STUDIES ON THE ECOLOGY OF *RESEDA LUTEA* L. IN WEST ANATOLIA

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We certify that we have read this thesis and in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy.

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ABSTRACT

In this study, the aim is to present ecological, anatomical, morphological and pollen and seed germination characteristics of *Reseda lutea* L. (*Resedaceae*) distributed in West Anatolia.

Reseda lutea is distributed widely in Turkey, as well as throughout the temperature zones of the world. It is a cosmopolitan species occurring 0-2300 m altitude in Turkey. It prefers open and sunny. It also occurs as a ruderal plant in Turkey.

In Turkey, the best colour of yellow for hand-woven carpets and kilims, as a source of dyeing substances is produced from *R. lutea* and *R. luteola*. This shows the economical importance of *R. lutea* in Turkey. In addition to this, its preference by honey bees in the apiculture, as a dry and fresh food source for farm animals, are other economical characteristics of this species. It is also used in the struggle against erosion which done to its roots which can go to deeper parts of soil according to soil structure and is one of the basic environmental problems in Turkey. This study was materialised on *R. lutea* because of the above mentioned economical characteristics.

According to the results of this study: The chemical and physical analysis of soil and plant samples, collected from 54 different localities in West Anatolia, showed that the plant prefers, generally sandy loam and sandy clay loam soils, with a light alkaline and medium alkaline pH. It also grows on non-saline, highly calcareous soils, poor potassium and phosphorus, and varying in nitrogen content. Soil and plant analysis results were evaluated statistically The morphological, anatomical, pollen and seed germination characteristics of the plant were examined. The results obtained were compared and discussed in the light of results published in different studies.

ÖZET

Bu çalışmada, Batı Anadolu'da yayılış gösteren *Reseda lutea* L. (*Resedaceae*)'nın ekolojik, anotomik, morfolojik ve tohum çimlenme özelliklerinin ortaya konması amaçlanmıştır.

Dünyada ılıman bölgelerde yayılış gösteren *R. lutea*, Türkiye'de yaygın olarak dağılış göstermektedir. Kozmopolit bir tür olarak bilinen bitkiye, 0-2300 m. arası yükseklikler arasında rastlanılmaktadır. Işığı bol alan ve gölgelik olmayan alanları tercih etmektedir. Ayrıca, Türkiye'de ruderal bitki olarak da görülmektedir.

Türkiye'de halı ve kilim dokumacılığında *R. luteola* ile birlikte en iyi sarı renk *R. lutea*'dan elde edilmektedir. Bunun yanı sıra, balcılıkta arılar tarafından tercih edilmesi; büyükbaş ve küçükbaş hayvancılıkta, yaş ve kuru besin kaynağı olması; köklerinin toprağın yapısına bağlı olarak oldukça derinlere inebilmesi nedeniyle temel çevre sorunlardan biri olan erozyonla mücadelede kullanılabilecek bir özelliğe sahip olması, bitkinin ekonomik açıdan önemini ortaya koymaktadır. Yukarıda bahsedilen ekonomik özelliklerinden dolayı *R. lutea* üzerinde bu çalışma gerçekleştirilmiştir.

Bu çalışmanın sonuçlarına göre: Batı Anadolu'dan tespit edilen 54 farklı lokaliteden toplanan toprak ve bitki örnekleri kimyasal ve fiziksel analizlere tabi tutulmuşlardır. Toprak analiz sonuçlarına göre; bitki, tekstür açısından genellikle kumlu tınlı ve kumlu killi; pH bakımında hafif alkali ve orta alkali toprakları tercih ettiği tespit saptanmıştır. Yine bitkinin tuzluluk etkisinin olmadığı; çok kireçli, potasyum ve fosfor bakımdan yetersiz, azot bakımından her türlü toprakta yetişebildiği görülmüştür. Ayrıca toprak ve bitki analiz sonuçları, istatistiksel olarak değerlendirilerek, sonuçlar karşılıklı olarak araştırılmıştır. Saptanan ilişkilerin istatistiksel yorumları yapılmıştır. Bunun yanı sıra

morfolojik, anatomik ve polen özellikleri ile beraber çimlenme fizyolojisi de incelenerek, tespit edilen özellikler ilgili literatür kaynakları ile karşılaştırılarak tartışılmıştır.

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Chapter One
INTRODUCTION

1. Introduction

To describe a living species one should know its habitat and biological characteristics. In another word, autecological structure of the species should be known. The studies on the plant ecology of Turkey has increased remarkably. Although the studies on the autecology were rare before, these studies have increased from day to day. But, when the number of studies is still insufficient floristic richness of Turkey is taken into consideration.

No local or general studies were recorded on *Reseda lutea* L. (*Resedaceae*) which is very widespread in Turkey. As such, *R. lutea* specimens, previously collected from 54 different localities in West Anatolia were investigated in terms of ecology, morphology, anatomy, pollen and seed germination characteristics.

Reseda is derived from the Latin "sedera", to be calm, to calm or recede. The species name, *lutea*, almost certainly refers to the yellow colour of the flowers (Heap *et al.* 1995).

Reseda lutea was described by C. Linnaeus, for the first time, from Southern Europe in 1873.

The family, *Resedaceae*, consists of six genera and of these, only the genus *Reseda* is distributed in Turkey. This genus includes nearly sixty species all over the world. In Turkey, the genus includes fifteen species, one subspecies and seven varieties. Of these taxa, six (2 species and 4 varieties) are endemic to Turkey (Davis, 1965; Davis *et al.*

1988; Özhatay *et al.* 1995). The list of taxa distributed in Turkey is as follows: *Reseda alba* L., *R. armena* Boiss. var. *armena* (Endemic), *R. armena* Boiss. var. *scabridula* Abdallah & De Witt (Endemic), *R. balansae* Müller (Endemic), *R. phyteuma* L., *R. orientalis* (Müller) Boiss., *R. odorata* L., *R. inodora* Reichb. var. *anatolica* Boiss., *R. lutea* L. var. *lutea*, *R. lutea* L. var. *nutans* Boiss., *R. microcarpa* Müller, *R. stenostachya* Boiss., *R. tomentosa* Boiss. var. *tomentosa* (Endemic), *R. tomentosa* Boiss. var. *glabrata* Abdallah and De Witt (Endemic), *R. germanicopolitana* Hub-Mor., *R. luteola* L., *R. saadae* Abdallah and De Witt (Endemic), *R. aucheri* Boiss. subsp. *rotundifolia* (Kotschy ex Müll.-Arg.) Rech. fil.

Davis (1965), states the presence of two varieties of *R. lutea* var. *lutea* and var. *nutans* Boiss. in Turkey. On the other hand, Abdallah and De Witt (1978) mentioned the presence of two subspecies, *lutea* and *neglecta* (Muell.) Arg.

It is reported that, *R. lutea* has been used as scatrizane, diuretic, sedative and sudorific (Bonnier, 1934).

Reseda lutea and *R. luteola* have great economical value in carpet and kilim industry and they are used as the natural dye source in Turkey (Tapan, 1983; Eyüboğlu *et al.* 1983; Seçmen *et al.* 1986; Uğur, 1988; Anonymous, 1991; Öztürk and Özçelik, 1991; Mert *et al.* 1993).

The natural dyeing is very closely related with the plants, growing in the vicinity depending upon the geographical and climatic features. The colour differences of hand-woven carpets and kilims based on the colour features of the dyeing plants and the plants growing nearby (Arlı, 1982). Başlar (1996) in his study *on Rubia tinctorum* L. and *Chrozophora tinctoria* (L.) Rafin. states that the colour features of the plants change with respect to habitat they grow.

The dyeing substances occur generally from the flower, young shoot, bark, leaf, fruit, underground stem, fruit pip and root (Arlı, 1982).

There are three basic colours are extracted from the plant. These are red, blue and yellow. Other colours are obtained by adding a different plant or/and mordant. The yellow colour is principally obtained from *R. lutea* and R. *luteola* in Turkey (Anonymous, 1991).

Inspite of a statement that the best colour is obtained from the whole plant of *R. lutea* (Tapan, 1983; Eyüboğlu *et al.* 1983; Seçmen *et al.* 1986), collected before fruiting period, it is reported that better productivity can be provided from flowers and young shoots of *R. lutea* (Uğur, 1988; Anonymous, 1991; Öztürk and Özçelik, 1991). Dry or fresh plant material can be used for the extraction of the dye.

With the addition of mordants different colours such as yellow, lemon yellow, moss green, light green, greenish yellow, light brown can be obtained from *R. lutea* (Tapan, 1983; Uğur, 1988; Anonymous, 1991; Öztürk and Özçelik, 1991).

The existence of approximately 150-200 dyeing plants in Turkey constitute a source of richness for the natural dyeing (Mert *et al.* 1992). Mairat (1948), for instance, reports from England that only 93 plant species are used in natural dyeing..

On the other hand, *R. lutea* can be used to prevent erosion because of its rapid growing roots which can reach 80-100 cm depth or even 400 cm in certain loose soils (Bruns and Jochimsen, 1989; Jochimsen and Janzen, 1991; Heap *et al.* 1995).

According to a study carried out in Poland, thirty plant species were recorded for the improvement of apiculture in this country (Jablonski *et al.* 1992). *R. lutea* and *R. luteola* L., are among these others being (*Centaurea scabiosa* L., *C. rhenana* Bor., *Circium oleraceum* (L) Scop., *Solidago canadensis* L., *S. serotina* Ait., *Scrophularia nodosa* L. and *S. alata* Gillib.). The researchers recommend the use of ten species in unfertile soils to increase the nectar secretion. These plants, therefore could be cultivated for this aim.

In Australia and Iran, the cattle breeders have been using *R. lutea* as a dried food source in winter time and fresh in spring and summer for grazing (Moghaddam, 1977; Heap *et al.* 1995).

Reseda lutea has evaluated as a harmful weed in the carrot and potato fields in England and Scotland (Forbes and Mathews, 1985) and crop fields in United States, Iran, Australia and Poland (Bailey and Wicks, 1995; Abdallah and De Witt, 1978). It can increase through seeds easily. This species could be reproduced vegetatively from the pieces of root. The agricultural equipment used for the ploughing of cultivated fields breaks roots into pieces and thus plant reproduces vegetatively. Sometimes, this phenomenon causes a loss of 35 % in the crop fields (Heap *et al.* 1987).

The struggle with this plant is difficult due to its long roots which are able to go into the soil very deeply and vegetatively. The chemicals are applied against *R. lutea*, which has a wide range and accepted as field weed. It is reported that Metsulfuron {2-[[[[(4-methoxy-6-methyl-1,3,5-triazinyl) amino] carbonyl] amino] sulfonyl] benzoic acid}, which is a kind of herbicide, has given a successful result against *R. lutea*. (Harris *et al.* 1995). It is stated that the combination of Metsulfuron and 2,4-D [(2,4-dichlorophenoxy) acetic acid] is more successful than a combination of the Dicamba (3,6-dichloro-2-metoxybenzoic acid), glyphosate [N-(phophonomethyl) glycine], picloram (4-amino-3,5,6-trichloro-2-pyridinecarboxylic acid) and 2,4-D (Harris *et al.* 1995). Heap *et al.* (1995) mentioned that, Metsulfuron-methyl, Chlorosulfuron and Trialsulfuron can be successfully used against the *R. lutea,* but Metsulfuron-methyl is most economic one. Furthermore, it is reported that the following chemical herbicides are being used against *R. lutea*: Chlorimuron-ethyl, Tribenuron-methyl, Thifensulfuron, Dicamba/bromoxynil/ MCPA, Diflufenican, Clopyralid, Mecoprop/dicamba, Imazethapyr, Fluroxypyr and Picloram/MCPA, Glyphosate, and Picloram/2,4-D (Harris *et al.* 1995). Moreover, the use of Alloy and Glean herbicides have been reported by Heap *et al.* (1987).

Bailey and Wicks (1995) have worked on the pathogens and insects of *R. lutea.*

Reseda lutea presents a potential threat to cucurbit crops in Australia and Iran because it is a potential host for water-melon mosaic virus (Amiri and Ebrahim-Nesbat, 1977; Heap *et al.* 1995). Water-melon mosaic virus occurs in South Australia as an economically damaging pest of several cucurbit crops and is spread by aphids (Heap *et al.* 1995).

Pemberton and Irwing (1990) have carried out studies on 47 species belonging to 13 families distributed naturally in United States and they investigated the elaiosomes and myrmecochary features in the seeds of *R. lutea.*

Since *R. lutea* fruits and seeds lack hooks, barbs, spines and adhesive exudes which might otherwise aid in external transport by animals, they have low potential for epizoochory (Heap *et al.* 1995).

Gibbs (1974) recorded the existence of raffinose (carbohydrate), cyanogenic glycosides, glcobarbari from mustard-oil glucodes, gliconaturtiin *m*- carboxyphenyl-*l*-ananine, leucoanthocyanins in the seeds and myrosin cell in *R. lutea.*

Ferlay *et al.* (1993) reported the existence of lipids in the seeds and they claim, lineolenic acid covers 60 % more place from the fatty acids.

The chromosome number was recorded as 2n= 48 by Eigsti (1936) and Hegi (1958).

In addition to above-mentioned studies, Bolle (1936), Abdallah (1967) and Pearce (1982) carried out studies on *Resedaceae* family and *R. lutea*; Salisbury (1961), Silvertown (1981), and Shimida and Ellner (1983) on the biology and ecology of *R. lutea;* Özer and Hasimoğlu (1977) on the seed germination of *R. lutea*; and Wichman (1990), Davis *et al.* (1993) and Heap (1994) carried out studies on the biology and control of the species.

From economical viewpoint; *R. lutea* is being used

- as the natural source of dyeing in kilims and carpets industry;
- as the grazing material and stock feeding source in the cattle breeding;
- in apiculture due to its high nectar secretion;
- as the primary succession plant against the erosion struggle.

As against the above mentioned useful benefits this plant is harmful for the fields as a weed.

In this study, our aim was to study the soil and plant characteristics, the anatomy, morphology, seed germination features and pollen characteristics of the species in order to determine the autecological features of *R. lutea* which shows a wide range in Turkey and is of economical importance.

Chapter Two
MATERIAL AND METHOD

2. Material and Method

2.1 Localities

The specimens of *R. lutea* collected from 54 different localities in West Anatolia were identified taxonomically with the help of "Flora of Turkey and the East Aegean Islands" (Davis, 1965) and "The Biology of Australian Weeds" (Heap *et al.* 1995).

All the specimens of *R. lutea* are deposited in the herbarium of Biology Dept., Faculty of Education, Dokuz Eylul University by Dogan code. In addition to the plant samples, soil samples were also taken from the same localities.

The samples area numbers of *Reseda lutea* in West Anatolia, the grid-square numbers according to Davis (1965), localities, altitudes, the code of herbarium records, and collecting dates are given in Table 1 and Figure 1.

2.2. Distribution

The distribution of *R. lutea* in the world, was recorded from different references and has been presented on a map. The distribution of the plant in Turkey has been given according to the grid-square system of Davis (1965), following all records from personal or official collections.

Table 2.1 Localities from where soil and plant samples of *R. lutea* were collected in West Anatolia.

Çanakkale

1. A1 Ecebat, between Alçıtepe-Eceabat, 1.5 km to Eceabat, near the field, 50 m, 24.06.1997, Dogan 239.
2. A1 Eceabat, near Yahyaçavuş Monument, wheat field, 60 m, 24.06.1997, Dogan 240.
3. B1 Ayvacık, Nusratlı village, near the main road, 300 m, 23.06.1997, Dogan 241.
4. A1 Lapseki, 5 km to Şevketiye, 40 m, 25.06.1997, Dogan 242.
5. A1 Çanakkale, 10 km to the city centre, field border, 30 m, 24.06.1997, Dogan 243.

