Pak. J. Bot., 36(1): 41-64, 2004.

ECOLOGICAL FACTORS AFFECTING PARTS OF VEGETATION IN NORTH IRAN (ELIKA AND DUNA WATERSHEDS) BY EMPLOYING ECO-PHYTOSOCIOLOGICAL METHOD

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Abstract

To determine ecological factors that affect vegetation of north Iran, the eco-phytosociological method with emphasis on physiognomic-floristic-ecologic criteria have been employed and the existing endogenous milieus were identified. In next stage, the placements of releves in any endogenous milieus were determined at random. The minimal area in each releve was determined on area-species method. The concerned floristic-ecologic data of each releve was entered in the forms related to releves, by concerning Braun-Blanquet's Composition Coefficients A-D and S. The data analysis was performed by using Anaphyto Software in F.C.A. and A.H.C. Method. After placing the ecological factors on the multiplex coordinate axes obtained from F.C.A. and comparing the axes together, the results were analyzed and interpreted and the ecological factors that affect the vegetation of the region were determined as the principal, determinant and differential ecological factors. These results showed that the factors of soil moisture, soil pH, OM%, OC%, slope degree and altitude from sea level of the region were the **principal ecological factors.** The factors of moisture, texture, pH, EC, OM%, OC%, percentage of the lime of soil as well as the altitude and exposition showed to be the **determinant ecological factors**. The factors of moisture, pH, EC, OM%, OC%, percentage of the lime of soil and exposition were effective as the **differential ecological factors**.

Introduction

A number of researchers who study vegetation of a region try to determine the placement of releves by making ecological factors as principal pillar or applying a pre-determined ranging (Archibold, 1996; Barbour *et al*., 1987; Gounot, 1969; Gordon, 1985; Lemee, 1978; Walter, 1985), where the studies of Atri (1996, 1999) and Guinochet (1973) show that with respect to the phenomena such as interaction, substitution, stenoece and euryece nature of the species and existence of intra-specific and inter-specific relations, consideration of the ecological factors as the base and pillar by focusing on one or a number of pre-determined ecological factors to study vegetation could not express the existing reality in all times. On the other hand, with respect to homogeneity of the environment for dominant species and its non-homogeneity for other species, the possibility of a careful determination of association individuals or the homogenic surfaces in ecologic-floristic term is low. With respect to the aforesaid instances in studying effective ecological factors on the vegetation of Elika Region, the eco-phytosociological method was employed through applying physiognomic-floristic-ecologic criteria to determine the homogenic surfaces in floristic-ecologic terms. In this approach, it became possible to determine principal, determinant and differential ecological factors through specifying the concerned ecological factors on the multiplex coordinate axes gained by F.C.A.

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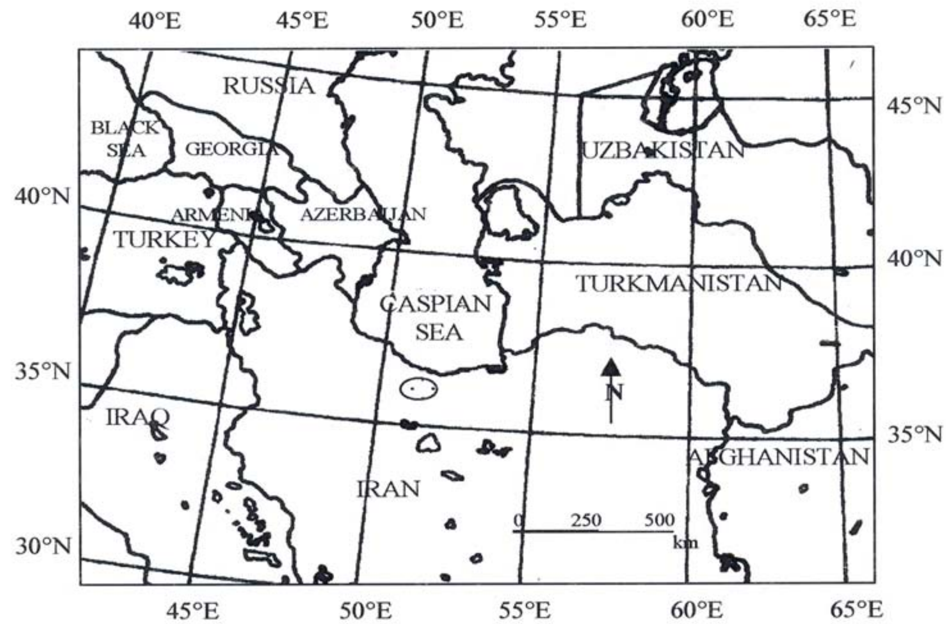

Fig. 1. Situation and map of N. Iran with the study area. The study area is shown by ⊙.

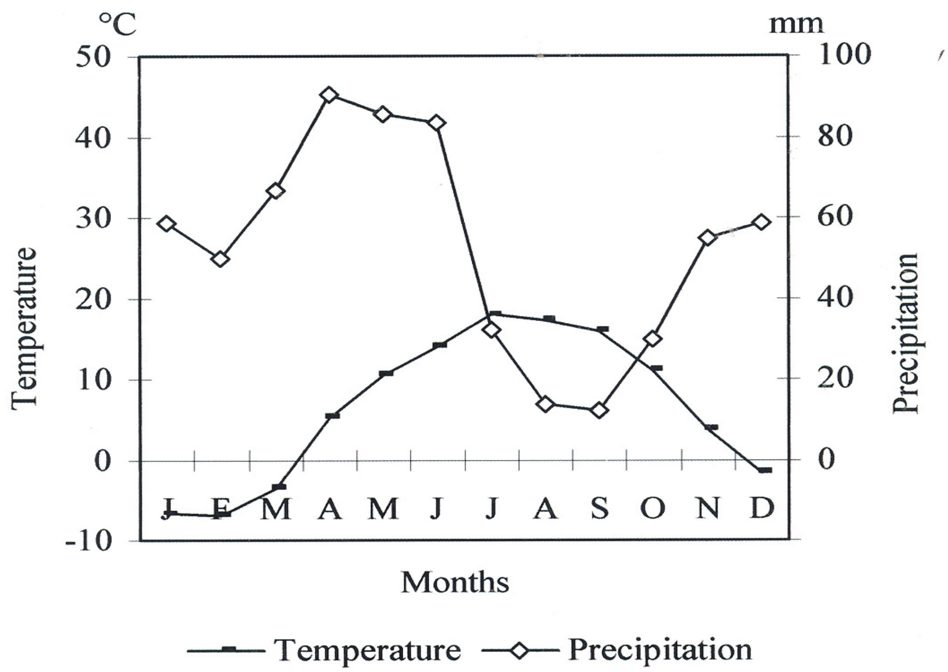

Fig. 2. The ombro-thermic diagram of Polour Meteorological station.

The study area

The area is situated in the Central Alborz Mountain Chains, between 36°, 9', 20" to 36°, 16', 35" northern latitudes and 51°, 18' to 51°, 23' eastern longitudes (Fig. 1). The lowest altitude from sea level is 1860 meters and the highest is 3935 m. The average annual rainfall is 790 mm. The highest amount of rainfall is observed in autumn, winter and spring seasons and summer has the lowest rainfall (Fig. 2). The average daytime temperature is 3.4 °C. The maximum daytime temperature in August is 25.7 °C and the minimum temperature in February is –7 °C. According to the Emberger Climatographical Method, the region has cold sub-humid to cold humid climate. About 79 % of the geological structure of the region belongs to Jurassic Period which is related to Shemshak Formation. Around 10% of the formation of the region belong to Terrias Period, that the major section of it is Elika Formation. About 6% of the region formation belong to Permian Period and 5% belongs to Carboniferous Period. Shale, sandstone, siltstone, limeston, claystone, quartzite, conglomerate, coal seams and lenses are of the most important formations of the region.

