affected zone tool geometry. To the best of our knowledge, there are no studies dealing with AIS approaches and the other recent bio-inspired algorithms in optimizing cutting temperature parameter in turning operations and other machining operations such as milling, drilling, grinding.

References

[1] Z. CAR . (2009). GA based CNC turning center exploitation process parameters optimization , Metabk.

[2] Nafis Ahmad.(2001). Optimization of process planning parameters for rotational components by genetic algorithms, International conference on mechanical engineering, Bangladesh.

[3] T. Tamizharasan, J. Kingston Barnabas , J. Fakrudeen. (2002). Optimization of parameters in hard dry turning using DoE, DE and PSO.

[4] Yi-Tung Kao . (2008). A Hybrid genetic algorithm and particle swarm optimization for multimodal functions,Applied Soft Computing.

[5] H. Ganesan . (2011). Optimization of machining parameters in turning process using genetic algorithm and particle swarm optimization with experimental verification. International journal of Engineering Science and Technology.

[6] Shutong XIE .(2011). Intelligent Selection of Machining Parameters in Multi-pass Turnings Using a GA-based Approach.

[7] T.Srikanth . (2008). A Real Coded Genetic Algorithm for optimization of Cutting Parameters in Turning . IJCSNS International Journal of Computer Science and Network Security.

[8] A. Yildiz . (2009).. A novel particle swarm optimization approach for product design and manufacturing, Int J Adv Manuf Technol 40. pp. 617–628.

[9] N. Yusup, A. Mohd , S. Zaiton. Evolutionary techniques in optimizing machining parameters: Review and recent applications (2007–2011). (2012). Expert Systems with Applications. pp. 9909–9927.

[10] D. Rini , S. Mariyam , S. Sophiyati . (2011). Particle Swarm Optimization: Technique, System and Challenges .International Journal of Computer Applications. pp. 0975 – 8887.

[11] Y. Karpat , T. Özel. (2007). Multi-objective optimization for turning processes using neural network modeling and dynamic-neighborhood particle swarm optimization. Int J Adv Manuf Technol. pp. 234–247.

[12] Y. Karpat , T. Ozel. (2005). Hard turning optimization using neural network modeling and swarm intelligence. Department of Industrial and Systems Engineering. pp. 179-186.

[13] Y. Karpat , T. Ozel. (2006). Swarm-Intelligent neural network system (SINNS) based multi-objective optimization of hard turning, Transactions of NAMRI/SME. pp. 1-8.

[14] Adam A. Cardi .(2008).Workpiece dynamic analysis and prediction during chatter of turning process. Mechanical Systems and Signal Processing.

[15] Srinivas, Giri, , Yang. (2009). Optimization of multi-pass turning using particle swarm intelligence, International Journal of Advanced Manufacturing Technology.

[16] Zheng, Ponnambalam. (2010). Optimization of multi pass turning operations using particle swarm optimization.ISMA'10 - 7th International Symposium on Mechatronics and its Applications. pp. 1-6.

[17] Costa, Celano , Fichera . (2011). Optimization of multi-pass turning economies through a hybrid particle swarm optimization technique. International Journal of Advanced Manufacturing Technology. pp. 421-433.

[18] Tang , Lie. (2008). parallel turning process parameter optimization based on a novel heuristic approach, Journal of Manufacturing Science and Engineering.

[19] S. Bharathi , N. Baskar . (2011). Particle swarm optimization technique for determining optimal parameters of different work piece materials in turning operation, the international journal of advanced manufacturing technology. pp. 5-8.

[20] Kusum , Jagdish. (2007) Performance Analysis of Turning Process via Particle Swarm Optimization, Nature Inspired Cooperative Strategies for Optimization Studies in Computational Intelligence. pp. 453-460.

[21] Abukhshim, Mativenga ,Sheikh. (2005) Heat generation and temperature prediction in metal cutting: A review and implications for high speed machining. International Journal of Machine Tools & Manufacture xx, pp. 1–19.

[22] U. Seker, İ. Korkut, Y. Turgut , M. Boy. The measurement of temperature during machining. International conference power transmissions 03.

[23] F.Aneiro , R. Coelho, L. Brandao. (2008). Turning Hardened Steel Using Coated Carbide at High Cutting Speeds. V.xxx.

[24] Luke , Huang, Joseph , Tao. (1999). Effect of Tool/Chip Contact Length on Orthogonal Turning Performance, journal of industrial technology.

[25] D. Sullivan.(2001). Temperature measurement in single point turning. Cork Institute Technology. pp. 301-308.

[26] O. Çolak. (2012). Tool-chip temperature simulation on high pressure jet assisted machining of Ti6Al-V4, Scientific Research and Essays. pp. 873-880.

[27] A. Amritkar,C. prakash , A. Kulkarni. (2012). Development of temperature measurement setup for machining. Conference on Advances in Mechanical Engineering (NCAME'12).

[28] L. Abhang, M. Hameedullah. (2010). The Measurement of chip-tool interface Temperature in the Turning of steel, International Journal of Computer Communication and Information System (IJCCIS). pp. 976 –1349.

[29] M. Lazard , P. Corvisier. (2005). Inverse method for transient temperature estimation during machining, Proceedings of the 5th International Conference on Inverse Problems in Engineering. Cambridge, UK.

[30] Mahdavinejad, Sharifi . (2009). Optimization of surface roughness parameters in dry turning, Journal of achievements in materials and manufacturing engineering.

[31] Ueda, Sato, Hosokawa , Ozawa. (2008) . Development of infrared radiation pyrometer with optical fibers -Two-color pyrometer with non-contact fiber coupler. CIRP Annals - Manufacturing Technology. pp. 69–72.

[32] S. Carvalho , S. Lima E. Silva , A. Machadoa , G. Guimar. (2006) . Temperature determination at the chip–tool interface using an inverse thermal model considering the tool and tool holder, Journal of Materials Processing Technology. pp. 97–104.

[33] M. Abdulla, S. Mithun, N. Ranjan . (2011). Modeling of Chip Tool Interface Temperature in Machining Steel- An Artificial Intelligence (AI) Approach. International Conference on Industrial Engineering and Operations Management. January. pp. 22 – 24.

[34] Z. Jurković. (2011). Optimization of cutting parameters based on tool chip interface temperature in turning process using Taguchi's method. 15th International Research/Expert Conference. pp. 12-18.

[35] A. Salihu, N.Qehaja, H.Zeqir, A. Kyqyku, A. Bunjaku , F. Zeqiri. (2011). The temperature research in increased speed processing by turning. 15th International Research/Expert Conference. pp. 12-18.

[36] U. Zuperl , F. Cus . (2000). Optimization of Cutting Conditions During Machining by Using Neural Networks. Production Engineering Institute Faculty of Mechanical Engineering. Maribor.

[37] S. Dolinšek. (2006). Mechanism and types of tool wear; particularities in advanced cutting materials. Journal of Achievements in Materials and Manufacturing Engineering. pp. 11-18.

[38] L. Yi, Z. Ming, W. Qing. (2005). Parameter estimation of cutting tool temperature nonlinear model using PSO algorithm. Journal of Zhejiang University SCIENCE.

[39] A. Yildiz . (2012) . A comparative study of population-based optimization algorithms for turning operations , Journal of Information Sciences. pp. 81–88.

[40] A. Riza. (2009). An effective hybrid immune– hill climbing optimization approach for solving design and manufacturing optimization problems in industry. J. Materials Processing Technology USA, pp. 2773-2780.