Balıkesir

6. B1 Ayvalık, city exit, side of Edremit-Çan road, 22.06.1997, Dogan 244.
7. B2 Bigadiç, 5 km to the city centre, field border, 350 m, 29.06.1997, Dogan 245.
8. B2 Bigadiç, Çağış village, in the village, 170 m, 29.06.1997, Dogan 246.
9. B1 Balıkesir, entrance to the city centre, road side, 80 m, 28.06.1997, Dogan 247.
10. B1 Savaştepe, Soğucak village, near the field, 400 m, 28.06.1997, Dogan 248.
11. A2 Bandırma, city entrance, road side, 130 m, 27.06.1997, Dogan 249.
12. A1 Gönen, Taştepe village, road side, 70 m, 26.06.1997, Dogan 250.

Manisa

13. B1 Spil mountain, Atalanı environs, 1200 m, 04.06.1997, Dogan 251.
14. B1 Sabuncubeli slope, 470 m, 04.06.1997, Dogan 252.
15. B1 Centre, Dilşeker quarter, the base of the wall, 25 m, 04.06.1997, Dogan 253.
16. B1 Akhisar, 20 km to Akhisar, near İzmir-Istanbul main road, 50 m, 04.06.1997, Dogan 254.
17. B2 Akhisar, 20 km to Gördes, near the field, 720 m, 04.06.1997, Dogan 255.
18. B2 Gördes, Softalar quarter, road side, 800 m, 05.06.1997, Dogan 256.
19. B2 Demirci, upper part of Klavuzlar village, 760 m, 05.06.1997, Dogan 257.

20. B2 Kula, city entrance, near Uşak-İzmir main road, 560 m, 06.06.1997, Dogan 258.

21. B2 Sarıgöl, near Sarıgöl-Buldan road, 225 m, 06.06.1997, Dogan 259.

İzmir

22. B1 Dikili, entrance to Salihler, near İzmir-Çanakkale road, in the field, 50 m, 17.06.1997, Dogan 260.

23. B2 Bergama, 5 km to Bergama, descent of Kozak plain, 50 m, 17.06.1997, Dogan 261.

24. B1 Gümüldür, Yeniköy exit, road side, 50 m, 19.06.1997, Dogan 262.

25. C1 Selçuk, city exit, towards Belevi, road side, 50 m, 19.06.1997, Dogan 263.

26. B1 Bornova exit, Manisa road, near MTA houses, 200 m, 20.06.1997, Dogan 264.

27. B1 Seferihisar, Akkum, 50 m to sea side, 25 m, 19.06.1997, Dogan 265.

28. B1 Urla, Çeşmealtı, near the pine forest, 25 m, 20.06.1997, Dogan 266.

29. B1 Karaburun, Mordoğan, city centre, near the field, 50 m, 20.06.1997, Dogan 267.

30. B1 Çeşme, Boyalık environs, 50 m, 20.06.1997, Dogan 268.

31. B1 Konak, near Şirinyer old aqueduct, in the park, 60 m, 20.06.1997, Dogan 269.

32. B1 Aliağa, city centre, 40 m, 21.06.1997, Dogan 270.

Aydın

33. C2 Kuşadası, entrance of Kadınlar Plajı, 50 m, 31.05.1997, Dogan 271.

34. C2 Söke, 8 km to Söke, in the field, 260 m, 31.05.1997, Dogan 272.

35. C2 Ortaklar, city exit, towards İzmir, near the field, 50 m, 03.06.1997, Dogan 273.

36. C2 Didim, Akbük cross-roads, near the road, 150 m, 31.05.1997, Dogan 274.

Denizli

37. B2 Güney, 19 km to Güney, near Sarıgöl-Güney road, 750 m, 07.06.1997, Dogan 275.

38. B2 Güney, between Güney-Çal, near Çal road, 800 m, 07.06.1997, Dogan 276.

39. B2 Çal, in Kabalar village, 830 m, 07.06.1997, Dogan 277.

40. C2 Denizli, between Denizli-Çal, Güzelpınar, near the field, 1200 m, 08.06.1997, Dogan 278.

41. C2 Denizli, city centre, towards Tavas, 520 m, 08.06.1997, Dogan 279.

42. C2 Honaz Mountain, upper part of Kocapınar village, near the field, 1500 m, 09.06.1997, Dogan 280.

43. C2 Tavas, near Denizli-Tavas road, 1150 m, 09.06.1997, Dogan 281.

44. B2 Çal, entrance of Denizler town, 875 m, 10.06.1997, Dogan 282.

45. B2 Çivril, in Yamanlar village, 850 m, 10.06.1997, Dogan 283.

46. C2 Baklan, in Hadım village, 850 m, .06.1997, Dogan 284.

47. C2 Pamukkale, near the south gate of Pamukkale (Hierapolis), 340 m, 11.06.1997, Dogan 285.

Muğla

48. C2 Milas, exit of Ovabat village, 500 m, 01.06.1997, Dogan 286.

49. C2 Yatağan, near Stratonikeia cross-roads, in the fallow field, 550 m, 01.06.1997, Dogan 287.

50. C2 Ula, Kızılağaç environs, road side, 700 m, 02.06.1997, Dogan 288.

51. C2 Muğla, city exit, upper part of Science-Art Faculty, near the new water store, 700 m, 02.06.1997, Dogan 289.

Kütahya

52. B2 Şaphane, city exit, towards Gediz, 750 m, 12.06.1997, Dogan 290.

53. B2 Gediz, Abideler village exit, towards Gediz, 625 m, 12.06.1997, Dogan 291

Uşak

54. B2 Uşak, 20 km to city centre, Gediz-Uşak road side, near the field, 575 m, 11.06.1997, Dogan 292.

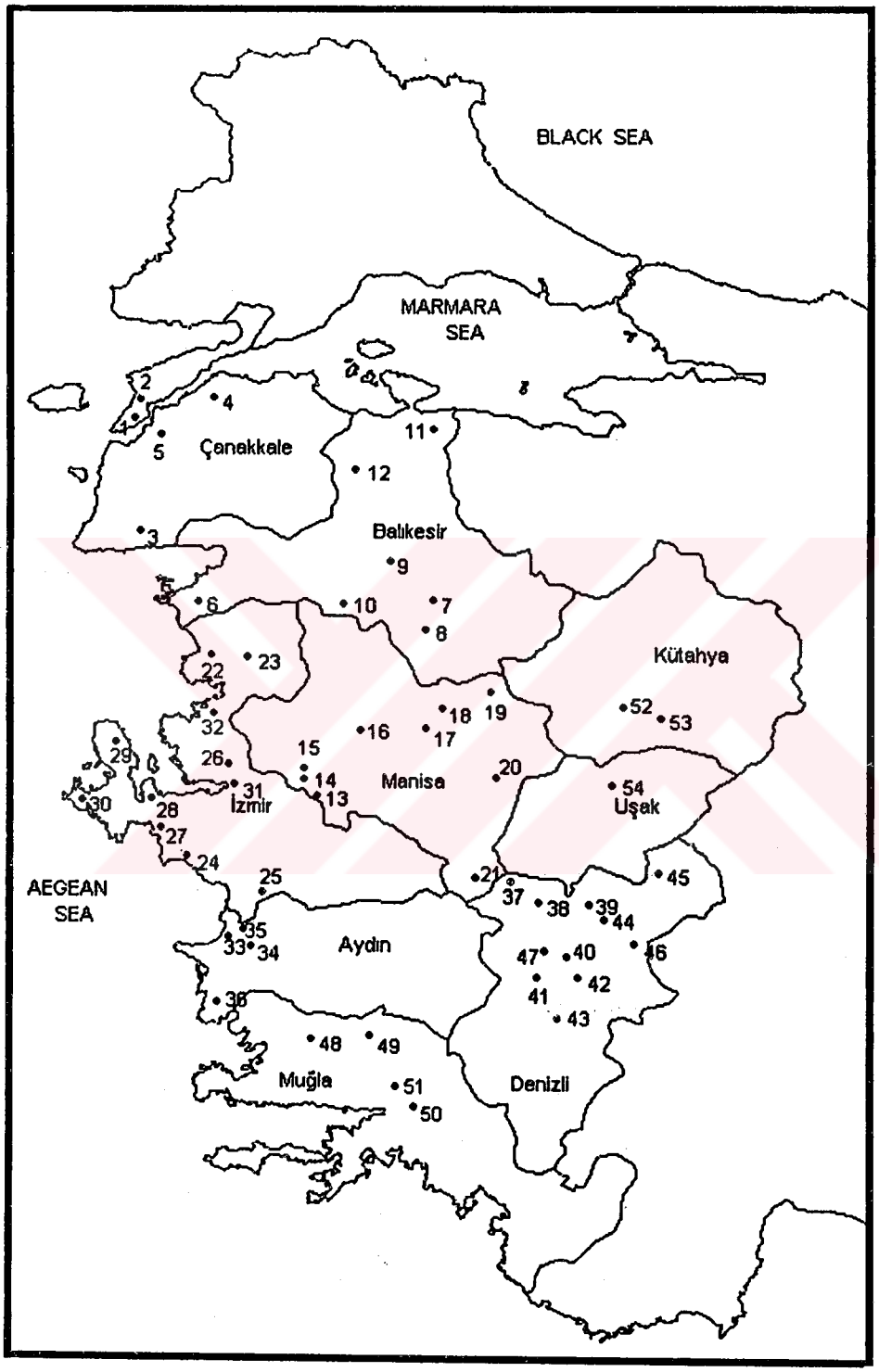

Figure 2.1 Map showing the collection localities of *R. lutea* from West Anatolia.

The localities in our study area are listed in "Material and Methods" so these were not repeated in "Results", where only numbers are cited.

2. 3. Morphology

The plants samples collected from different localities from West Anatolia were determined according to Davis (1965) and Heap *et al.* (1995). Necessary parts of the plant were drawn. 40 different plant samples, collected from 54 different localities, were used for the biometric measurements. Mean, standard deviation of the measurements, standard error values of the mean were calculated by statistical packet program in the computer. Later, these values were presented as a table.

2.4. Pollen Structure

The pollens of *R. lutea* were left in glycerine-gelatine with safranine which was prepared according to Brown (1960) and Aytug (1967). From these pollen preparates were prepared. Average 30 pollen measurements were taken from pollen preparations from different localities. These were examined under light microscope and their photographs taken by microphotography. Pollen measurements were taken by micrometric ocular. Pollen type, ornamentation type and P/E ratio results were recorded according to Erdtman (1966), Moore *et al.* (1991) and Punt and Mark (1995). Statistical evaluations were done by computer statistics packet programme and results are presented in the table.

2.5. Anatomy

Plant materials of *R. lutea*, collected from different localities, were fixed in 70 % alcohol and then the anatomical sections of root, stem and leaf taken. After staining with 'sartur' reactive and 'Milon's reagent', photographs were taken with the help of an optic microscope.

2.6. Germination

The seeds which had completed stratification were used in the germination. These were sterilised with 5 % sodium hypochloride to prevent fungal attack during the experiment. After sterilisation, the seeds were washed by distilled water three times and put for germination in sterilised petri dishes, containing double filter papers. Incubator was used for germination with a 7 W fluorescence lamp is used for illumination in refrigerated oven. Petri dishes were kept 40 cm away from the light source. In dark room, 25 W of green lamp was used counting the germinated seeds. Petri dishes were placed 30 cm away from the light source to count the seeds in dark. At the end of the eleventh day, the germination had finished completely. Although dishes were left up to twenty first day just in case germination could happen later, no changes were seen in germination. The experiments were duplicated with 100 seeds per petri dish. Seeds were left for germination after following treatments:

2.6.1 Effects of Temperature on Germination

The germination rate was followed at 10, 15, 20, 25, 30, 35 , 40 and 45° C, in continuous dark and light.

2.6.2 Effects of Light on Germination

Seeds were left in continuous dark and 6, 12, 18 and 24 hours continuous light at 25° C, (the optimum germination temperature) to study the light effects.

2.6.3 Germination of Seeds in the Soil

The seeds were left at 10, 30, 50 and 100 mm depths from the surface in 500 ml glass jars, filled with garden soils. Seeds were kept in the middle and on the border of jars. The germination was observed at each depth. 100 seeds were kept in each jar at each depth. The germination was recorded when the first leaf appeared on the soil surface. The study was

followed for four weeks.

2.7 Soil Analysis

Soil samples were collected from localities mentioned above during June-July, 1997. The soil samples were collected, after cleaning the litter on the soil, put into polyethylene bags and brought immediately to the laboratory. They were left under laboratory conditions to get air dried. The completely dried up soils samples were ground, passed through a 2 mm sieve and subjected to analysis.

Textural classification, pH, total soluble salts, and calcium carbonate contents in soils were determined by the methods outlined in detail in Öztürk *et al.* (1997). The total nitrogen analysis was determined according to Bremner (1965) by Kjeldahl method. The phosphorus was determined according to Bingham (1949). The potassium was determined acording to Chapman and Pratt (1961). Phosphorus and potassium were recorded from "Spectrum 2000 Spectrophotometer" and "Jenwaw Flame photometer" respectively.

Soil structure was discussed according to Bouyoucos (1955), pH according to Jackson (1958), $CaCO_3$ according to Scheffer and Schactschabel (1956), total salt according to Anonymous (1951), nitrogen according to Loue (1968), phosphorus according to Bingham (1949) and potassium according to Pizer (1967).

2.8. Plant Analysis

Samples of the plants were collected from 54 different localities in the flowering and fruiting periods during May-June, 1997. These were dried at 80° C in the air blown oven for 24 hours ground with blender and prepared for analysis.

Two different methods were used for plant analysis. At first all parts (root, stem, leaf and flower) of plant samples, collected from different 54 localities, were subjected to analysis.

Secondly, the analysis were done to ascertain the elements in different organs of plant. The analysis of root, stem, leaf and flowers of plant samples, collected from 1, 5, 6, 10, 13, 21, 24, 28, 36 and 47 numbered, totally 10 localities, were done separately.

The total nitrogen analysis was determined according to Bremner (1965) using Kjeldahl method. The phosphorus analysis was followed according to Lott *et al.* (1956) and read from "Spectrum 2000 spectrophotometer". The potassium and calcium was read from "Jenway Flame photometer" directly according to Kacar (1962).

At the end of plant analysis, nitrogen and potassium results were discussed according to Kacar (1972), phosphorus according to Johnson and Ulrich (1959) and calcium according to Chapman (1967).

2.9 Statistical Evaluation of the Soil and Plant Analysis Results

Plant analysis results (nitrogen, phosphorus, potassium and calcium) and soil analysis results (pH, total soluble salts, calcium carbonate, total nitrogen, phosphorus and potassium) were subjected to an analysis via statistical packages. The results were evaluated by using multiple stepwise regression analysis. The results obtained were interpreted according to Daniel and Terrell (1995), İkiz *et al.* (1996) and Mc Clave *et al.* (1998).

Chapter Three
RESULTS

3. Results

3.1 Distribution

3.1.1 Distribution in the World

South, West and Central Europe extending upto Finland, Norway, Sweden (Davis, 1965); England (Hegi, 1958; Abdallah and De Witt, 1978); Mediterranean basin, Asia minor (Harris *et al.* 1995; Heap *et al.* 1995); Southwest Asia (Bonnier, 1934; Tutin, 1964; Bailey, 1947); Iran (Davis, 1965); former Soviet Union, Afghanistan (Harris *et al.* 1995), Chile, United States (Harris *et al.* 1995), Australia, New Zealand, South and North Africa (Bonnier, 1934; Tutin, 1964; Bailey, 1947) (Figure 3.1).