Methods

To determine the principal, determinant and differential ecological factors in the vegetation of the region, in first place, the base map of the region was prepared by using satellite and aerial photos as well as topographic and geologic maps. Then, the delimitation map was prepared by referring to the region. To determine the placement of the releves, the eco-phytosociological method was used with emphasis on physiognomic-floristic-ecologic criteria (Neo-Zigmatist) (Atri, 1996). In this method, by employing physionomic criterion, the existing formations (principal and secondary formations) were specified. By employing the floristic criterion in each formation, the homogenic areas were determined in terms of floristic composition and their delimitations were specified on the map as association individuals respect. Then, by using ecological criterion in each association individuals, based on observation of any changes in one or more ecological factors, the existing endogenic milieu(s) could be specified in each association individuals. Then, in any endogenic milieu, which showed homogeneity in floristic-ecologic term, the releves were placed at random. To determine the minimal area of each releve, by using the Area-Species Method on the basis of area-species curve and Cain Method were applied (Cain, 1959). The necessary floristic-ecologic information and data (including plant species, texture class, OM%, OC%, pH, EC, moisture, percentage of lime of soil, altitude, exposition and slope degree) were collected for each releves and were duly entered in the related forms. In the next stage, the species and samples of soil identified and duly studied so that they would be prepared to be analyzed by computer software after labeling and coding of the releves. The data analysis was performed by Anaphyto Software (Briane, 1995) in both F.C.A. and A.H.C. Methods, by concerning Braun-Blanquet’s Composition Coefficient A-D and S (Mueller-Dombois & Ellenberg 1974). In the F.C.A. Method the releves were estimated and grouped together and at the same time based on the species available in them and the species in turn, grouped on the releves basis. The ranking of the groups obtained through F.C.A. was preformed by employing H.C.A. Method. The results obtained by data analysis in F.C.A. Method were presented on the multiplex coordinate axes with various compositions, such as (1, 2), (1, 3), (1, 4), (3, 4)… axes. In this grouping, since the releves are located near or far from each other based on their similarity or dissimilarity in the floristic compositions and with respect to the fact that each endogenic milieu has particular ecological factors and subsequently, its own floristic composition; by placing exclusive marks on the coordinate axes for each ecological factors subject of study, it became possible to determine the effective factor(s) on the groups as specified in differential duplex compositions. In this approach, on the multiplex coordinate axes, those factors in the region which cause separation and categorizing the principal formations have been considered as the **principal ecological factors**; however, the factors that cause separation and categorizing the floristic composition in a formation are considered as **determinant ecological factors** and those factors that cause division and differentiation of a part of floristic composition of a formation were considered as **differential ecological factors**. In this manner, the ecological factors were specified as principal, determinant and differential ecological factors in the region.

Results

By comparing the results obtained from F.C.A. on multiplex coordinate axes through placing the ecological factors, we were led to select one or more coordinate axes for each one of the ecological factors subject of study and present the quality of the effect of those factors on vegetation of the region. Among the obtained axes, only a few of the coordinate axes have been selected as sample to be presented.

Soil moisture: This factor has been effective as principal, determinant and differential ecological factor in the region. The results showed that the soil moisture factor- as a principal ecological factor in the region- caused division in range, hygrophilic forest, the hydrophilic forest in the river margin and hydrophilic grassy formations (Fig. 3), in such a way that the group I as a range formation has *Astraglus verus*, *Onobrychis cornuta*, *Acantholimon hohenackeri* and *Artemisia chamaemelifolia* dominant species with a soil moisture equal to a 2.8-9%. Group II as a hygrophilic forest formation has *Acer campestre*, *Quercus macranthera*, *Carpinus betulus* and *Quercus petraea subsp. iberica* dominant species with a soil moisture of 9-14.5%. Group III is the hydrophilic forest formation in the river margin has *Salix aegyptiaca*, *Salix alba,* and *Hippophae rhamnoides* dominant species with a soil moisture of 25-35.5%. Group IV as a hydrophilic grassy formation has *Ranunculus brachylobus var. major*, *Carex caucasica*, *Primula auriculata*, *Juncus inflexus* dominant species with a soil moisture equal to 45-50%. The releves 139, 140, 141, 142, 143 and 144 are for rocky formation. The soil moisture factor in each of the formations might be effective as a determinant factor in such a way that in the axes 1-3 of the secondary analysis (Elika 2), after deletion of forest, the river margin forest and hydrophilic grassy formations, the three groups of I, II and III were specified with a soil moisture equal to 2.8-5%, 5-8% and 8-9%. Group I has *Camphorosma monspeliaca* ssp., *monspeliaca*, *Salsola montana*, *Jurinella microcephala* and *Stipa arabica* ssp., *arabica* dominant species, group II has *Artemisia chamaemelifolia*, *Bromus tomentosus*, *Alopecurus textilis*, *Onobrychis cornuta* dominant species and group III has *Diplotaenia cachrydifolia*, *Ferula ovina* and *Plantago atrata* dominant species.

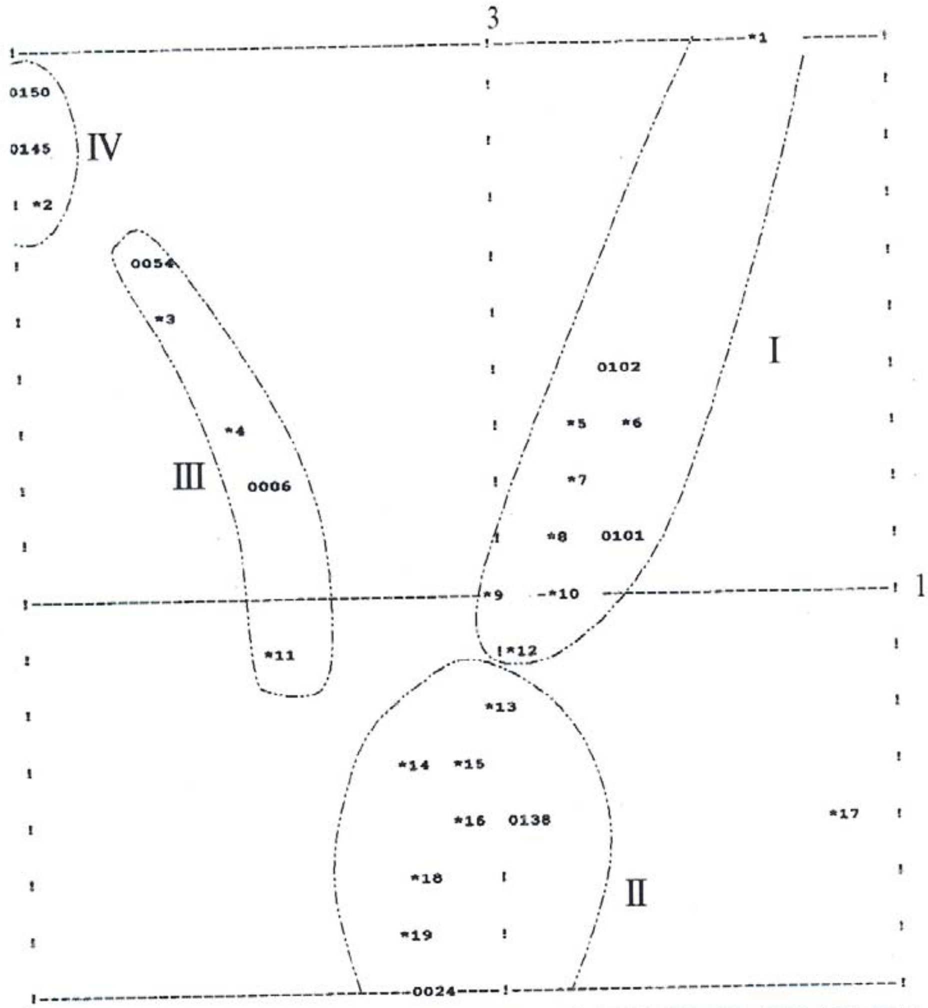

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Fig. 3. Grouping releves on axes 1-3 obtained from F.C.A. by considering the ecological factor of soil moisture.