3.1.2 Distribution in Turkey

Localities established during study in West Anatolia and other field observations together with grid-square are given below: **A1**: Çanakkale, centre (5); Eceabat (1); Eceabat (2); Lapseki (4); Balıkesir, Gönen (12). **A2**: Balıkesir, Bandırma (11). **A7**: Gümüşhane, Torul (25.07.1997, Dogan 293). **B1**: Çanakkale, Ayvacık (3); Balıkesir, centre (9); Ayvalık (6); Savaştepe (10); Manisa (15); Spil mountain 13); Sabuncubeli (14); Akhisar (16); İzmir, Dikili, (22); Bergama (23); Gümüldür (24); Bornova (26); Seferihisar (27); Urla (28); Karaburun (29); Çeşme (30); Konak (31); Aliağa (32). **B2**: Balıkesir, Bigadiç (7); Bigadiç (8); Manisa, Akhisar (17); Gördes (18); Demirci (19); Kula (20); Sarıgöl (21), Denizli, Güney (37); Güney (38); Çal (39); Çal (44); Çivril (45); Kütahya, Şaphane (52); Gediz (53); Uşak (54). **B5**: Nevşehir, Ürgüp (12.08.1997, Dogan 294). **C1**: İzmir, Selçuk (25); Aydın, Kuşadası

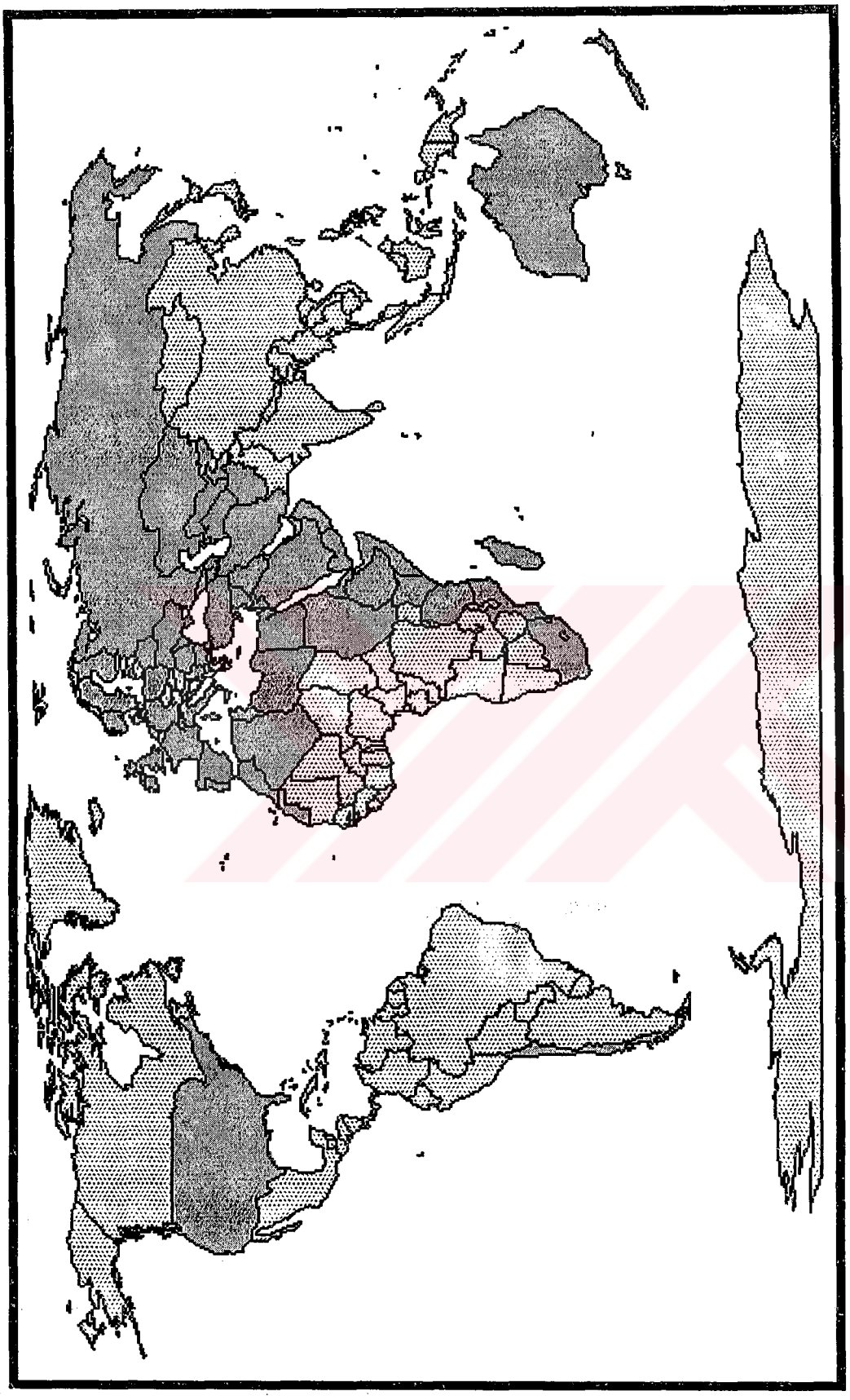

Figure 3.1 Distribution of *R. lutea* in the world (According to Hegi, 1958; Tutin *et al.* 1964; Davis, 1983; Harris *et al.* 1995 and Heap *et al.* 1995).

(33); Söke (34); Ortaklar (35); Didim (36); Muğla, Milas (48). **C2**: Denizli, centre (41); Güzelpınar (40); Honaz mountain (42); Tavas (43); Baklan (46); Pamukkale (47); Muğla, centre (51); Yatağan (49); Ula (50). **C4**: İçel, Mut, Silifke (06.04.1998, Dogan 295); Antalya, Alanya (12.04.1998, Dogan 301). **C5**: Adana, highway (08.04.1998, Dogan 297), Adana exit (08.04.1998, Dogan 298); İçel, Tarsus (07.04.1998, Dogan 296); Hatay, Samandağ (11.04.1998, Dogan 300) **C6**: Gaziantep, Nizip (09.04.1998, Dogan 299).

Records according to Davis (1965): **A1**: Takirdağ, Marmara Ereğlisi. **A2**: İstanbul, Makriköy; Kocaeli, İzmit. **A2/3**: Bilecik, centre. **A3**: Sakarya, Gevye. **A4**: Karabük, Safranbolu. **A5**: Amasya, centre. **A6**: Samsun, centre. **A7**: Trabzon, centre. **A8**: Çoruh, Artvin to Ardanuc. **A9**: Kars, Aras valley. **B1**: İzmir, Bornova. **B2**: Kütahya, Gediz to Uşak. **B3**: Konya, Akşehir. **B4**: Ankara, Tuz lake. **B6**: Kahramanmaraş, Nurhak mountain. **B7**: Erzincan, Keşiş mountain. **B8**: Erzurum, mountains between Ilıca and Tercan. **B9**: Bitlis, Adilcevaz. **C2**: Afyon, Denizli to Çardak. **C3**: Isparta, Sütçüler to Darıbükü. **C4**: Konya, Konya to Sille. **C5**: İçel, Tarsus. **C6**: Adana, Seyhan, Haruniye. **C8**: Siirt, centre. **C9**: Hakkari, Zab **C10**: Hakkari, Cilo mountain.

Records from Ege University Herbarium Centre (EGE): **A1**: Çanakkale, Truva; Gökçeada. **A3**: Adapazarı. **A5**: Çorum, Boğazkale **A7**: Trabzon, Maçka **A9**: Kars, Digor. **B1**. İzmir, Bornova; Çeşme-Ilıca; Dikili-Bademli; Urla; Balçova; Manisa, Kırkağaç; Spil mountain-Başpınar; Soma; Balıkesir, Edremit-Zeytinalan; Çanakkale, Bozcaada. **B2**: Uşak, centre; Denizli, Çivril-Işıklı. **B3**: Eskişehir, Çifteler. **B5**; Nevşehir, Göreme. **B6**: Sivas, Zara. **C2**: Denizli, Tavas; Antalya, Elmalı;. **C3**: Isparta, Eğridir;. **C4**: Konya, centre.

Records given in studies and some personal herbaria: **A1**: Çanakkale, Gelibolu (Turril, 1958); Eceabat (personal herbarium İ. Uysal 602, 29.06.1995); Edirne, Enez (Kireç and Yarcı, 1999). **A5**: Yozgat, Çekerek (İlarslan, 1994). **A6**: Samsun, Bafra (Kutbay *et al.* 1995); Tokat-Sivas (Civelek, 1992). **A7**: Sivas, Suşehri-Kelkit valley (Yıldız, 1996). **A9**: Kars (Ocakverdi, 1986). **B1**: İzmir, Çeşme-Altınkum (Görk *et al.* (1989); Karaburun-Akdağ (Bekat and Seçmen, 1982); Yamanlar mountain (Gemici and Seçmen, 1983). Kemalpaşa-Nif mountain (Seçmen, 1980). **B2**: Uşak, Murat mountain (Çırpıcı, 1989). **B7**: Malatya, Çelikhan-Surgu (Yıldız and Aktoklu, 1996). **B8**: Erzurum, Dumlu mountain (Behçet and Tatlı, 1989). **B9**: Van, Van castle (personal herbarium, İ. Özçelik, 1985); **C2**: Aydın, Nazilli-Karıncalı

mountain (Çelik and Seçmen, 1996); Denizli, Honaz mountain (Tuzlacı, 1977); Acıgöl (Kesercioğlu and Serin, 1996). C4: Konya, Beyşehir (Küçüködük, 1989); Konya, Ermenek-Kazancı (Sümbül and Erik, 1987); Karaman, Taşeli plateau (Sümbül and Erik, 1988).

3.2 Ecology

It is distributed along the roadsides, railways, embankments, damps, near harbour, field borders, ditches, waste places, fields, walls, rocky slopes, open stony hillsides, cultivated and disturbed ground and gravel piles.

This species is seen widely in our study area as a ruderal plant. Plant samples were collected from 25 m to 1500 m altitudes in West Anatolia.

3.3 Morphology

Reseda lutea is a perennial or rarely annual herb; with stems erect or ascending, usually diffusely branched, glabrous 25 to 130 cm tall (Table 3.1, 3.2, Figure 3.2, 3.3, 3.4). Leaves usually are dark green; narrow, trifid or pinnatifid; segments elongate. Basal leaves sometimes are entire, 34.55 to 178.05 mm long x broad; cauline leaves 19.80 to 84.05 mm tall. Bracts usually caducous. Flowers zygomorphic and arranged in racemes. Sepals 5-6, free, persistent and becoming twisted in fruit, 2.8-3.5 x 0.6-0.9 mm. Petals 6, free, yellow coloured, 3.55-4.00 x 2.20-2.50 mm; the limbs trilobed, and with the lateral lobes lunulate, entire, crenulate and occasionally more deeply divided into irregular segments; the midlobes shorter, entire, narrowly linear. Stamens 13-24, inserted on a dorsally enlarged disc, their lengths are 2.40-4.50 mm, anther length is 1.20-1.50 mm. Filaments caducous, very long before fruit is ripe, 2.30-3.70 mm. Ovary 3, superior, unilocular, usually open at the apex, 2.00-3.30 mm., ovules numerous. Plecentation parietal, capsules 4.00-15.00 x 2.00-5.40 mm, erect, rarely lowermost stem capsules pendulous when fully ripe, opening more widely at maturity; capsule nerves scabrous, cylindrical, sometimes ovate or even subglobose or triquetrous, glabrous, with three very short teeth. Pedicel 2.2-4.4 mm (in flowers), more or less twice the fruit. Seeds 1.40-1.80 x 1.05-1.25 mm, reniform or suborbicular, without endosperm; each capsule with 4-27 seeds, shiny, yellow to black, slightly smooth, mature seeds remain in capsules until dispersed by physical disturbance. Flowering period is from April to late

September.

3.4 Anatomy

3.4.1 Root

When the anatomical structure of the cross section taken from *R. lutea*'s root was examined (Fig. 3.5); there is a lignified eksodermis layer which is seen in pieces in some parts, on the outer side. Epidermis cells are not seen clearly. Paranchymatic cortex shows a squeezed structure in a narrow area. Vascular area constitutes a wide area. The phloem tissue occupies a very little place and cannot be distinguished. The xylem tissue extends until pith and occupies a very wide area. Epidermis and pericycle are not clear and cannot be distinguished. In cortex and pith zones of root, myrosin (myrosin, the specific enzyme catalysing the hydrolysis of all isothiocyanate glycosides has been found in all plants containing this substrate) is present in secretory cells (Figure 3.6).

3.4.2 Stem

When the cross section taken from *R. lutea*'s stem was examined (Figure 3.7, 3.8, 3.9); there is a thick cuticle layer and an epidermis which is formed by small cells which have thick membranes. There are secretory hairs on the epidermis layer. Just under epidermis, cortex layer takes places, which is constituted by cells that do not have a homogenous appearance. The cells of cortex tissue contain secretory (myrosin) cells in a big amount. The cells of phloem tissue, squeezed between cortex tissue and xylem tissue, occupy a very little area. Xylem tissue has the shape of a correct circle and occupies a wide area. There are lots of myrosin cells among the cells close to pith, as in cortex zone (Figure 3.7, 3.8).

Table 3.1 Biometric measurement of *R. lutea* (measurement numbers: plant height mean of 54 samples, others mean of 40 samples).

	Min.	Max.	Mean	S. D.*	S. E.**
Plant height (above ground parts) (cm)	25	130	82.82	25.353	3.585
Basal leaves (mm)	34.55	178.05	74.97	36.792	6.953
Cauline leaves (mm)	19.80	84.05	42.65	16.211	2.629
Sepal length (mm)	2.80	3.50	2.76	0.346	0.081
Sepal width (mm)	0.60	0.90	0.73	0.084	0.020
Petal length (mm)	3.55	4.00	3.57	0.298	0.054
Petal width (mm)	2.20	2.50	2.19	0.142	0.031
Stigma length (mm)	2.00	3.30	2.91	0.376	0.094
Stamen length (mm)	2.40	4.50	3.46	0.634	0.184
Stamen number of a flower	13	24	17.30	2.398	0.379
Filament length (mm)	2.30	3.70	2.92	0.306	0.055
Anther length (mm)	1.20	1.50	1.43	0.099	0.026
Pedicel length of the flower (mm)	2.20	4.40	3.45	0.441	0.068
Pedicel length of the fruit (mm)	4.40	7.55	6.14	0.780	0.123
Capsule length (mm)	4.00	15.0	8.98	3.135	0.522
Capsule width (mm)	2.00	5.40	3.86	0.762	0.122
Seed length (mm)	1.40	1.80	1.58	0.103	0.018
Seed width (mm)	1.05	1.25	1.15	0.060	0.010
Seed number in a capsule	4	27	13.91	8.423	1.339

* S.D.: Standard Deviation, ** S.E.: Standard Error

Table 3.2 Measurement results of plant height in İzmir and Denizli.