The soil moisture factor could also be effective as a differential factor in the range formation as well. In the axes 1-3 of the secondary analysis (Elika 2) in group II, *Bromus tomentosus* along with *Ulmus minor* have been obtained in the releves 51, 52 and 79; where, *Bromus tomentosus* is not present in other releves of group II. In the releves 51, 52 and 79 (group IIB), the soil moisture is equal to 7-8% and in other releves (group IIA), the soil moisture is equal to 5-7%.

Also, in the 1-2 axes of secondary analysis (Elika 3), after deleting the range, hydrophilic forest of river margin and the hydrophilic grassy formations, the two groups I and II with a 9-12.99% and 13-14.5% soil moisture were specified. Group I has *Quercus macranthera*, *Acer campestre*, *Carpinus orientalis* and *Crataegus meyeri* dominant species and group II has *Carpinus betulus*, *Quercus petraea subsp. iberica*, *Acer hyrcanum*, *Fraxinus excelsior* and *Evonymus latifolia* dominant species. Therefore, the soil moisture factor could act as the determinant factor in forest formation.

The species *Quercus macranthera* and *Acer campestre* in group IIB is associated with *Carpinus betulus*, *Quercus petraea subsp. iberica*, *Acer hyrcanum* and *Evonymus latifolia*; whereas, in IIA, the former species are not with these species. Group IIA has a soil moisture equal to 13-13.8% and group IIB has a soil moisture of 13.8-14.5%. In this manner, the soil moisture has been able to be a cause for differentiation of these two groups.

Groups IA and IB could be separated in the group I. Group IA has a soil moisture equal to 9-9.5% and group IB has a soil moisture of 9.5-13%. *Juniperus communis ssp. hemisphaerica* in groups IA (releves 29, 30, 131 and 147) and IB (releves 28, 148 and 146) is dominant species. *Acer monspessulanum* ssp., *ibericum* in group IB1 is associated with *J. communis*; where in group IA, the former species is not with this species. Therefore, this factor has acted as a differential factor in the forest formation.

Soil texture: The ecological factor of soil texture in range formation has been able to be effective as a determinant factor; in such a manner, that it has been able to divide the range formation into four groups I, II, III and IV (Fig. 4). Group I has species *Androsace villosa*, *Jurinella microcephala*, *Physoptychis gnaphaloides*, *Stipa lessingiana* and *Myosotis lithospermifolia* with a sandy soil texture, group II has *Camphorosma monspeliaca* and *Salsola montana* species with loamy-sand soil texture, group III has *Artemisia chamaemelifolia*, *Bromus tomentosus*, *Alopecurus textilis*, *Onobrychis cornuta*, *Diplotaenia cachrydifolia* and *Ferula ovina* species with a sandy-loam soil texture and group IV has *Trifolium radicosum*, *Hordeum violaceum* and *Astragalus judotropis* species with sandy-clay-loam soil texture.

This ecological factor in the forest formation has also been able to act as a determinant factor; in such a manner that it has been able to divide the forest formation into two groups (Fig. 5). Group I has *Quercus macranthera*, *Acer campestre*, *Carpinus orientalis* and *Crataegus meyeri* species with sandy-loam soil texture class and group II has *Carpinus betulus*, *Quercus petraea subsp. iberica*, *Acer hyrcanum*, *Fraxinus excelsior* and *Evonymus latifolia* species with sandy-clay-loam soil texture class.

Soil EC: This factor has been effective, as determinant and differential ecological factor in the region. Four groups could be distinguished in range formation (Fig. 6). Group I has species *Trifolium radicosum* and *Hordeum violaceum* with an EC of 0.61-0.65 µs/m, group II has the dominant species *Diplotaenia cachrydifolia* and *Ferula ovina* with an EC

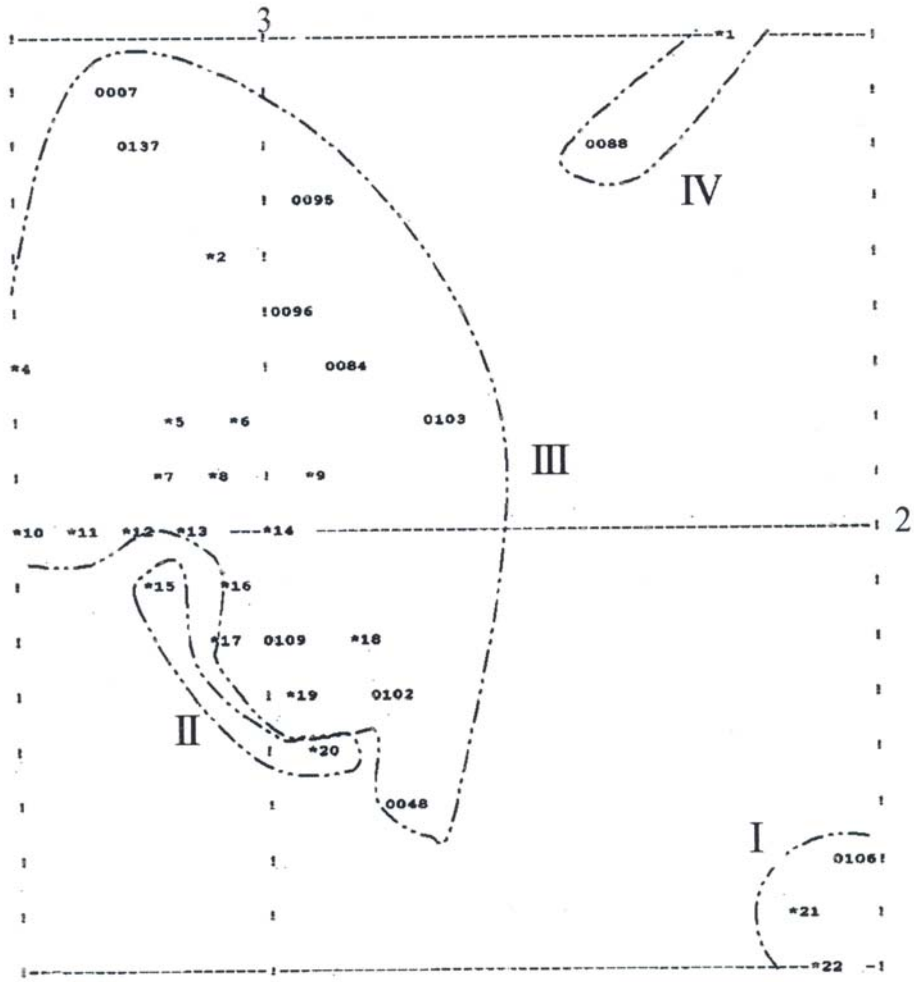

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Fig. 4. Grouping releves on axes 2-3 of secondary analysis obtained from F.C.A. by considering the ecological factor of soil texture in the range formation.