İzmir			Denizli		
Loc.	Altitude (m)	Plant height (cm)	Loc.	Altitude (m)	Plant height (cm)
22	50	103	37	750	50
23	150	86	38	800	80
24	50	116	39	830	75
25	50	106	40	1200	60
26	200	106	41	520	82
27	25	102	42	1500	50
28	25	107	43	1150	67
29	50	86	44	875	81
30	50	103	45	850	35
31	60	86	46	850	60
32	40	130	47	340	50
Mean	68	103	Mean	801	62

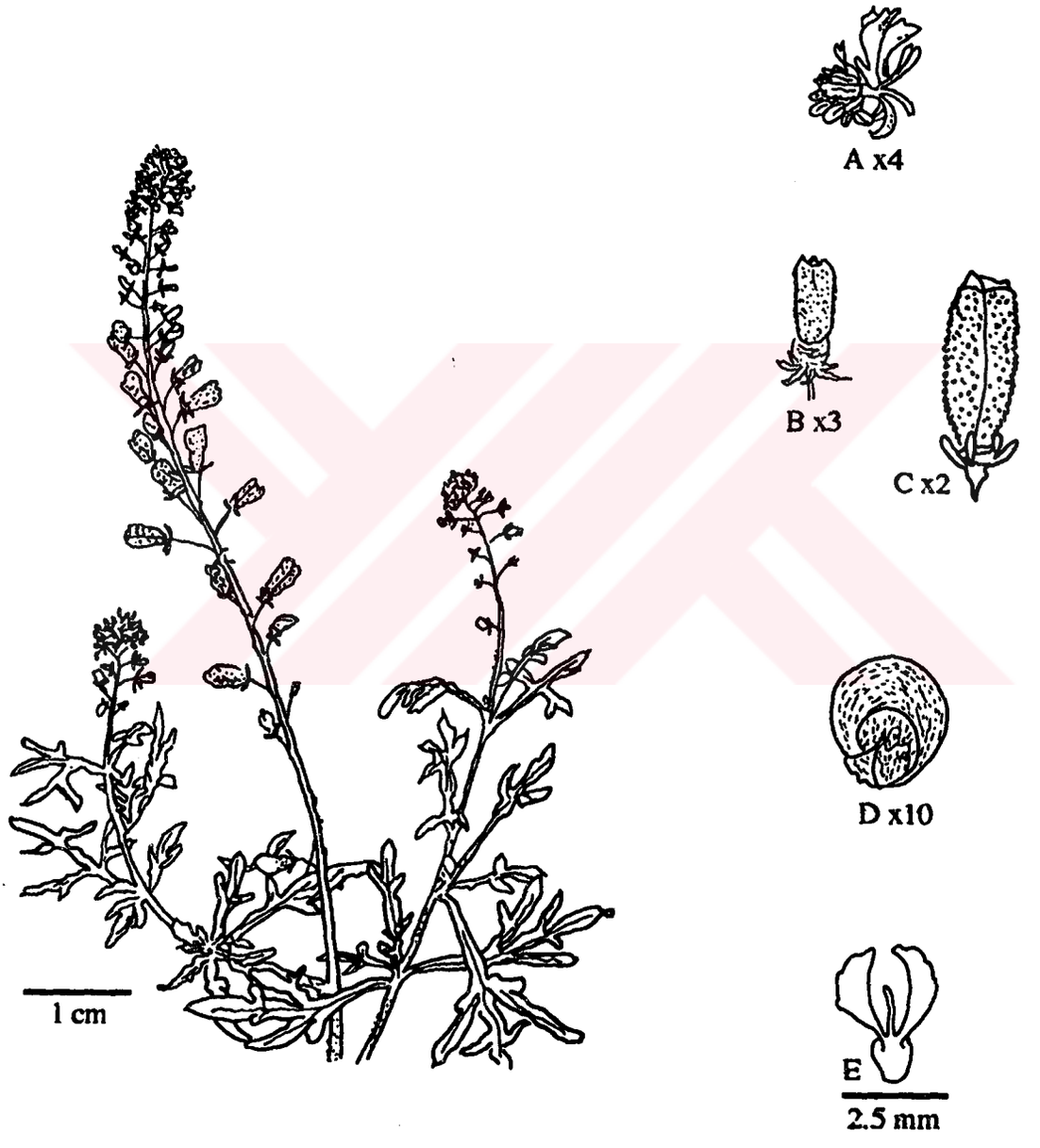

Figure 3.2 Floral parts of *R. lutea* a) Flower, B) Pistil, C) Capsule, D) Seed, E) Back petal.

Figure 3.3 General appearance of *R. lutea*.

Figure 3.4 A branch of *R. lutea*.

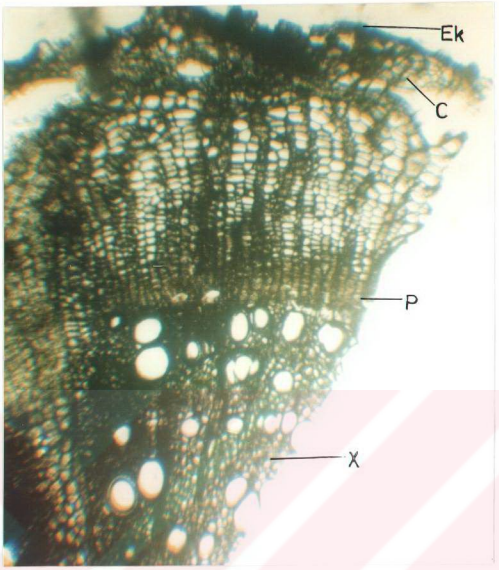

Figure 3.5 A cross section of the root of *R. lutea* (3.2 x 6.3). Ek-Eksodermis, C-Cortex, P-Phloem, X-Xylem.

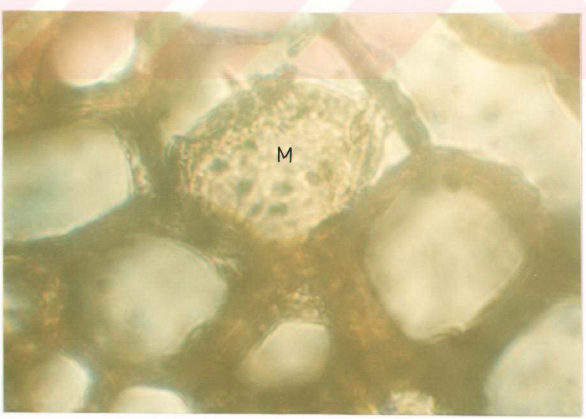

Figure 3.6 A cross section of the central part of root of *R. lutea* (40 x 6.3). M-Myrosin cells.

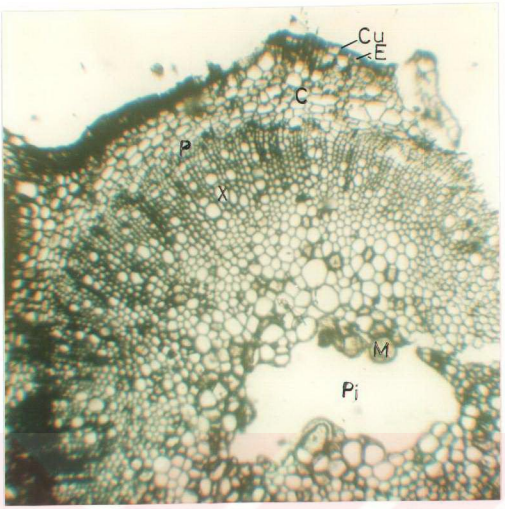

Figure 3.7 General appearance from the cross section of the stem of *R. lutea* (3.2x6.3). Cu-Cuticle, E-Epidermis, C-Cortex, P-Phloem, X-Xylem, M-Myrosin cell, Pi-Pith space.

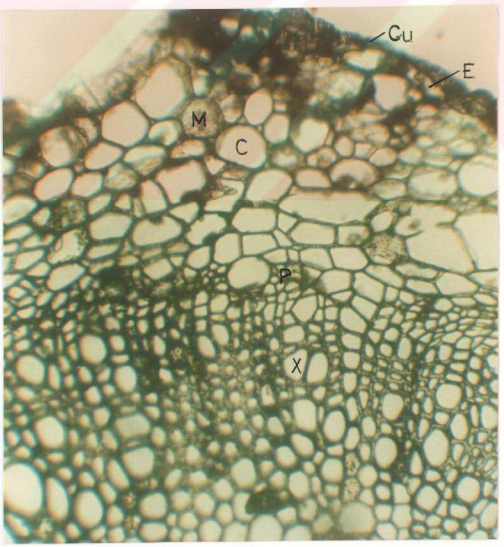

Figure 3.8 Detail appearance from the stem of *R. lutea* (10 x 6.3). Cu-Cuticle, E-Epidermis, C-Cortex, P-Phloem, X-Xylem, M-Myrosin cell.

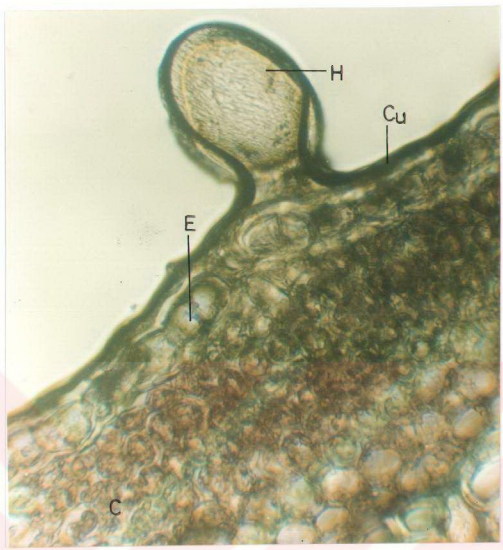

Figure 3.9 A cross section of the stem (10 x 6.3). Cu-Cuticle, H-Hair, E-Epidermis, C-Cortex.

3.4.3 Leaf

Cross section of *R. lutea*'s leaf shows that (Fig. 3.10), there is a cuticle layer, which is thick on upper and lower surfaces of the leaf. Under the cuticle lies epidermal layer formed of one lined, large cells. The upper and lower walls of epidermal cells are thickened. The leaf shows an equifacial structure with palisade parenchyma on the upper and lower surfaces of the leaf and spongy parenchyma cells of lying between these. While the spongy parenchyma cells occupy a little place, the palisade parenchyma occupies a wider place. Stomata are ranunculaceous (anomocytic) type. Stomata are present on both the surfaces of leaf (amphistomatic type)(Fig. 3.11, 3.12). Stomata show mesophytic characters in the cross section of leaf (Figure 3.13), epidermis and stoma cells being on the same level. Again, myrosin cells are present in mesophyl tissue of leaf, as seen in the anatomical sections of root and stem. But crystal structures are not visible.

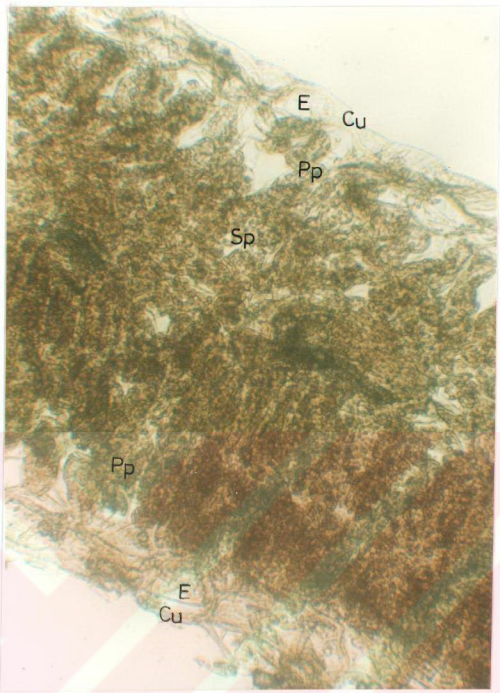

Figure 3.10 A cross section of the leaf of *R. lutea* (10 x 6.3). Cu-Cuticle, E-Epidermis, Pp-Palisade parenchyma, Sp-Spongy parenchyma

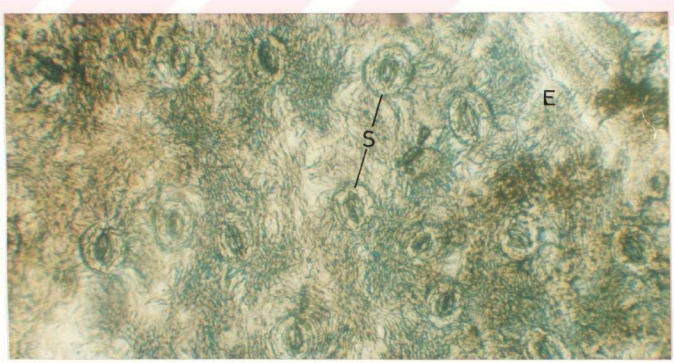

Figure 3.11 Upper epidermis with stomata in the transverse section of the leaf of *R. lutea* (10 x 6.3). E-Epidermis, S-Stoma.

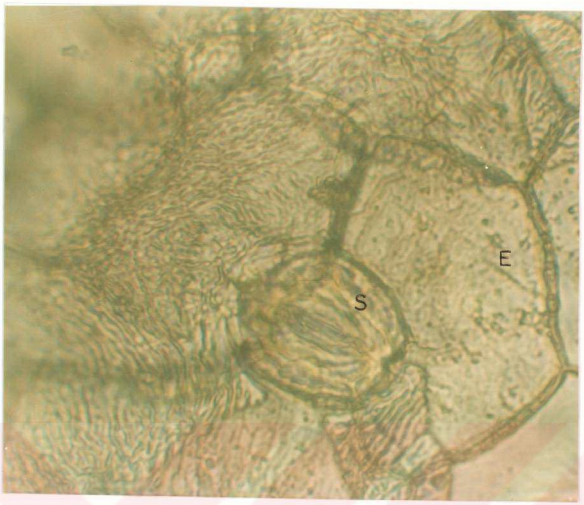

Figure 3.12 Lower epidermis with stomata in the transverse section of the leaf of *R. lutea* (10 x 6.3). E-Epidermis, S-Stoma.

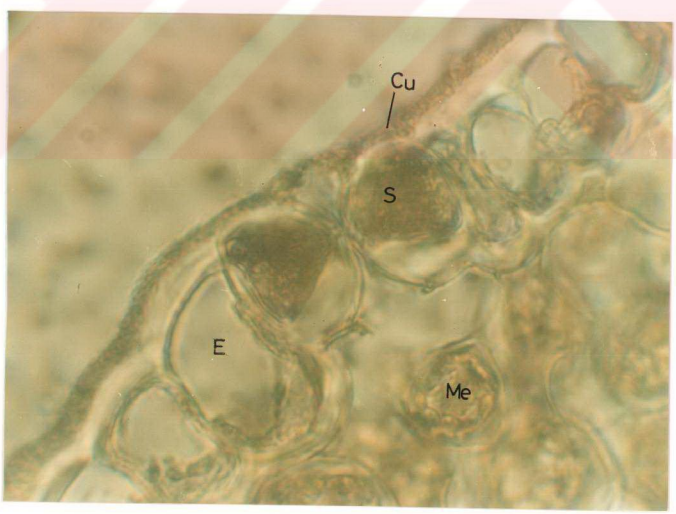

Figure 3.13 A cross section of the leaf of *R. lutea* (40 x 6.3). Cu-Cuticle, S-Stoma, Me-Mesophyll.

3.5 Germination

3.5.1 Germination at Different Temperatures.

The germination rates of *R. lutea* seeds at different temperatures are given Table 3.3 and Figure 3.14. Germination was followed at 10, 15, 20, 25, 30, 35 and 40° C for 21 days to find the optimum temperature in continuous dark and continuous light. At the end of 21 days no germination occurred below 10 and above 40° C. Germination rates obtained are 17 % at 10° C, 39 % at 15° C, 58 % at 20° C, 87 % at 25° C, 69 % at 30° C, 45 % at 35° C and 28 % at 40° C. According to these result, optimum germination rate of *R. lutea* seeds is 87 % at 25° C.