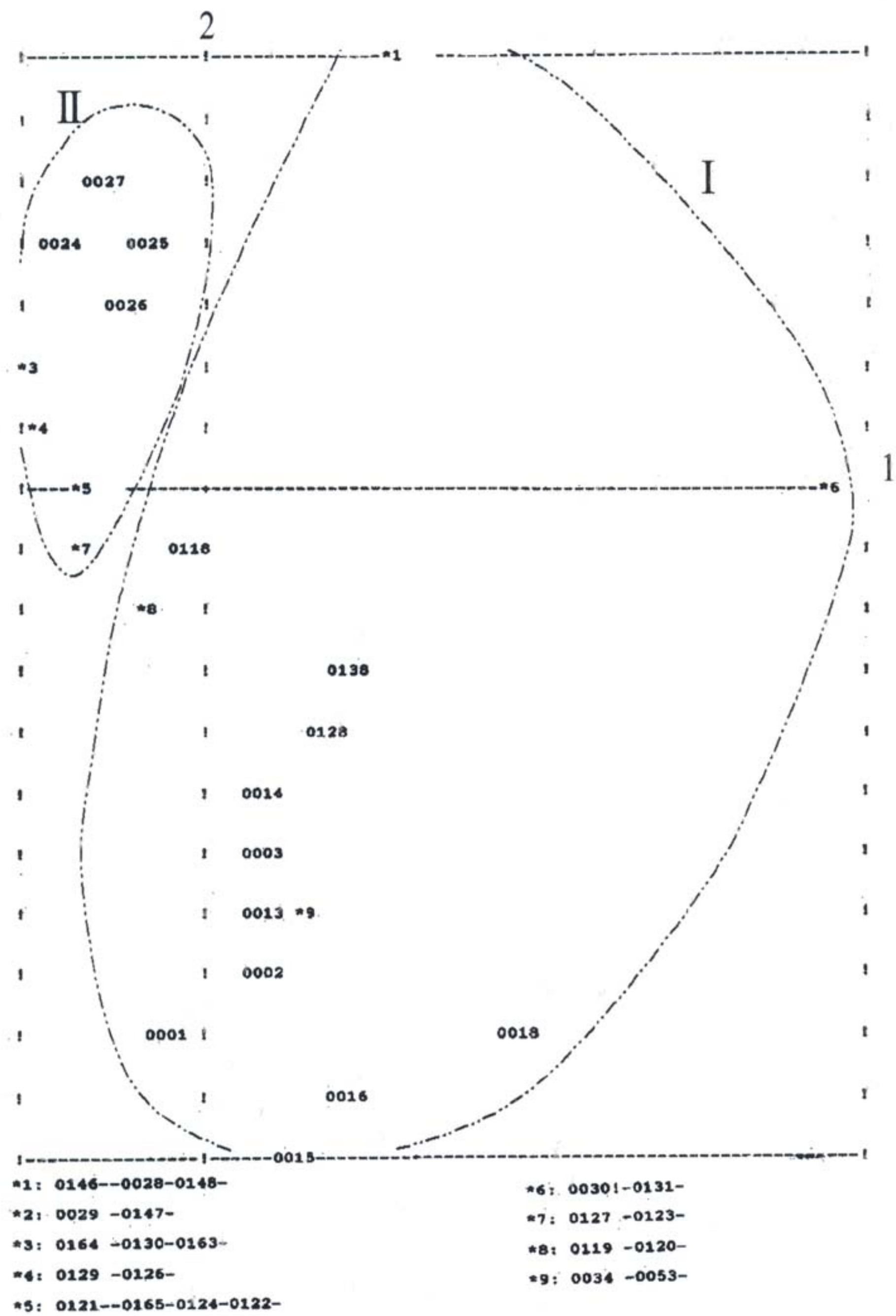

Fig. 5. Grouping releves on axes 1-2 of secondary analysis obtained from F.C.A. by considering the ecological factor of soil texture in the range formation.

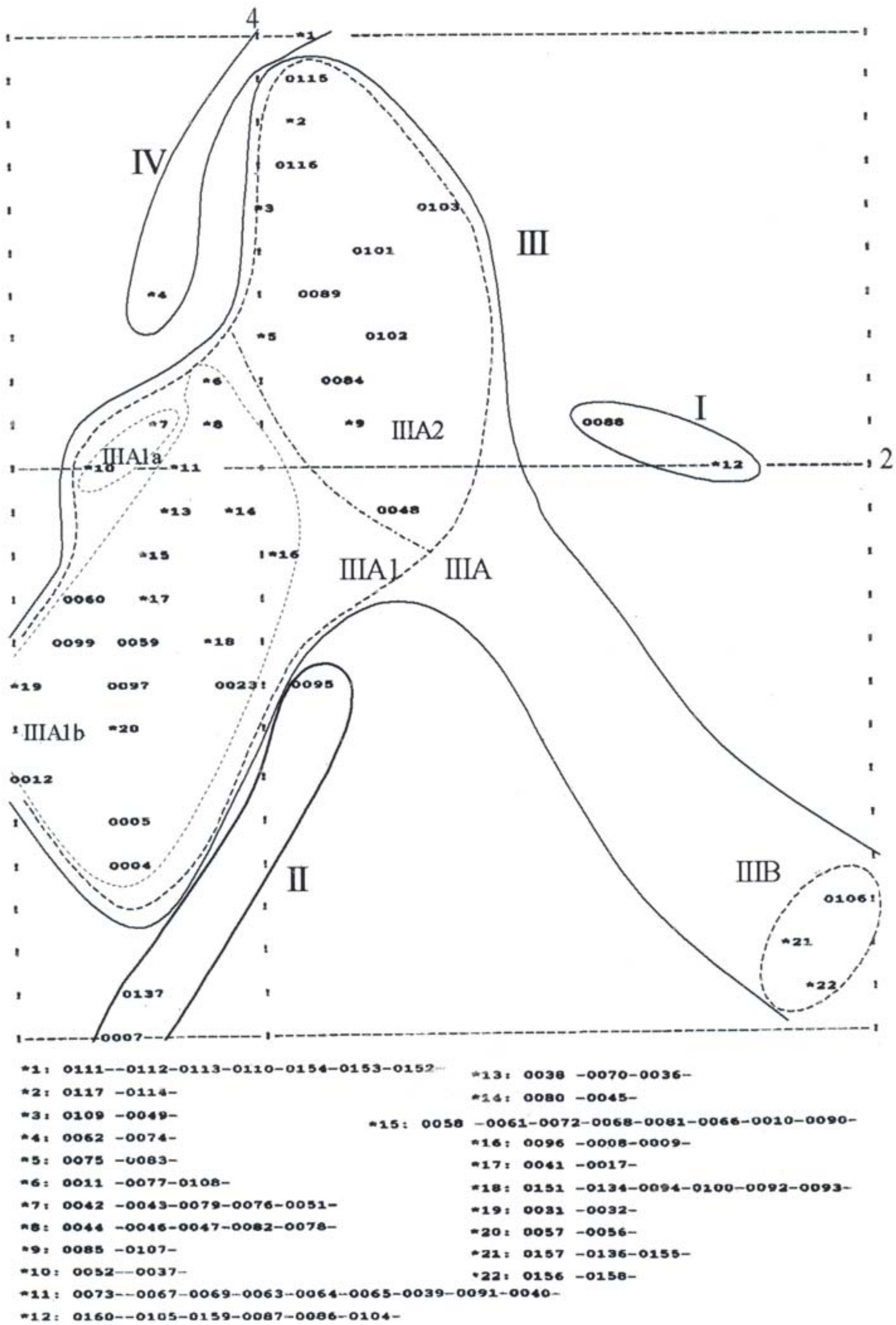

Fig. 6. Grouping releves on axes 2-4 of secondary analysis obtained from F.C.A. by considering the ecological factor of soil EC in the range formation.

of 0.65-0.7 µs/m, group III has species *Bromus tomentosus*, *Onobrychis cornuta*, *Artemisia chamaemelifolia*, *Acantholimon hohenackeri*, *Poa araratica*, *Cerasus pseudoprostrata*, *Salvia verticillata*, and *Alopecurus textilis* with an EC of 0.7-0.82 µs/m and group IV has species *Camphorosma monspeliaca* and *Salsola montana* with an EC of 0.82-0.98 µs/m. Therefore, this factor in range formation has been able to be effective as a determinant ecological factor.

Groups IIIA1a and IIIA2b have species *Astraglus verus*, *Bromus tomentosus*, *Onobrychis cornuta*, *Artemisia chamaemelifolia*, *Acantholimon hohenackeri*, *Poa araratica* and *Alopecurus textilis*. In addition group IIIA1a has *Ulmus minor* species in its floristic composition. This species is not found in the floristic composition of group IIIA1b. Group IIIA1a has an EC of 0.7-0.72 µs/m and group IIIA1b has an EC of 0.72-0.78 µs/m.

Bromus tomentellus, *Cousinia multiloba* and *Acantholimon erinaceum* are dominant in groups IIIA2 and IIIB. In the floristic composition of group IIIB in addition to the mentioned species, there are also *Jurinella microcarpa*, *Myosotis lithospermifolia* and *Androsace villosa* while they are not found in group IIIA2. Group IIIA2 has an EC of 0.72-0.78 µs/m and group IIIB has an EC of 0.78-0.82 µs/m. Therefore, the EC factor has also been able to act as a differential ecological factor in range formation.

The soil EC factor has also been able to act as a determinant and differential factor in forest formation (Fig. 7). In this formation four groups were specified; group I has *Carpinus betulus*, *Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia* dominant species with an EC of 0.63-0.70 µs/m, group II has *Crataegus meyeri*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica*, *Rosa canina*, *Cotoneaster multiflorus* and *Prunus spinosa* dominant species with an EC of 0.7- 0.78 µs/m, group III has *Juniperus communis ssp. hemisphaerica* dominant species with an EC of 0.78- 0.85 µs/m and group IV has *Ephedra major* and *Rhamnus pallasii* dominant species with an EC of 0.85- 0.9 µs/m. Therefore, the EC factor of the soil has been able to act as a determinant ecological factor in the forest formation.

Group I is divided into IA and IB groups. In the reveles 24, 27, 126, 129, 130, 163 and 164 (group IA), *Acer campestre* and *Quercus macranthera* are associated with *Carpinus betulus, Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia*; however, in the reveles 25, 26, 122, 123, 127 and 165 (group IB) they are not associated with these species. Group IA has an EC of 0.63-0.67 µs/m and group IB has an EC of 0.67- 0.7µs/m. Also, group III is divided into IIIA (releves 28, 146 and 148) and IIIB (releves 29, 30, 131 and 147) groups. *Juniperus communis ssp. hemisphaerica* is dominant species in groups IIIA and IIIB. *Acer monspessulanum ssp. ibericum* is present in group IIIA, where, it is not present in group IIIB. Group IIIA has an EC of 0.78-0.82 µs/m and group has an EC of 0.82-0.85 µs/m.

Percentage of the lime of soil: This factor has been effective as determinant and differential ecological factor in the region. This factor has been able to divide the floristic composition of range formation into five groups of I, II, III, IV and V (Fig. 8). Thus, group I has species *Trifolium radicosum*, *Hordeum violaceum* and *Astragalus judotropis* with 14-18 lime percent, group II has *Diplotaenia cachrydifolia* and *Ferula ovina* species with 18-21% lime, group III has *Astraglus verus*, *Onobrychis cornuta*, *Artemisia chamaemelifolia*, *Bromus tomentosus*, *Alopecurus textilis*, *Melica jacquemontii*, *Tanacetum abrotanifolium*, *Bupleurum exaltatum*, *Helichrysum psychrophilum* and *Psathyrostachys fragilis* with 21-30% lime, group IV has *Physoptychis gnaphaloides* and *Stipa lessingiana* with a lime contents of 30-32% and

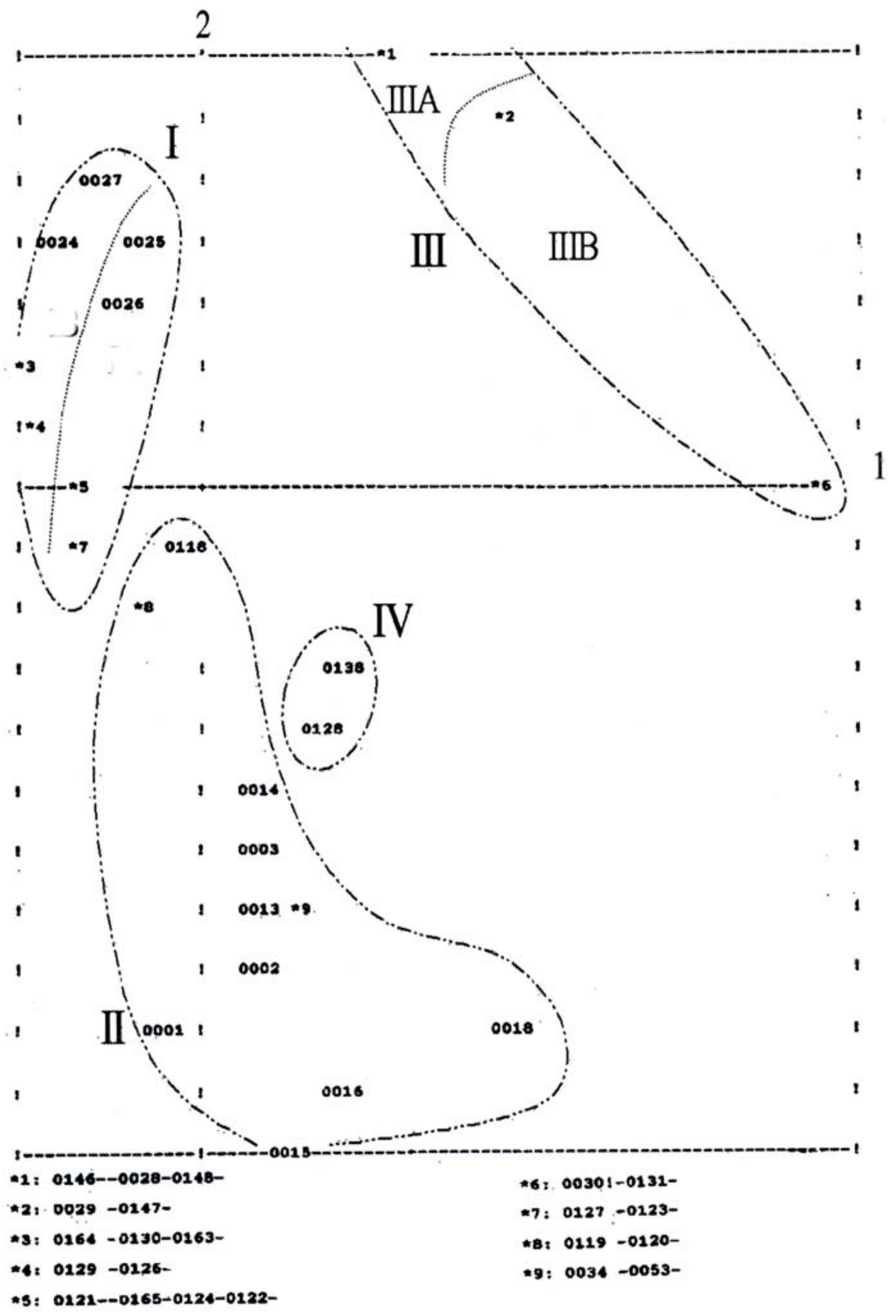

Fig. 7. Grouping releves on axes 1-2 of secondary analysis obtained from F.C.A. by considering the ecological factor of soil EC in the range formation.