Table 3.3 Germination of *R. lutea* at different temperatures.

	Germination (%)	
Temperature (° C)	Continuous dark	Continuous light
10	17	4
15	39	7
20	58	10
25	87	42
30	69	25
35	45	21
40	28	16

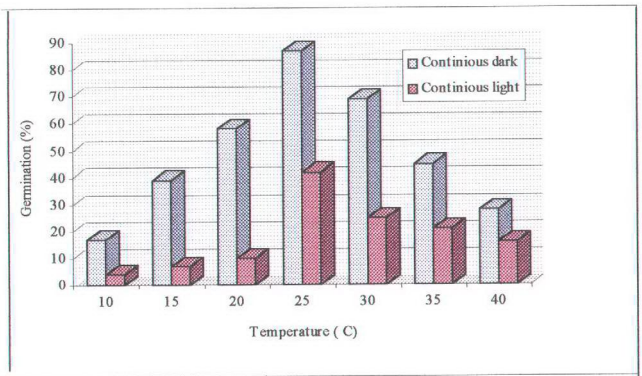

Figure 3.14 Germination rates of *R. lutea* seeds at different temperatures.

3.5.2. Germination at Different Illumination Periods

Germination rates of *R. lutea* in continuous dark, 6 hours of light, 12 hours of light, 18 hours of light and 24 hour of light (continuous light) at optimum temperature was followed. Germination in continuous dark was 87 %, 76 % under 6 hours of light, 67 % under 12 hours of light, 52 % under 18 hours of light and 42 % in continuous light. Germination occurs under all light periods (Table 3.4). The highest rate of germination (87 %) is seen in continuous dark and germination rates decrease, when the light periods last longer (Figure 3.15).

Germination at all temperatures starts on the second day, reaches the highest level on third and fourth days and decreases slowly after fifth day. Germination stops at the end of eleventh day, although experiments where continued until the twenty-first day (Table 3.4).

Table 3.4 Germination rates of *R. lutea* seeds at different photoperiods at 25° C.

Illumination (Hours)	Days												Germination (%)
	1	2	3	4	5	6	7	8	9	10	11	21	
0	0	2	47	28	5	1	0	2	1	0	1	0	87
6	0	3	45	23	2	1	1	0	0	1	0	0	76
12	0	2	23	28	9	3	0	0	2	0	0	0	67
18	0	2	22	14	6	3	2	1	1	1	0	0	52
24	0	0	18	16	5	1	0	0	1	0	1	0	42

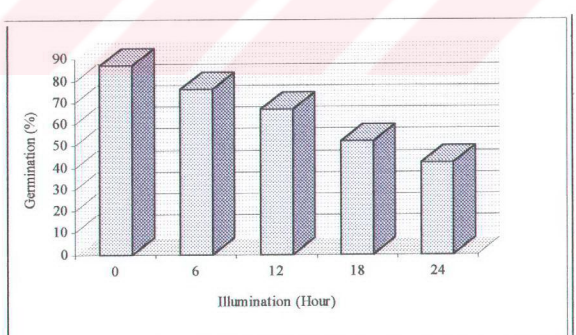

Figure 3.15 Germination rates under different illumination periods at 25° C.

3.5.3 Germination at Different Depths in Soil.

This experiment lasted four weeks. Planting was done at 10, 30, 50 and 100 mm depths, in the middle and along the border glass jars (Table 3.5, Figure 3.16, 3.17). The reason of using jars instead of flowerpots is to ascertain the germination ability of seeds in light, in soil. 30 % of seeds at 10 mm and in the middle and 23 % of seeds at 10 mm and along the border of jars have germinated. At 30 mm 18 % of seeds in the middle and 1 % along the border germinated. At 50 and 100 mm, no germination occurred. It is clearly seen that germination and seedling appearance decreases while depth increases. Besides this a negative effect of light on germination is ascertained.

Table 3.5 Germination results of *R. lutea* at different depths in soil.

	Centre	Border
10 mm	36	23
30 mm	18	1
50 mm	0	0
100 mm	0	0

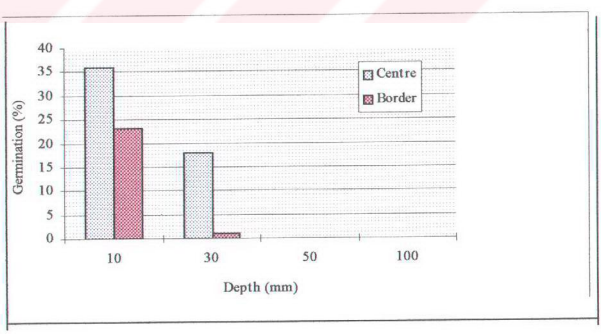

Figure 3.16 Seed germination results of *R. lutea* under various depths in soils.

Figure 3.17 Seed germination at different depths in soil.

3.6 Pollen

Pollens of *R. lutea* are tricolporate (Figure 3.18 A, B). The rate of P/E is 1.23 (subspheroidal) and ornamentation is reticulate (Table 3.6).

Table 3.6 Pollen specifications of *R. lutea*.

	Min	Max.	Mean	S.D.	S.E.
P (μ)	19.5	29	23.5	3.18	0.65
E (μ)	16.5	22.5	19.0	1.96	0.40
P/E (μ)	0.91	1.31	1.23	0.09	0.01

P: Polar axis, E. Equatorial axis

3.7 Physical Analysis of the Soils

Physical analysis results of *R. lutea* soil are shown in Table 3.7. According to these results: at 54 localities of *R. lutea*, the soil structure is like this: 44.4 % sandy loam, 27.75 % sandy clay loam, 9.25 % clayey loam, 9.25 % loamy, 5.55 % loamy sand, 1.85 % clay and 1.85 % silty loam. It is ascertained that the pH of soils changes between 7.17 and 8.3, 5.55 % of the

soil are neutral, 64.75 % slightly alkaline and 29.60 % are moderately alkaline. Percent of dissolved salts varies between 0.030 and 0.050 %. $CaCO_3$ content lies between 0.408- 40.800 % (Table 3.7).

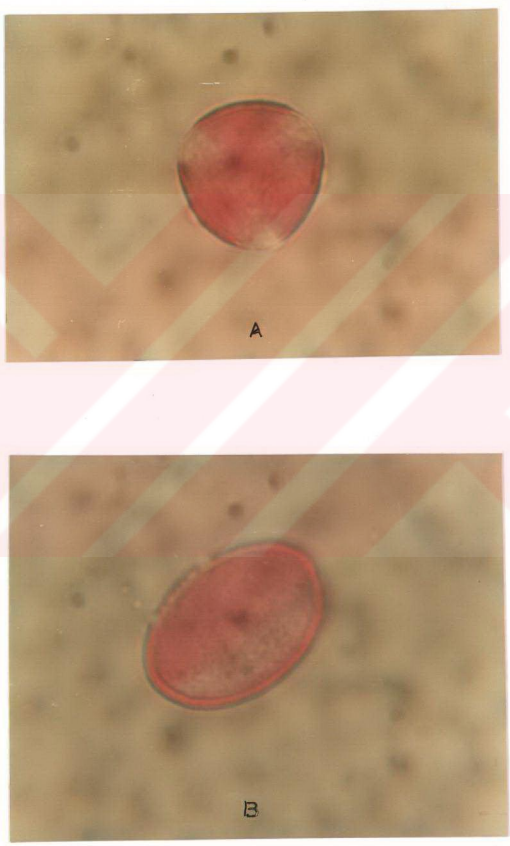

Figure 3.18 Pollens of *R. lutea* A: Polar axis appearance (40 x 6.3), B: Equatorial axis appearance (40 x 6.3).

Table 3.7 Physical analysis of the soils of *R. lutea*.

Loc.	Sand (%)	Clay (%)	Silt (%)	Structure	pH	Salinity (%)	$CaCO_3$ (%)
1	58.16	23.84	18	Sandy-clayey-loam	7.70	0.03	7.749
2	62.16	17.84	20	Sandy-loam	7.96	0.03	14.68
3	60.16	21.84	18	Sandy-clayey-loam	7.96	0.03	8.970
4	52.16	27.84	20	Sandy-clayey-loam	7.65	0.03	2.450
5	44.16	29.84	26	Sandy-clayey-loam	8.00	0.03	27.33
6	74.16	17.84	8	Sandy-loam	7.75	0.03	9.790
7	52.16	27.84	20	Sandy-clayey-loam	7.57	0.03	17.950
8	64.16	21.84	14	Sandy-clayey-loam	7.79	0.03	31.820
9	62.16	19.84	18	Sandy-loam	7.64	0.03	14.680
10	28.16	17.84	51	Silty-loam	7.70	0.03	40.800
11	72.16	13.84	14	Sandy-loam	8.02	0.03	24.470
12	72.16	17.84	10	Sandy-loam	7.39	0.03	0.816
13	66.16	17.84	16	Sandy-loam	7.88	0.03	11.420
14	86.16	9.84	4	Loamy-sand	8.30	0.03	15.500
15	62.16	17.84	20	Sandy-loam	7.54	0.03	36.710
16	70.16	13.84	16	Sandy-loam	7.84	0.03	11.420
17	72.16	21.84	6	Sandy-clayey-loam	7.65	0.03	0.408
18	36.16	37.84	26	Clayey-loam	7.64	0.05	34.260
19	68.16	19.84	12	Sandy-loam	7.89	0.03	33.450
20	78.16	9.84	12	Sandy-loam	7.79	0.03	0.816
21	78.16	7.84	14	Loamy-sand	7.81	0.03	3.260
22	64.16	25.84	10	Sandy-clayey-loam	7.89	0.03	40.800
23	81.44	8.56	10	Loamy-sand	7.17	0.03	0.816
24	41.44	32.56	26	Sandy-clayey-loam	7.50	0.03	1.220
25	71.44	8.56	20	Sandy-loam	7.44	0.03	29.780
26	45.44	34.56	20	Sandy-clayey-loam	7.72	0.03	23.660
27	41.44	30.56	28	Clayey-loam	7.71	0.03	2.860
28	55.44	18.56	26	Sandy-loam	7.92	0.03	35.080

29	61.44	22.56	16	Sandy-clayey-loam	7.68	0.03	40.800
30	53.44	24.56	22	Sandy-claycy-loam	7.77	0.03	11.420
31	55.44	18.56	26	Sandy-loam	7.75	0.03	7.750
32	61.44	18.56	20	Sandy-loam	8.10	0.03	22.840
33	37.44	28.56	34	Loamy	7.72	0.03	40.800
34	47.44	22.56	30	Loamy	7.70	0.03	16.310
35	59.44	16.56	24	Sandy-loam	7.82	0.03	25.290
36	49.44	18.56	32	Loamy	7.19	0.03	2.450
37	45.44	22.56	32	Loamy	7.95	0.03	40.800
38	31.44	38.56	30	Claycy-loam	7.50	0.03	40.800
39	61.44	14.56	24	Sandy-loam	7.95	0.03	34.260
40	57.44	18.56	24	Sandy-loam	7.82	0.03	5.710
41	43.44	24.56	32	Loamy	7.88	0.03	30.590
42	57.44	24.56	18	Sandy-claycy-loam	7.65	0.03	40.800
43	51.44	18.56	30	Sandy-loam	7.76	0.03	1.630
44	51.44	28.56	20	Sandy-claycy-loam	7.46	0.05	17.560
45	47.44	30.56	22	Sandy-clayey-loam	8.06	0.03	16.320
46	61.80	18.56	20	Sandy-loam	8.05	0.03	36.710
47	67.80	14.56	18	Sandy-loam	7.96	0.03	36.710
48	69.80	12.56	18	Sandy-loam	8.06	0.03	15.500
49	23.80	32.56	44	Clayey-loam	7.75	0.03	40.800
50	31.80	28.56	40	Claycy-loam	7.56	0.03	1.220
51	69.80	14.56	16	Sandy-loam	7.79	0.03	2.450
52	71.80	14.56	14	Sandy-loam	8.10	0.03	6.530
53	53.80	18.56	28	Sandy-loam	8.06	0.03	8.970
54	27.80	42.56	30	Clay	8.02	0.03	35.890
Min					7.17	0.030	0.408
Max.					8.30	0.050	40.800
Mean					7.776	0.031	19.701
S.D.					0.226	0.0049	14.569
S.E.					0.031	0.0007	1.983

3.8 Chemical Analysis of the Soils

The chemical analysis results of 54 soils of *R. lutea* are given in table below. According to Table 3.8, total nitrogen contents varies between 0.028 and 0.644 %, phosphorus between 0.00002-0.00060 %, and potassium between 0.080 and 0.780 %.

3.9 Chemical Analysis of the Plants

The samples of *R. lutea* plants were collected during May and June, during the flowering period between April and September from 54 different localities in West Anatolia. These were subjected to chemical analysis as a whole plant (root, stem, leaf, and flower and fruit). At the end of these chemical analysis the following results were obtained. Nitrogen content in plants lies between 1.246-3 %, phosphorus between 0.054-0.340 %, potassium varies from 2-7 % and calcium from 0.520 to 1.790 % (Table 3.9).

3.10 Chemical Analysis of Root, Stem, Leaves and Flowers

The root, stem, leaf and flowers of plant samples from 10 sites were collected and subjected to analysis separately (Table 3.10).

At the end of the chemical analysis, the following results were obtained. Nitrogen changes between 1.358-1.778 % in roots, 0.930-2.030 % in stems, 2.003-3.290 % in leaves and 2.534-3.276 % in flowers; phosphorus changes between 0.016-0.038 % in roots, 0.022-0.049 % in stems, 0.040-0.062 % in leaves and 0.080-0.146 in flowers; potassium changes between 1.2-3.3 % in roots, 2.3-3.9 % in stems, 2.3-3.8 % in leaves and 2.1-4.4 % in flowers; and calcium changes between 0.40-1 % in roots, 0.78-1.13 % in stems, 0.99-1.59 % in leaves and 0.60-1.86 in flowers (Table 3.10).

Table 3.8 Chemical analysis of the soils of *R. lutea.*

Loc.	N (%)	P (%)	K (%)
1	0.070	0.00036	0.053
2	0.077	0.00007	0.019
3	0.098	0.00007	0.013
4	0.126	0.00011	0.028
5	0.070	0.00004	0.020
6	0.049	0.00004	0.019
7	0.161	0.00050	0.074
8	0.084	0.00007	0.064
9	0.077	0.00030	0.041
10	0.133	0.00013	0.018
11	0.028	0.00002	0.008
12	0.091	0.00040	0.030
13	0.091	0.00011	0.023
14	0.028	0.00002	0.020
15	0.154	0.00025	0.046
16	0.126	0.00023	0.072
17	0.042	0.00015	0.025
18	0.049	0.00010	0.025
19	0.084	0.00007	0.050
20	0.070	0.00025	0.062
21	0.070	0.00036	0.047
22	0.056	0.00004	0.047
23	0.105	0.00046	0.029
24	0.070	0.00002	0.025
25	0.168	0.00060	0.039
26	0.266	0.00011	0.072
27	0.336	0.00020	0.068
28	0.119	0.00013	0.047

29	0.049	0.00002	0.044
30	0.126	0.00004	0.076
31	0.119	0.00043	0.060
32	0.035	0.00002	0.032
33	0.098	0.00004	0.039
34	0.133	0.00010	0.034
35	0.273	0.00010	0.025
36	0.644	0.00016	0.072
37	0.042	0.00002	0.029
38	0.056	0.00002	0.031
39	0.140	0.00025	0.051
40	0.063	0.00011	0.050
41	0.119	0.00004	0.027
42	0.133	0.00002	0.031
43	0.161	0.00046	0.078
44	0.090	0.00012	0.060
45	0.056	0.00004	0.024
46	0.063	0.00002	0.025
47	0.042	0.00002	0.010
48	0.056	0.00013	0.021
49	0.084	0.00004	0.010
50	0.329	0.00011	0.030
51	0.245	0.00016	0.039
52	0.105	0.00004	0.033
53	0.105	0.00010	0.026
54	0.070	0.00002	0.029
Min	0.028	0.00002	0.0080
Max.	0.644	0.00060	0.0780
Mean	0.117	0.00025	0.0383
S.D.	0.1009	0.00015	0.0191
S.E.	0.0137	0.00002	0.0026

Table 3.9 Chemical analysis of the plant samples.

Loc.	N (%)	P (%)	K (%)	Ca (%)
1	2.240	0.086	7.0	0.97
2	3.234	0.156	2.7	1.48
3	2.814	0.080	4.6	0.62
4	2.310	0.216	4.3	0.89
5	2.030	0.188	2.9	1.40
6	1.806	0.130	4.2	0.94
7	2.002	0.146	6.5	1.10
8	2.926	0.090	3.7	1.25
9	2.898	0.074	3.6	1.20
10	2.842	0.254	6.7	1.56
11	1.946	0.120	4.7	1.26
12	1.652	0.088	2.7	0.79
13	3.318	0.188	4.6	1.20
14	2.072	0.090	4.7	0.97
15	2.576	0.080	4.2	0.52
16	2.282	0.106	4.1	1.06
17	2.590	0.180	3.6	1.40
18	2.506	0.162	3.8	1.02
19	1.708	0.078	2.6	0.97
20	2.086	0.202	3.8	1.33
21	2.702	0.124	2.1	0.94
22	2.394	0.120	4.1	1.10
23	3.164	0.340	4.5	1.24
24	2.758	0.130	4.4	1.59
25	2.450	0.118	4.5	0.96
26	2.842	0.108	3.7	1.79
27	1.694	0.166	3.5	0.78
28	2.702	0.056	5.6	1.01

29	2.170	0.108	3.1	1.24
30	2.324	0.162	4.0	1.69
31	2.114	0.202	2.3	1.39
32	1.806	0.146	3.8	1.11
33	1.750	0.070	2.8	1.21
34	2.086	0.108	3.5	0.83
35	2.422	0.066	2.0	1.10
36	2.632	0.054	4.5	1.46
37	3.024	0.140	4.1	0.88
38	2.730	0.226	4.4	1.67
39	2.800	0.134	2.9	1.16
40	1.820	0.216	4.8	1.62
41	2.814	0.202	3.3	1.26
42	2.324	0.144	3.1	1.38
43	1.246	0.194	3.8	1.37
44	2.436	0.078	3.4	0.78
45	2.086	0.102	2.6	0.99
46	2.800	0.140	3.2	0.69
47	2.618	0.188	3.2	1.42
48	2.086	0.216	3.8	1.24
49	3.080	0.113	4.0	1.56
50	2.352	0.216	2.7	1.26
51	2.758	0.170	3.3	1.36
52	1.974	0.146	3.5	1.01
53	2.674	0.144	4.0	1.16
54	2.226	0.248	5.3	1.21
Min	1.246	0.054	2	0.52
Max.	3.318	0.340	7	1.79
Mean	2.4018	0.1446	3.8519	1.1740
S.D.	0.4577	0.0587	1.0570	0.2838
S.E.	0.0623	0.0080	0.1438	0.0386

Table 3.10 Statistical evaluation of chemical analysis results of root, stem, leaves and flowers of *R. lutea*.

	Min.	Max.	Mean	S.D.	S.E.
N (%) root	1.358	1.778	1.5428	0.1887	0.0844
N (%) stem	0.930	2.030	1.4012	0.4203	0.1880
N (%) leaf	2.003	3.290	2.5678	0.5308	0.2374
N (%) flower	2.534	3.276	2.961	0.3687	0.1844
P (%) root	0.016	0.038	0.0272	0.0097	0.0043
P (%) stem	0.022	0.049	0.0336	0.0111	0.0049
P (%) leaf	0.040	0.062	0.0502	0.0097	0.0043
P (%) flower	0.080	0.146	0.0975	0.0323	0.0162
K (%) root	1.2	3.3	2.00	0.7842	0.3507
K (%) stem	2.3	3.9	3.34	0.7436	0.3326
K (%) leaf	2.3	3.8	3.04	0.5550	0.2481
K (%) flower	2.1	4.4	3.00	1.0033	0.5017
Ca (%) root	0.40	1.00	0.6960	0.2133	0.0964
Ca (%) stem	0.78	1.13	0.8720	0.1458	0.0652
Ca (%) leaf	0.99	1.59	1.3880	0.2421	0.1083
Ca (%) flower	0.60	1.86	1.1625	0.5207	0.2603

3.11 Statistical Evaluation of the Soil and Plant Analysis

In the results of soil and plant analysis, relationships between pH, salt, calcium carbonate, nitrogen, phosphorus and potassium values of soil and nitrogen, phosphorus, potassium and calcium values of plant were examined by regression analysis. According to multiple stepwise analysis negative relationships were found between

- plant nitrogen and soil potassium (Table 3.11),
- plant phosphorus and interaction between soil calcium carbonate and soil potassium (Table 3.12) and
- plant potassium and interaction between soil pH and soil phosphorus (Table 3.13).

Table 3.11 Double logarithmic regression model (Dependent variable: plant nitrogen, independent variable: soil potassium).

	Plant nitrogen
Constant	0.561460 (0.171775)
Soil Potassium	-0.087103 (0.049982)
P	0.08
Significant F	0.08
R^2	0.05
R	0.23
Standard Error	0.19779

The value in parenthesis shows the standard error of estimator.

P: Probability value for estimator

Sig. F: Probability value for F

R2: Determination coefficient

R: Correlation coefficient

Table 3.12 Double logarithmic regression model (Dependent variable: plant phosphorus, independent variable: soil calcium carbonate and soil potassium interaction).

	Plant phosphorus
Constant	-2.109678 (0.066942)
Soil $CaCO_3$ and potassium	-0.100237 (0.041894)
P	0.02
Significant F	0.02
R^2	0.09
R	0.31
Standard Error	0.39841

Table 3.13 Double logarithmic regression model (Dependent variable: plant potassium, independent variable: soil pH and phosphorus interaction).

	Plant potassium
Constant	-0.159948 (0.160318)
Soil pH and phosphorus	-0.040491 (0.021933)
P	0.07
Significant F	0.07
R^2	0.06
R	0.24
Standard Error	0.025414

Chapter Four
DISCUSSION AND CONCLUSION

4.Discussion and Conclusion

To know the characteristics a plant, is necessary to determine the properties and structure of its habitats, particularly the soil. It is possible through an autecological study. The physical and chemical analysis of soils and plant samples of *Reseda lutea*, collected from 54 sample areas in West Anatolia, were thus carried out in detail. In addition to this, morphology, anatomy, seed germination and pollen characteristics were investigated. These were compared the studies done in other countries on this plant.

The morphological observations and biometric measurements were made on the plants of *R. lutea*, collected from West Anatolia, were compared with the results of Bonnier (1934), Hegi (1958), Butcher (1961), Tutin *et al.* (1964), Davis (1965), Pearce (1982), and Harris *et al.* (1995). Results showed that there is a great similarity with these of above workers. However, they differ as follows:

Plant length, which usually changes with the habitat, is reported as 20-70 cm by Bonnier (1934), 30-60 cm by Hegi (1958), 30 cm by Butcher (1961), 70 cm by Davis (1965), 20-80 cm by Pearce (1982) and 30-70 cm by Harris *et al.* (1995). It was found that length in our 54 plant samples changes between 25-130 cm (Table 3.1). The average plant length is 103 cm at an average altitude of 68 m in 11 localities in İzmir, the same values in 11 localities in Denizli are 62 cm and 801 m respectively (Table 3.2). In Table 3.2, it is seen that the average plant length in the samples from İzmir is higher than 54 plants average length of 82.82 cm. This is inversely proportional with the altitude. Again in Denizli, plant length is less than the average length of 54 plants which too is inversely proportional with altitude. The altitude starts from 750 m in 13, 37, 38, 39, 40, 42, 43, 44,

45, 46 and 52 numbered localities. It is seen that plant lengths are lower in these localities, in another word, it is lower (59.54 cm) than average length 54 plants (82.82 cm). It is seen that plant length starts decreasing after 750 m and goes down when altitude increases. In our plant samples collected from high altitudes, the length decreases, as seen in the results. The reason for this decrease is reported to be higher radiation and air currents. In our case ecological factors mentioned above are not effectual in these areas, instead longer vegetative periods due to the effects of ecological factors, cause the lengthening of these plants.

Although Harris *et al.* (1995) has informed the petal length as 5 mm on an average basis, in our 40 plant samples petal length was 3.57 mm on average (Table 3.1). The value reported by Harris *et al.* (1995) is thus quite higher than ours.

The number of anthers in *R. lutea* flowers are reported as 20 on an average basis by Bonnier (1934), 15-25 by Harris *et al.* (1995) and 14-18 by Heap *et al.* (1995), but it was observed to be around 17.30 in our area (Table 3.1). Thus the anther numbers of our flowers are lower as compared to Bonnier (1934), but with those of others.

Although Tutin *et al.* (1964), have reported the capsule width as 4.5-5.5 mm. It was seen that these numbers vary between 2.00-5.40 mm in our samples, and the fruit capsule width of *R. lutea* is narrower in material (Table 3.1).

The biometric measurements, done on *R lutea* seeds, by Davis (1965) report an average seed length of 2 mm or more, but our measurements lie around 1.58 mm on average (Table 3.1). Again Butcher (1961) has found the seed width as 1.4 mm on an average basis, which 1.15 mm on average in our samples.

The differences in the biometric measurements of *R. lutea*, can be explained as follows: Other workers have used a less number of samples. The differences in geographic areas studied by other researchers as well as the differences in soil and edaphic conditions of these areas add to these. Ecological differences can cause differences in the morphological features of a plant (Öztürk and Seçmen, 1996). Although Davis (1965) has separated *R. lutea* into two varieties as var. *lutea* and var. *nutans* and Abdallah and De Witt (1978) have separated this species into two subspecies as subsp. *lutea* and subsp. *neglecta*, but we have

dealt with the species here.

Except the morphological features mentioned above, our measurements and observation on the morphology of *R. lutea* show a big resemblance with those Davis (1965) (Table 3.1).

Reseda lutea grows in different habitats in our research area (Table 2.1). It occurs widely throughout the temperature zones of the world (Fig. 3.1), but prefers calcareous and sandy soils. It usually covers fallow fields, field borders, wall sides, old buildings, road sides as well as cultivated areas. These results show a parallelism with those of Davis (1965) and Heap *et al.* (1995).

In our study area, *R. lutea* shows a distribution between 25-1500 m altitudes (Table 2.1). But Davis (1965) has reported that the plant can go up to 2000 m altitudes from sea level, and Moghaddam (1977) has reported the plant is seen between 300-1900 m in Iran. Özçelik and Öztürk (1991) have informed that the plant can grow up to 2300 m in Turkey. Moghaddam (1977) has informed the plant shows a good growth between -25 and 50° C under a yearly precipitation varying between 100 mm and 400 mm. But in Turkey, the plant grows up to 2300 m in East Anatolia where winter temperatures decrease below -25° C. This shows that the plant can live at lower temperatures and at higher altitudes than reported by Moghaddam (1977). Bolle (1936) and Abdallah (1967) have stated that the plant has some xeric features like deep and wide root system and tracheids on leaf margins, which possess water storage cells. These features give a clue about our plant that it can adapt itself to drought easily.

Reseda lutea clearly needs light to grow and develop. When the sample areas and habitats, it grows, are examined, it is observed that the plant usually prefers open areas, where vegetation is sparse and elevation is low. The plant roots can reach meters of depths below the soil and spread out; thus giving it an adaptation character against high temperature and drought. This depicts that *R. lutea* is a heliophytic plant. Heap *et al.* (1995) has reported that the plant roots can reach a depth of 4 m of soil. Moghaddam (1977), Bruns and Jochimsen (1989) and Jochimsen and Janzen (1991) have thus concluded that this plant is one among those which can hold the soil in the struggle against erosion in mining areas and spoiled banks. Our findings too coincide with those of above

workers in this connection.

Reseda lutea is not found in pure communities in West Anatolia. It mostly grows in small groups or as individuals. But, it is reported that it forms communities in carrot and potato fields in England and Scotland (Forbes and Mathews, 1985), mostly in crop fields in Hungary, USA and Australia (Abdallah and De Witt, 1978; Heap *et al.* 1995, and Harris *et al.* 1995). It is reported that it causes a loss of product in these areas. Heap *et al.* (1995) and Harris *et al.* (1995) have determined that herbicide are used against this plant in the mentioned areas to prevent the loss of product. But in Turkey, this plant is not found in big groups or communities, no loss of product in cultivated areas is possible.

The distributional pattern discussed above clearly shows that *R. lutea*'s ecological amplitude is very wide. It is good as a cosmopolite species.

When seeds germination of *R. lutea* under laboratory conditions is examined, it shows that seeds can germinate between 10 and 40° C. But the highest germination is 87 % obtained at 25° C (Table 3.3). Heap (1994) has reported that this plant can germinate between 10-35° C under dark conditions, but the maximum germination is 85 % at 25° C under laboratory conditions. In our findings it is ascertained the maximum germination is 87 % at 25° C, but it can germinate between 10-40° under dark conditions. Our findings show a parallelism with those of Heap (1994). Heap (1994) has studied 6 years old *R. lutea* seeds in laboratory. He found the same germination rate, but the seeds over 11 years old do not show any germination under laboratory conditions. In our studies 1 and 2 years old seeds were used. Our germination results and those of Heap (1994) show a good similarity.

In germination studies, the effect of light showed that seeds can germinate under all light conditions from continuous dark till continuous light (Table 3.4). The lowest germination occurs in continuous light (42 %), germination increases parallel to increase of darkness. The highest germination 87 % is seen in continuous dark. These results agree with those of Heap (1994) and Heap *et al.* (1995).

When the germination results are examined on daily basis, it is seen that the highest germination is on the third and forth days. The germination decreases from the fifth day, finishes at the and of the eleventh day (Table 3.4). In another study, following rates of

germination were obtained, 40 % at the end of the seventh day, 73 % at the end of the fourteenth day. The rest of ungerminated seeds (25 %) are thought to be, 2 % did not germinate although live (Anonymous, 1973). In our results, these rates are 83 % at the end of the seventh day, 87 % at the end of the fourteenth day. The germination is completed to a large extend in the first week.

In a study done in South Australia, it is reported that *R. lutea* seeds, can stay live under soil for at least 4 years. These seeds show a germination of 33-63 % (Heap, 1994).