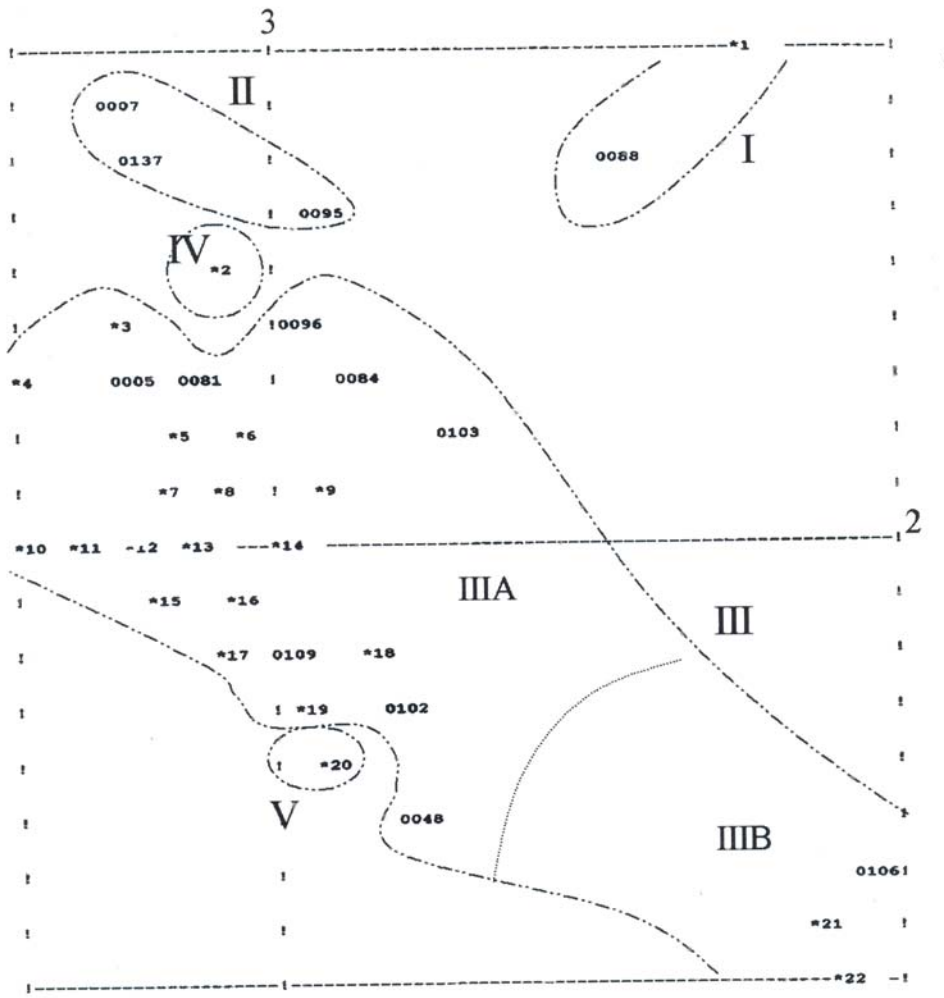

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Fig. 8. Grouping releves on axes 2-3 of secondary analysis obtained from F.C.A. by considering the ecological factor of percentage of lime in soil in the range formation.

group V has *Camphorosma monspeliaca* and *Salsola montana* with a lime contents of 50-57%. Therefore, the factor of lime percent of the soil has been able to play role in range formation as a determinant ecological factor.

This factor has been able to be effective as a differential factor in the range formation. Group III is divided into IIIA and IIIB groups. Group IIIA has a 21-28% lime contents and group IIIB has a lime content of 28-30%. *Jurinella microcarpa*, *Myosotis lithospermifolia* and *Androsace villosa* are in the floristic composition of group IIIB but these species are not found in the floristic composition of group IIIA. Therefore, the soil lime percentage plays a role as a differential ecological factor. This also has been effective as a determinant and differential factor in the forest formation. This factor has caused existence of four groups I, II, III and IV in the forest formation (Fig. 9). Group I has *Carpinus betulus*, *Quercus petraea* ssp. *iberica*, *Acer hyrcanum* and *Evonymus latifolia* dominant species with a 10-15% lime contents, group II has species *Crataegus meyeri*, *Carpinus orientalis*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica*, *Rosa canina*, *Cotoneaster multiflorus* and *Prunus spinosa* with 15-25% lime contents, group III has *Juniperus communis ssp. hemisphaerica* with a lime contents of 25-45%, and group IV has *Ephedra major* and *Rhamnus pallasii* with a lime content of 45-55%. Therefore, forest formation has been effective as a determinant factor.

This factor has been able to play role as a differential ecological factor in the forest formation. *Juniperus communis* ssp. *hemisphaerica* is dominant species in groups IIIA (releves 28, 146 and 148) and IIIB (releves 29, 30, 131 and 147). *Acer monspessulanum ssp. ibericum* is present in group IIIA, where, it is not present in group IIIB. Group IIIA has 25-40% lime contents and group IIIB has 40-45% lime contents. Also, in the releves 24, 27, 126, 129, 130, 163 and 164 (group IA) *Acer campestre* and *Quercus macranthera* are associated with *Carpinus betulus*, *Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia*; however in the releves 25, 26, 122, 123, 127, and 165 (group IB) are not associated with these species. Group IA has 10-13% lime contents and group IB has 13-15% lime contents.

Soil pH: This factor has been effective as principal, determinant and differential ecological factor in the region which caused division in the hydrophilic grassy (group I), hydrophilic forest in the river margin (group IIA), closed forest (group IIB), open forest (group IIIA) and range formations (group IIIB) (Fig. 10). Group I has a pH of 6-6.5, group II has a pH of 6.5-7 and group III has a pH of 7-8.5. The results obtained by secondary analysis of range formation (Elika 2) on axes 2-4 show that the factor of soil pH has been acting as a determinant ecological factor that divides the floristic composition of this into four groups; thus, group I has *Trifolium radicosum* and *Hordeum violaceum* species with a pH equal to 7-7.2, group II has *Diplotaenia cachrydifolia* and *Ferula ovina* species with a pH of 7.2-7.5, group III has *Bromus tomentellus*, *Poa araratica*, *Cerasus pseudoprostrata*, *Salvia verticillata* and *Artemisia chamaemelifolia* species with a pH equal to 7.5-8 and group IV has *Camphorosma monspeliaca* and *Salsola montana* species with a pH of 8-8.5.