Bolle (1936) and Abdallah (1967) report similar findings on the seeds of *Resedaceae* members, pointing out that these seeds do not stay alive for more than 4 years. It is reported that, 93 % of *R. luteola* seeds can germinate at the end of the first or second year (Dorp-Peterson, 1924). It shows that these results too are close to the germination results of *R. lutea.*

Moghaddam (1977) has reported that *R. lutea* grows even in areas where temperatures decrease upto -25° C in Iran. The germination studies on the pre-treated seeds; for seven days at 5° C; showed a higher rate of germination than those treated for seven days at 20° C (Heap *et al.* 1995). Heap *et al.* (1995) point out that *R. lutea* seeds can alive at low temperatures and under cold conditions. This results in an increase in their germination rates. This depicts that seeds need a vernalisation treatment for better germination

Seeds germinate at an optimum depth, according to light requirement. Under some depths, seeds can not germinate because they can not get light. But seeds germinate easily if close to the soil surface, because of enough light. Every species has an optimum germination depth, changing according to conditions (Weaver and Clements, 1938). Öztürk *et al.* (1984) has reported that, seed germination rates show differences in relation to planting on the surface and at the border of a glass jar and planting from surface to deeper parts. The seeds of *Myrtus communis* L. (Öztürk, 1979), *Inula viscosa* (L) Aiton (Pirdal, 1980) and *Asphedolus aestivus* Brot. (Pirdal, 1986); which show a parallel distribution with our species, show optimum germination under 10 mm, *Briza* (Özdemir *et al.* 1984) and *Bromus* (Türdü *et al.* 1984) show better germination on the surface and under 10 mm. *R. lutea* seed germinate well under 10 mm depth (36 %). But, the germination decreases while depth increases. It was observed that the optimum germination and

seedling appearance is seen in the middle as well as along the border of glass jars (Table 3.5). This shows that *R. lutea* seeds do not need light for germination, as under studies on the effects of light. *R. lutea* seeds germinate more under dark conditions (Table 3.5). Heap (1994) has reported *R. lutea* seeds can germinate even upto 80 mm depth, but the maximum germination is seen between 5-10 mm. Our results show a parallelism with those of Öztürk (1979), Pirdal (1980), Özdemir *et al.* (1984), Türdü *et al.* (1984), Pirdal (1986) and Heap (1994).

No detailed study on the anatomy of *R. lutea* has been done. There is only a general reference made by Metcalfe and Chalk (1957) and Fahn (1967) which deals with *Resedaceae* family and some *Reseda* species. Bonnier (1934), Metcalfe and Chalk (1957), Gibbs (1974) and Jorgensen (1995) report that the existence of myrosin cells is characteristic of *Resedaceaea* family, like *Caricaceae*, *Caparaceae* and *Brassicaceae*.

In anatomical sections of *R. lutea*, myrosin cells were seen in root cortex and pith, in stem cortex, pith and leaf mesophyl tissue. These results coincide with the results regarding the existence of myrosin cells in *Resedaceae* members as stated, by Bonnier (1934), Metcalfe and Chalk (1957), Fahn (1967), Gibbs (1974) and Jorgensen (1995).

The equifacial characteristics of leaf has not been mentioned by Metcalfe and Chalk (1957). They report that palisade and spongy parenchymas cannot be separated from each clearly other in mesophyl tissue. Our anatomical studies on the root, stem, and leaf showed parallelity with those of Metcalfe and Chalk (1957) on family level.

Reseda lutea pollens investigated by us clearly depict that pollen type, P/E ratio and ornamentation is same as given by Hegi (1958), Erdtman (1966), Moore *et al.* (1991) and Punt and Mark (1995).

Physical analysis of soils taken from 54 different localities of *R. lutea* show that soil structure according to Bouyoucos (1955) is clayey-loam, loamy-sand, clay and silty-loam. But *R. lutea* basically prefers sandy-loam and sandy-clayey-loam soils (Table 3.7). Heap *et al.* (1995) has stated that *R. lutea* grows a wide range of soils from very light alkaline sandy Mallee soils to red-brown clayey loam soils in South Australia. This supports our

results.

The pH of soils supporting *R. lutea* in West Anatolia changes from 7.17-8.3 and these soils are neutral, lightly alkaline and moderately alkaline (Table 3.7), stressing physical analysis that our plant usually prefers light alkaline, and besides moderate alkaline soils. Heap (1994) has informed this plant largely prefers alkaline soils South Australia. Our results show resemblances with those of Heap (1994).

The soluble salt content in the soils was found to vary between 0.030 % and 0.050 % (Table 3.7). None of these soils have effect of salinity according to the classification given for salinity (Anonymous, 1951). *R. lutea* appears to be a glycophyt. These has not been reported by Heap (1994), Heap *et al.* (1995) and Harris *et al.* (1995), who are authorities on this species.

It is ascertained that $CaCO_3$ contents of soils changes between 0.408 % and 40.800 % (Table 3.7). According to Scheffer and Schachtschabel (1956) our results point out that 20.35 % are poor, 3.70 % medium, 12.95 % rich and 62.90 % very rich in $CaCO_3$. It can be clearly seen that this plant prefers generally very rich calcareous soils, but can keep on living on poor and medium calcareous soils as well. Abdallah and De Witt (1978) have stated that *R. lutea* shows a distribution mostly on calcareous and to some extent on non-calcareous; Clapham *et al.* (1962) and Grubb (1976) stress that it is distributed on especially calcareous areas. The results of Abdallah and De Witt (1978), Clapham *et al.* (1962) and Grubb (1976) support our findings.

Chemical analysis of *R. lutea* soils shows that, the total nitrogen content changes between 0.028-0.644 % (Table 3.8). These soils are according to Loue (1968) can be classified as; 16.65 % poor, 40.70 % medium, 12.95 % sufficient and 18.50 % very rich in nitrogen. The plant accordingly does not show any preference to nitrogen content.

When the results on soil phosphorus are examined values vary between 0.00002-0.00060 % (Table 3.8). According to Bingham (1949)'s classification for phosphorus contents of soils, it is ascertained that all the soils at 54 different sample areas are poor in phosphorus.

The potassium content of soils changes between 0.080 % and 0.780 % (Table 3.8). All these soils are under the limit of deficiency according to potassium classification of Pizer (1967).

Plant samples of *R. lutea* collected from 54 localities in West Anatolia showed that their nitrogen contents change between 1.246 % and 3.318 %. It is reported that total nitrogen contents change between 0.2- 6.0 % on dry weight basis (Kacar, 1972). Nitrogen content of our plants lies between these values (Table 3.9). Harris *et al.* (1995) and Davis *et al.* (1993) have reported that this plant contains nitrate at a high level. It is ascertained that *R. lutea* is very delicious for farm animals and the level of nitrate is between 2.5-3.1 % from the first leaves upto the first flowering. Although this nitrate level is high, it does not cause any injuries or deaths to farm animals (Davis *et al.* 1993). The nitrate level obtained by us varies between 1.246-3.318 %, which is near to the results of Davis *et al.* (1993) and Harris *et al.* (1995). Again in our area, no negative effects of this high nitrate level on farm animals have been reported.

The phosphorus in our plants changes between 0.054-0.340 % (Table 3.9). The phosphorus in plants changes between 0.01-1.0 % on dry weight basis according to Johnson and Ulrich (1959). The phosphorus analysis results of *R. lutea* samples are within the values given by Johnson and Ulrich (1959).

The potassium content in *R. lutea* plant samples changes between 2-7 % (Table 3.9). According to Kacar (1972), the potassium contents of plants vary between 0.2-11 %, so potassium analysis results of our plant are between the limits given by Kacar (1972).

The calcium amounts of our plant material change between 0.520 % and 1.790 % (Table 3.9). Chapman (1967) has stated that the level of lack of calcium is around 0.93 % for plants. It is ascertained that 4.86 % of *R. lutea* plant samples are under this level, but 95.14 % are over this level.

A chemical analysis of different parts of *R. lutea* reveals that, nitrogen changes between 1.358-1.778 % in root, 0.930-2.030 % in stem, 2.003-3.290 % in leaf and 2.534-3.276 % in flower; phosphorus changes between 0.016-0.038 % in root, 0.022-0.049 % in stem, 0.040-0.062 % in leaf and 0.080-0.146 % in flower; potassium changes between 1.2-3.3 % in

root, 2.3-3.9 % in stem, 2.3-3.8 % in leaf and 2.1-4.4 % in flower; and calcium content changes between 0.40-1 % in root, 0.78-1.13 % in stem, 0.99-1.59 % in leaf and 0.60-1.86 % in flower (Table 3.10).

A comparison of nitrogen, phosphorus, potassium and calcium contents of root, stem, leaf and flower the at end of the chemical analysis of plant samples collected in May-June term; which is the reproductive period (April-September) of the plant; verifies that: nitrogen is highest in flower (mean 2.961 %), and the least in root (mean 1.5458 %), same is the case with phosphorus being highest in flower (mean 0.0975 %), least in root (mean 0.0272 %). Potassium mostly accumulates in the stem (3.34 %), and is low in the root (mean 2.00 %). Calcium mostly accumulates in the leaf (mean 1.3880 %) and the least is in the root again. Statistical evaluations reveal a least accumulation of nitrogen, phosphorus, potassium and calcium amounts in root, highest accumulation of nitrogen and phosphorus in flower, potassium in stem and calcium in leaf (Table 3.10). The minerals taken from the soil are accumulated in plant, during the reproductive period. We conclude that during this period, ion transportation is more, so minerals are more in above-ground parts of the plant. In Pirdal (1986)'s study on *Asphedolus aestivus* L. distributes in West Anatolia, the results on the nitrogen, phosphorus and potassium contents of root and rhizome are lower than aboveground part of the plant. These support our results.

Chemical analysis data on root, stem, leaf and flower of *R. lutea* are between the limits of chemical analysis results of a whole plant. It is seen that the contents of nitrogen, phosphorus, potassium and calcium of root, stem, leaf and flower are between the values reported by Kacar (1972) on nitrogen and potassium, Johnson and Ulrich (1959) on phosphorus. But some results are lower than the values reported by Chapman (1967) like those on calcium (Table 3.10). According to mean values it is seen that root and stem are under the given values, but leaf and flower are over the limits given by Chapman (1967).

Statistical analysis of the results of physical and chemical analysis of plants and soils on multiple stepwise basis shows that each of the plant elements such as nitrogen, phosphorus, potassium and calcium is accepted as dependent variable and such characteristics of soils as pH, total soluble salts, calcium carbonate, total nitrogen, phosphorus, potassium and interactions between these are independent variables. Beside the individual effects of soil characteristics on plant elements, interactions between soil characteristics that represent

joint impacts were also considered. Regression models are of double log forms. The coefficient of R-squared is implying that what percent the independent variables can explain the changes in dependent variable and R is correlation coefficient that states the direction and degree of the relationship among the dependent and independents variables.

Both estimator's and F's significant value (P) is the probability value that analyst can decide if the estimator or the model is statistically significant. If a variable's estimator is statistically significant then it is accepted that the variable has an effect on dependent variable. The regression models in this study was of double log form, any significant estimator is elasticity coefficient which is the percentage change in dependent variable by the percentage change in independent variable (Daniel and Terrell, 1995; İkiz *et al.*1996; Mc Clave *et al.* 1998).

Under the light of statistical analysis, the following significant relationships were determined: plant nitrogen and soil potassium (R^2: 0.05, R: 0.24 and P:0.08) (Table 3.11); plant phosphorus and interaction between soil calcium carbonate and soil potassium (R^2:0.09, R: 0.31 and P: 0.02) (Table 3.12); plant potassium and interaction between soil pH and soil phosphorus (R^2: 0.06, R:0.24 and P: 0.07) (Table 3.13). Correlation coefficients, R, of the regression models show that there exists a weak and negative relationship. However, significant values of Fs (P) for the regression models are sufficient to assume that the models are able to be used statistically (Daniel and Terrell, 1995; İkiz *et al.* 1996; Mc Clave *et al.* 1998).

Taking low R and R^2 values into consideration, Başlar and Mert (1999) also found low values for *Rubia tintorum* and *Chrosophora tinctoria* in the same area, it is possible to say that lack of factors affecting soil productivity and insufficient utilisation of soil minerals by plants prevents the expected relationship between plant and soil.

From day to day, synthetic products have covered all walks of our life. But recently human beings have started to return to nature. Although natural products are more expensive economically, they are preferred by human beings more. It is known that the best colour of yellow is produced from *R. lutea* and *R. luteola*, for hand-woven carpets and kilims as a source of dyeing substances. Besides, its preference by honey bees in the apiculture, being dry and fresh food source for farm animals, increase economical value of

R. lutea. In addition, because of its roots can go to deeper parts of soil based on the soil structure, it can be used in the struggle against erosion which is one of the basic environmental problems of Turkey now. This stresses another economical importance of *R. lutea*.

This autecological study was carried out on *R. lutea*, because of its economical uses mentioned above. We believe that this regional based study done in West Anatolia, will be helpful to future studies on the better evaluation of *R. lutea*.

REFERENCES

Abdallah, M. S. & De Witt, H. C. D. (1978). The *Resedaceae*-A Taxonomical Revision of the Family (Final instalment). Mededelingen Landbouwhogeschool Wageningen. (Veenman H. and Zonen N. V., Wageningen).

Abdallah, M. S. (1967). The *Resedaceae*-A Taxonomical Revision of the Family. Mededelingen Landbouwhogeschool Wageningen. (Veenman H. and Zonen N. V., Wageningen).

Amiri, J. & Ebrahim-Nesbat, F. (1977). *Reseda lutea* L. and *Fumaria asepala* Boiss. The Natural Hosts of Watermelon Mosaic Virus in the Mashed Areas. Iranian Journal of Plant Pathology, 13, 51-52.

Anonymous (1991). Bitkilerden Elde edilen Boyalarla Yün Liflerinin Boyanması. Ankara: Sanayi ve Ticaret Bak. Küçük Sanatlar ve San. Böl. ve Siteleri Gen. Müd. Yay.

Anonymous (1951). Soil Survey Staff. Washington: Soil Survey Manual U. S. D. A. Handbook, 18.

Anonymous (1973). Seed Analysis Report. South Australian Department of Agriculture, Australia.

Arlı, M. (1982). Doğal Bitkisel Boyalarla Boyama Yöntemleri Üzerinde Düşünceler. II. Ulusal El Sanatları Sempozyumu. İzmir: D.E.Ü. Güzel San. Fak. Yay.

Aytuğ, B. (1967). Polen Morfolojisi ve Türkiye'nin Önemli *Gymnosperm*'leri Üzerinde Palinolojik Araştırmalar. İstanbul: İstanbul Üniv. Orman Fak., 12661.

Bailey, L. H. (1947). The Standard Cyclopedia of Horticulture, III. New York: Mac Millan Company.

Bailey, P. T. & Wicks, T. J. (1995). Biological control of *Reseda lutea* L. (*Resedaceae*), a weed of cereal crops in South Australia. Thirteenth Int. Plant Protection Cong., The Hague, 2-7 July 1995, Abstract No. 1410, European Jr. of Plant Pathology Supplement.

Başlar, S. & Mert, H. H. (1999). Studies on the Ecology of *Chrozophora tinctoria* (L.) Desf. and *Rubia tinctorum* L. in Western Anatolia. Turkish Jr. of Botany, 23, 1, 33-44.

Başlar, S. (1996). An Investigation on Ecology and Quantitative Analysis of Dyeing Substances of Some Dye Plants Distributed in West Anatolia. Ph. D. Thesis, Graduate School of Natural and applied sciences of Dokuz Eylul University.

Behçet, L. & Tatlı, A. (1989). Dumlu Dağları (Erzurum) Vejetasyonu Üzerine Fitososyolojik Bir Araştırma. Doga Tu. Botanik Dergisi, 13, 3, 388-417.

Bekat, L. & Seçmen Ö. (1982). Karaburun-Akdağ Florası. Doğa Bil. Dergisi Temel Bil., 6, 3, 49-66.

Bingham, F. T. (1949). Soil Tests for Phosphate. California: Agriculture, 3, 8, 11-14.

Bolle, F. (1936). Die Naturlichen Pflanzenfamilien, A. Enger and K. Prantl (Eds.), *Resedaceae.* Berlin: Volume 17b, 659-692.