Soil pH factor in range formation has also been effective as a differential factor. The IIIA1 and IIIA2 groups have the species *Astraglus verus*, *Onobrychis cornuta*, *Artemisia chamaemelifolia*, *Bromus tomentosus*, *Alopecurus textilis* and *Psathyrostachys fragilis*. In the floristic composition of group IIIA1, there is also *Ulmus minor* in addition to the mentioned species. This species is not found in group IIIA2. Group IIIA1 has a pH of 7.3-7.5 and the pH of group IIIA2 is equal to 7.5-7.8. *Bromus tomentellus*, *Cousinia*

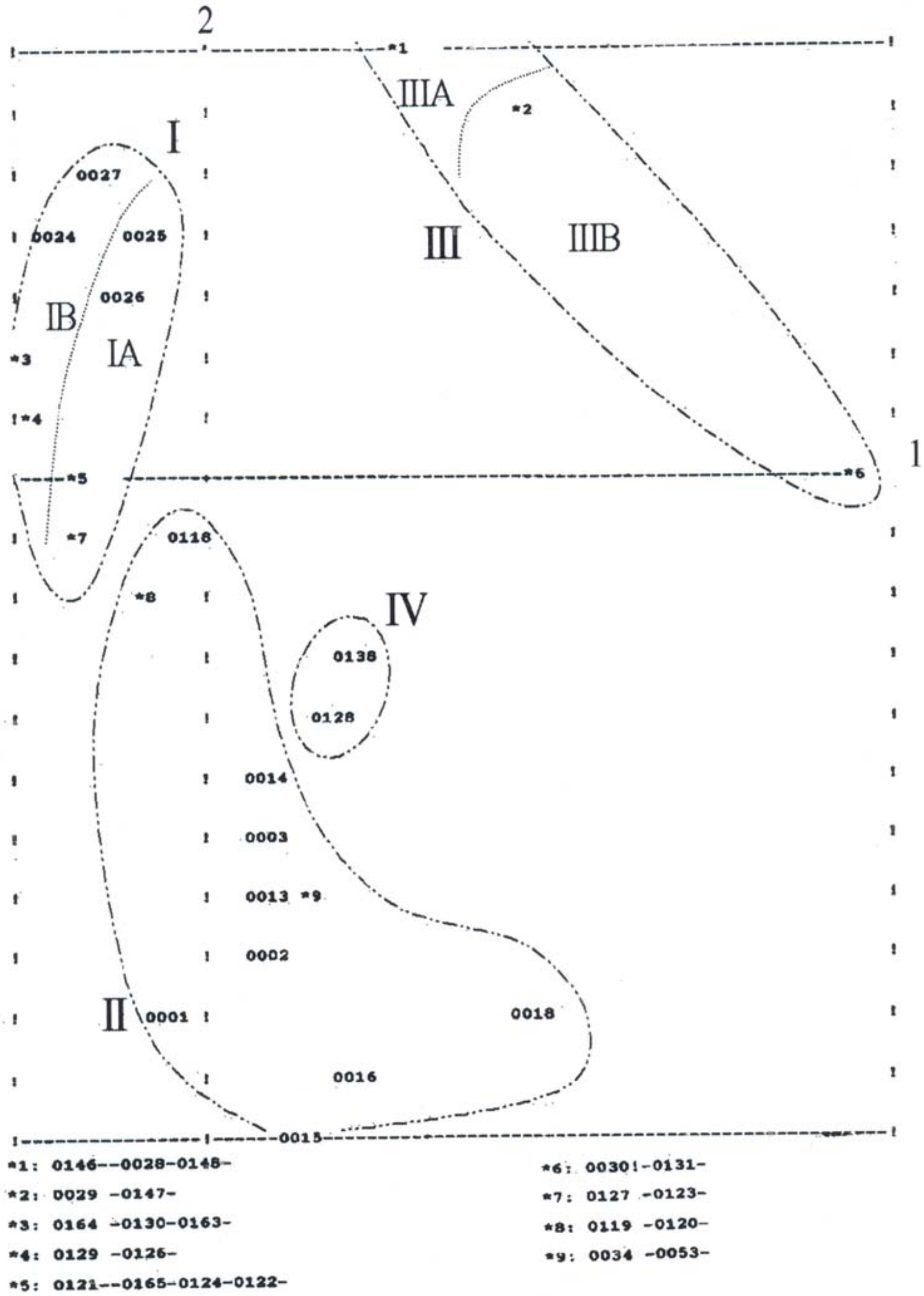
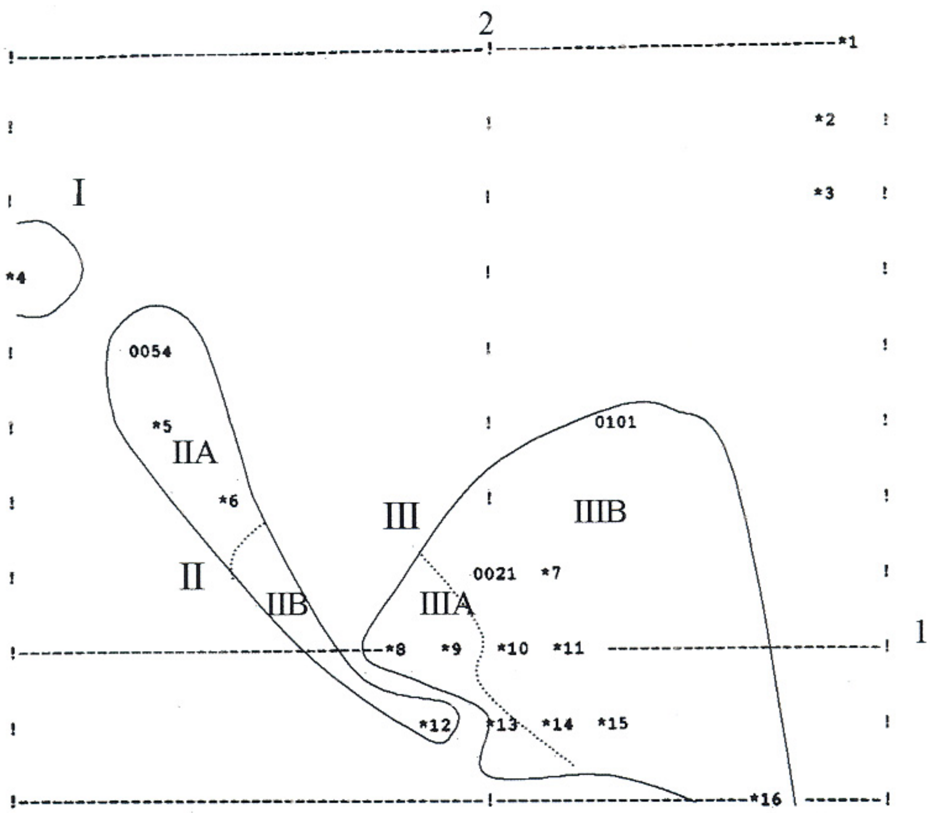


Fig. 9. Grouping releves on axes 1-2 of secondary analysis obtained from F.C.A. by considering the ecological factor of percentage of lime in soil in the range formation.