Bonnier, G. (1934). Flore Complete Illustree en Couleurs de France Suiss et Belgique, Tome III. Paris.

Bouyoucos, G. J. (1955). Hydrometer method improved for making particle size analysis of soil. Agr. Jour. Vol. 54: 3.

Bremner. M. M. (1965). Total Nitrogen. C. A. Black. (Ed). Methods of Soil Analysis, Part II, Amar. Soc. Of. Agr. Inc. Pub. Madison, Wisconsin, USA, 1149-1178.

Brown, C. A. (1960). Palynological Techniques, Baton Rague, La.

Bruns, D. & Jochimsen, M., (1989). Der Einfluß unterschiedlich behandelten Bergematerials auf das Wurzelwachstum ausgewählter Pionierpflanzen. Verhandlungen Gesellschaft fur Okologie. 18, 73-78.

Butcher, R. W. (1961). A New Illustrated British Flora, Part I. London: Leonard Hill (Books) Lim.

Chapman, H. D. & Pratt, P. F. (1961). Methods of analysis for Soils, Plants and Waters. Riverside, California: Univ. of California, Div. of Agricultural Sciences.

Chapman, H. D. (1967). Plant Analysis Values Suggestive of Nutrient Status of Selected Plants. Soil Testing and Plant Analysis, II: 77-91.

Civelek, Ş. (1992). Çamlıbel Geçidi ve Yıldız Dağı (Sivas-Tokat) Florası. Turkish Jr. of Botany, 16, 1, 21-54.

Clapham, A. R., Tutin, T. G. & Warburg, E. F. (1962). Flora of the British Isles. Cambridge: Cambridge University Press.

Çelik, A. & Seçmen, Ö. (1996). Karıncalı Dağı'nın (Nazilli-Aydın) Florası. Turkish Jr. of Botany, 20, Ek sayı, 163-172.

Çırpıcı, A. (1989). Murat Dağı (Kütahya- Uşak)'nın Florası. Doğa Tu. Botanik Dergisi 13, 2, 157-222.

Daniel, W. W. & Terrell, J. C. (1995). Business Statistics (For Management and Economics). Seventh Edition, Boston: Houghton, Mifflin Comp.

Davis, E. S., Wichman, P. R. & Harris, J. D. (1993). Yellow mignonette biology and control. Proc. West Soc. Weed Sci. 46. 89-90.

Davis, P. H., Mill, R. R. & Tan, K. (Eds) (1988). Flora of Turkey and East Aegean Island, X. (Supplement), Edinburgh: Edinburgh Univ. Press.

Davis, P. H. (1965). Flora of Turkey and East Aegean Island, I., Edinburgh: Edinburgh Univ. Press.

Dorp-Petersen, K. (1924). Examination of the occurrence and vitality of various weed seed species under different conditions, made at the Danish Estate Seed Testing Station during the years 1896-1923. Fourth International Seed Testing Congress Report, 124-138.

Eigsti, O. J. (1936). Cytological studies in the *Resedaceae*. Botanical Gazette 98, 363-369.

Erdtman, G. (1966). Pollen Morphology and Plant Taxonomy Angiosperms (An Introduction to Palynology I). New York and London: Hatner Pub. Com.

Eyüboğlu, Ü., Okaygün, İ. & Yaras, F. (1983). Doğal Boyalarla Yün Boyama. Istanbul.

Fahn, A. (1967). Plant Anatomy. Pergamon Press.

Ferlay, V., Malley, G., Masson, A., Ucciani, E. & Grubber, M. (1993). Composition en acides gras des huiles graines d'especes spontanees du sud-est Mediterranean. Oleagineux, 48, 2, 91-97.

Forbes, G. R. & Mathews, P. R. (1985). Pre-emergence R-40244 for early weed control in potatoes and carrots. Br. Crop Prot. Conf. Weeds. 3: 747-804.

Gemici, Y. & Seçmen, Ö. (1983). İzmir Yamanlar Dağı Florası. Doğa Bilim Dergisi A, 7, 3, 473-507.

Gibbs, R. D. (1974). Chemotaxonomy of Flowering Plants, 1, 3. Montreal & London: Mc Gill-Queen's Univ. Press.

Görk, G. Bekat, L., Gemici, Y. & Yılmazer, Ç. (1989). Çeşme (İzmir) Yarımadası Florası. Doğa Tu. Botanik Dergisi 13, 2, 249-295.

Grubb, P. J. (1976). A Theoretical Background to the Conservation of Ecologically Distinct Groups of Annuals and Biennials in the Chalk Grassland Ecosystem. Biology and Conservation, 10, 53-76.

Harris, J. D., Davis, E. S. & Wichman, D. M. (1995). Yellow Mignonette (*Reseda lutea*) in the United States. Weed Technology, 9, 196-198.

Heap, J. W., Wilcocks, M. C. & Kloot, P. M. (1995). The Biology of Australian Weeds, Volume I., Groves, R. H., Shepherd, R. C. H. & Richardson, R. G. (Eds.). *Reseda lutea* L. Melbourne: R. G. & F. J. Richardson Pub.

Heap, J. W., Willcooks, M. C. & Kloot, P. M. (1987). The Biology of Australian Weeds. 17. *Reseda lutea* L., Plant Protection Quarterly, 2, 179-185.

Heap. J. W. (1994). Biology and control of *Reseda lutea* L. (Cutleaf mignonette). Master Thesis. Dept. Crop Protection and Plant Science, University of Adelaide, Waite Agricultural Research Institute, Adelaide, South Australia.

Hegi, G. (1958). Illustrierte Flora von Mittel-Europa, IV/I. München: Carl Hanser Verlag.

İkiz, F., Püskülcü, H. & Eren, S. (1996). İstatistiğe Giriş. 4. Baskı, İzmir: Ege Üniv. Basımevi.

İlarslan, R. (1994). Deveci Dağlarının (Yozgat-Tokat) Florasına Katkı. Turkish Jr. of Botany, 18, 4, 337-366.

Jablonski, B., Koltowski, Z. & Dabska, B. (1992). Nectar Secretion and Honey Efficiency of Important Plants in Poland Conditions, Part VII. Pszczelnicze Zeszyty Naukowe, 36, 54-64.

Jackson, M. L. (1958). Soil Chemical Analysis. New Jersey: Prentice Hall.

Jochimsen, M. & Janzen, D. (1991). Facets of Modern Ecology. G. Easer & D. Overdieck, (Eds.), Structure and phytomass production of a pioneer community, Elsevier, 39-69.

Johnson, C. M. & Ulrich, A. (1959). Analytical Methods for Use in Plant Analysis. California Agricultural Experiment Station Bulletin, 766.

Jorgensen, L. B. (1995). Stomatal Myrosin Cells in *Caricaceae*. Taxonomic Implications for a Glucosinolate-Containing Family. Nordic Jr. of Botany. 15, 5, 523-540.

Kacar, B. (1972). Bitki ve Toprağın Kimyasal Analizleri. II, Bitki Analizleri. Ankara Üniv. Zir. Fak. Yay. 453, Uygulama Klavuzu: 155, Ankara: Ankara Üniv. Basımevi.

Kesercioğlu, T. & Serin, O. (1996). Acıgöl'ün (Denizli) Floristik ve Palinolojik Yönden Araştırılması. XIII. Ulusal Biyoloji Kongresi Tebliğleri, 17-20 Eylül 1996, İstanbul.

Kireç, M. & Yarcı, C. (1999). the Flora of the Agricultural Areas in Enez (Edirne) and Environs. Turkish Jr. of Botany, 23, 1, 53-62.

Kutbay, G., Kılınç, M. & Karaer, F. (1995). Nebyan Dağı (Samsun-Bafra) Florası. Turkish Jr. of Botany, 13, 3, 345-371.

Küçüködük, M. (1989). Beyşehir Gölü Florası. Doğa Tu. Botanik Dergisi, 13, 1, 55-78.

Lott, L, Nery, J. P., Gello, J. R. & Medcaff, J. C. (1956). Leaf Analysis Technique in Coffee Research. IBEC. Res. Inst. II. 9. 21-24.

Loue, A. (1968). Diagnostic Petiolaire de Prospection, Etudes sur la Nutrition et la Fertilisation Potossiques de la Vigne. Societe Commerciole des Potosses d'Alsace Services Agronomiques, 31-41.

Mairet, E (1948). Vegetables Dyes. London: Faber & Faber Ltd.

Mc Clave, J. T., Benson, P. G. & Sincich, T. (1998). Statistics for Business and Economics. Seventh Edition. Prentice Hall International Inc.

Mert, H. H., Başlar, S. & Doğan, Y. (1993). Çevre Sorunları Yönünden Bitkisel Boyaların Önemi. II. Uluslararası Ekoloji ve Çevre Sorunları Simpozyumu Bildirileri, Ankara: 5-7 Kasım 1992,Türk-Alman Kültür İşleri Kurulu Yayın Dizisi, Nr: 3, 104-111.

Mert, H. H., Doğan, Y. & Başlar, S. (1992). Doğal Boya Eldesinde Kullanılan Bazı Bitkiler. Ekoloji Çevre Dergisi, 2, 5, 14-17.

Metcalfe, C. R. & Chalk, L. (1957). Anatomy of the Dycotyledons, II. London: Oxford Univ. Press.

Moghaddam, M. R. (1977). *Reseda lutea*: Multipurpose plant for arid and semiarid lands. Jr. Range Manage. 30: 71-72.

Moore, P. D., Webb, J. A. & Collinson, R. (1991). Pollen Analysis. Second Edition. Oxford: Blackwell Scientific Pubs.

Ocakverdi, H. (1986). Akyaka, Arpaçay, Melikköy ve Değirmenköprüköy Yaylaları (Kars) ile Sovyet Sınırı Arasında Kalan Bölgenin Florası. Doğa Tu. Biyoloji Dergisi, 10, 3, 412-437.

Özdemir, F., Zeybek, N. & Öztürk, M. (1984). Morphological, Anatomical and Ecological Observations on Three *Briza* L. species. Ege Univ. Fac. Sci. Jr. Series B, 7, 111-121.

Özer, Z. & Hasimoğlu, S. (1977). Preservation of Germination Ability of Some Weed Seeds Passed Through the Gastro-Intestineal Tract of Sheep. Jr. of Turkish Phytopathology, 6, 105-110.

Özhatay, N., Kültür, Ş. & Aksoy, N. (1994). Check-List of Additional Taxa to the Supplement Flora of Turkey. Turkish Jr. of Botany, 18, 6, 497-514.

Öztürk M., Oflas, S. Mert, H. H. (1984). Studies on the Germination of *Inula graviolens* Desf. Seeds. E.U. Fac. Sci. Jour. Ser. B, 7, 1, 39-46.

Öztürk, M. A. & Seçmen, Ö. (1996). Bitki Ekolojisi. İzmir-Bornova: Ege Üniversitesi Basımevi.

Öztürk, M. A. (1979). Preliminary Observations on the Edaphic and Biotic Relations of *Myrtus communis* L. Ege Üniv. Fen Fek. Dergisi, Seri B, III, 1, 2, 3, 4, 137-142.

Öztürk, M. & Özçelik, H. (1991). Doğu Anadolu'nun Faydalı Bitkileri (Useful Plants of East Anatolia). Ankara: SİSKAV.

Öztürk, M., Pirdal, M. & Özdemir, F. (1997). Bitki Ekolojisi Uygulamaları. Ege Üniv. Fen Fak. Kitaplar Serisi No: 157, Ege Üniv. Basımevi, Bornova-İzmir.

Pearce, R. D. (1982). Flora of Australia, A. S. George (Ed), *Resedaceae* Canberra: Australian Government Publishing Service, 359-361.

Pemberton, R. W. & Irwing, D. W. (1990). Elaiosomes on Weed Seeds and the Potential for Myrmecochory in Naturalised Plants. Weed Science, 38, 615-619.

Pirdal, M. (1980). *Inula viscosa* (L.) Aiton Bitkisin Edafik Etmenlerle Olan İlişkisi. VII. Ulusal Biyoloji Kongresi, 6-10 Ekim 1980, Kuşadası, Aydın, 657-664.

Pirdal, M. (1986). Batı Anadolu'da Yayılış Gösteren *Asphodelus aestivus* Brot., "Çiriş Otu" nun Morfolojisi, Anatomisi ve Ekolojisi ile İlgili Gözlemler. Doktora Tezi. E. Ü. Fen Fak., Biyoloji Bölümü, Botanik Anabilim Dalı, Bornava- İzmir. (1989).

Pizer, N. H. (1967). Some Advisory Aspects Soil Potassium and Magnesium. Tech. Bull., 14, 184.

Punt, W. & Marks, A. (1995). The Northwest European Pollen Flora, 54, *Resedaceae*. Review of Paleobotany and Palynology, 88, 47-59.

Salisbury, E. J. (1961). Weeds and Aliens. London: Collins.

Scheffer, F. & Schactschabel, P. (1956). Lehrbuch der Agrikultür Chemie und Bodenkunde. Stuttgart: Ferdmant Ecke. Verlag, 1.

Seçmen, Ö. (1980). Nif Dağı Florası (I). Ege Üniv. Fen Fak. Der., B, 4, 1-4, 97-113.

Seçmen, Ö., Gemici, Y., Leblebici, E., Görk, G. & Bekat, L. (1986). Tohumlu Bitkiler Sistematiği. Bornova-İzmir: Ege Üniv. Fen Fak. Kitaplar Serisi No: 116.

Shimida, A. & Ellner, S. (1983). Seed Dispersal on Pastoral Grazers in Open Mediterranean Chaparral. Israeli Journal of Botany, 32, 147-159.

Silvertown, J. W. (1981). Micro-Spatial Heterogeneity and Seedling Demography in Species-Risk Grassland. New Phytologist, 88, 117-128.

Sümbül, H. & Erik, S. (1987). Taşeli Platosu'ndan (C4) Yeni Kayıtlar. Doğa Tu. Botanik Dergisi 11, 3, 330-347.

Sümbül, H. & Erik, S. (1988). Taşeli Platosu Florası I, Doğa Tu. Botanik Dergisi 12, 2, 175-205.

Tapan, N. (1983). Doğal Boyalarla Yün Boyama, İstanbul.

Turril, W. B. (1958). Gelibolu Yarımadası'nın Florası. İ. Ü. Orman Fak. Dergisi, Seri B, 8, 2, 133-175.

Tutin, T. G. *et al.* (Eds)(1964). Flora Europe, I. Cambridge Univ. Press.

Tuzlacı, E. (1977). Honaz Dağının Bitkileri II. İst. Ecz. Fak. Mec., 13, 47-61.

Türdü, P., Zeybek, N. & Öztürk, M. (1984). Studies on the Morphology, Anatomy and Ecology of Some *Bromus* L. Species. E. U. Fac. Sci. Jour. Series B, Vol.7.

Uğur, G. (1988). Türk Halılarında Doğal Renkler ve Boyalar. Ankara: Türkiye İş Bankası Kültür Yay. 289.

Weaver, J. E. & Clements, F. E. (1938). Plant Ecology. Mc Grow Hill Book Co. Inc.

Wichman, D. M. (1990). Yellow mignonette biology and control. Proc. West Soc. Weed Sci. 43, 58-59.

Yıldız, B. & Aktoklu, E. (1996). Malatya Florasına Katkılar I, Sürgü-Çelikhan Yöresinde Bir Önçalışma. Turkish Jr. of Botany, 20, 3, 267-278.

Yıldız, B. (1996). Floristic Characteristics of Köse Dağı (Sivas). Turkish Jr. of Botany, 20, 5, 417-456.