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*13: 0128 -0138-0005-0004

*14: 0017 -0023-0059-0096-0105-0104-0066-0160-0067-0070-0068-0061-0041-0010-0042-0058-0043-0086-0159-0090-0087-0095-0072-0080-0091-0089-0009-0008-0040-0082-0078-0069-0047-0044-0045-0046-0083-0065-0084-0088-0085-0039-0011-0048-0064-0063-0109-0115-0114-0117-0116-

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Fig. 10. Grouping releves on axes 1-2 obtained from F.C.A. by considering the ecological factor of soil pH.

multiloba and *Acantholimon erinaceum* are dominant in groups IIIA3 and IIIB. In the floristic composition of group IIIB, there are *Jurinella microcarpa*, *Myosotis lithospermifolia* and *Androsace villosa* in addition to the mentioned species. These species are not found in group IIIA3. Group IIIA3 has a pH of 7.5-7.8 and the pH of group IIIB is equal to 7.8-8.

The results obtained from secondary analysis of forest formation (Elika 3) on the axes 1-2 shows that as a determinant ecological factor, pH causes an establishment of the four groups I, II, III and IV. In Group I, *Carpinus betulus*, *Quercus petraea subsp. iberica*, *Acer hyrcanum* and *Evonymus latifolia* are dominant and it has a soil pH of 6-7, in group II, *Crataegus meyeri*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica*, *Rosa canina*, *Cotoneaster multiflorus* and *Prunus spinosa* are dominant and it has a soil pH of 7-8, group III has *Juniperus communis ssp hemisphaerica* with a soil pH of 8-8.3 and group IV has *Ephedra major* and *Rhamnus pallasii* with a soil pH of 8.3-8.5.

The soil pH has also acted as differential ecological factor in the forest formation. Group I in itself could be divided into two groups IA and IB. *Acer campestre* and *Quercus macranthera* in group IA are associated with *Carpinus betulus*, *Quercus petraea* ssp. *iberica*, *Acer hyrcanum* and *Evonymus latifolia*, whereas in group IB, these species are not associated with the aforesaid species. Group IA has a soil pH of 6-6.5 and group IB has a soil pH of 6.5-7. Group III could also be divided into two groups IIIA and IIIB. *Acer monspessulanum ssp. ibericum* is present in group IIIA, whereas, it is not present in group IIIB. Group IIIA has a soil pH of 8-8.1 and group IIIB has a soil pH of 8.1-8.3. In this manner, the soil pH, has been able to be a cause for differentiation of these two groups.

OM% of soil: This factor has been effective as principal determinant and differential ecological factor in the region. OM% of soil has been able to separate the range formation (group I) from the open forest (group IIA), close forest (group IIB), hydrophilic forest in the river margin (group IIC) and hydrophilic grassy (group IID) formations (Fig. 11). The formation of group I has an organic materials of 1-4% and group II has an organic materials of 4-12%. Therefore, this factor has been able to play a role as a principal ecological factor in the region.

The organic material factor has been able to divide the forest formation into three groups: group I has *Juniperus communis ssp. hemisphaerica*, *Acer monspessulanum ssp. ibericum*, *Ephedra major* and *Rhamnus pallasii* dominant species with 4-7.5% OM, group II has *Crataegus meyeri*, *Carpinus orientalis*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica*, *Rosa canina*, *Cotoneaster multiflorus* and *Prunus spinosa* dominant species with 7.5-8.79% OM and group III has *Carpinus betulus*, *Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia* dominant species with 8.8-12.46% OM.

In the releves 24, 27, 126, 129, 130, 163, and 164 (group IIIB) *Acer campestre* and *Quercus macranthera* are associated with *Carpinus betulus*, *Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia*; however, in releves 25, 26, 122, 123, 127 and 165 (group IIIA) the former species are not associated with the latter species. Group IIIA has 8.8-9.69% OM and group IIIB has 9.7-2.46% OM.

Similar results were obtained on the OM% by studying on the OC% as an ecological factor which has not been presented here.

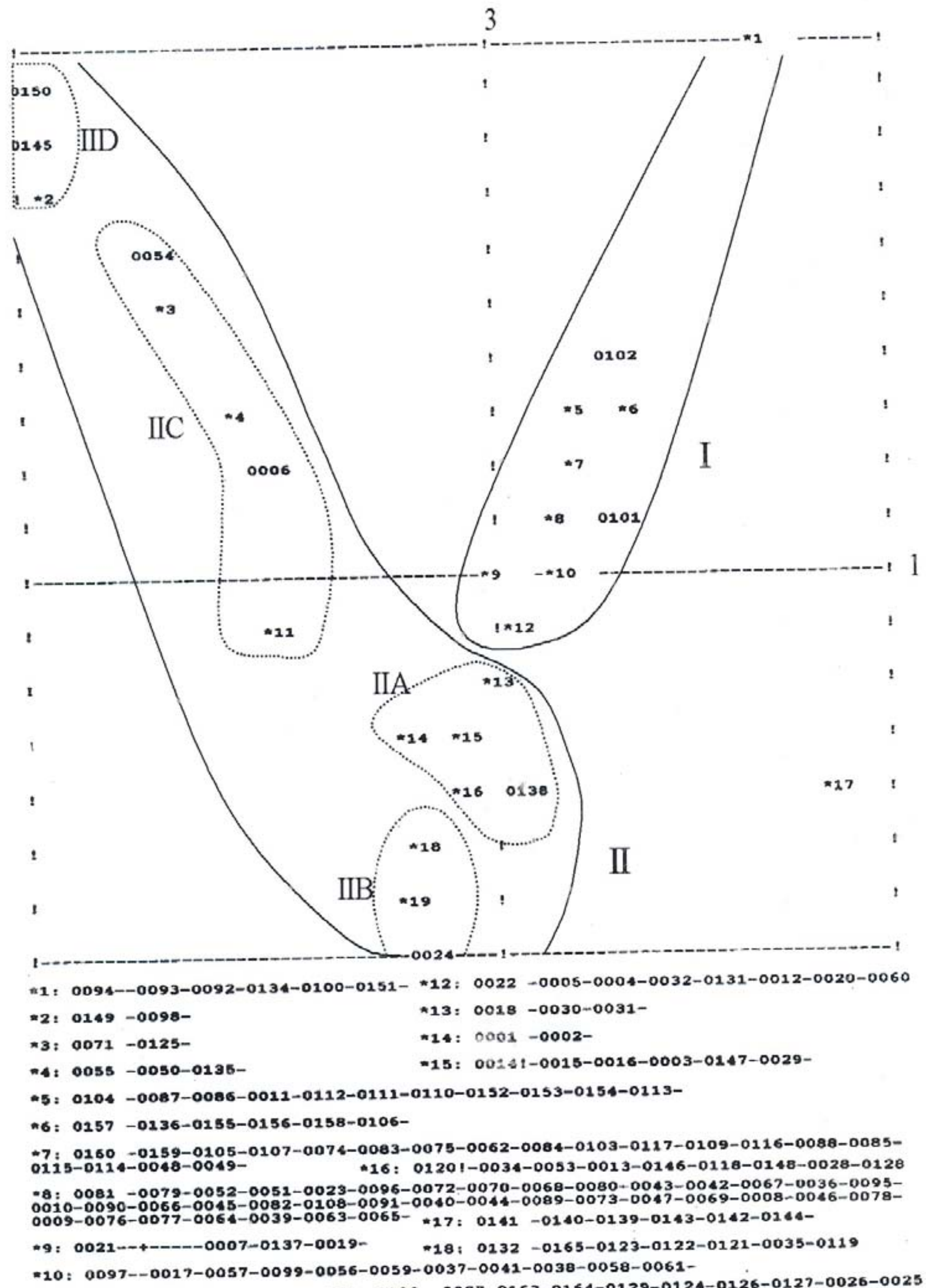

Fig. 11. Grouping releves on axes 1-3 obtained from F.C.A. by considering the ecological factor of OM% of soil.

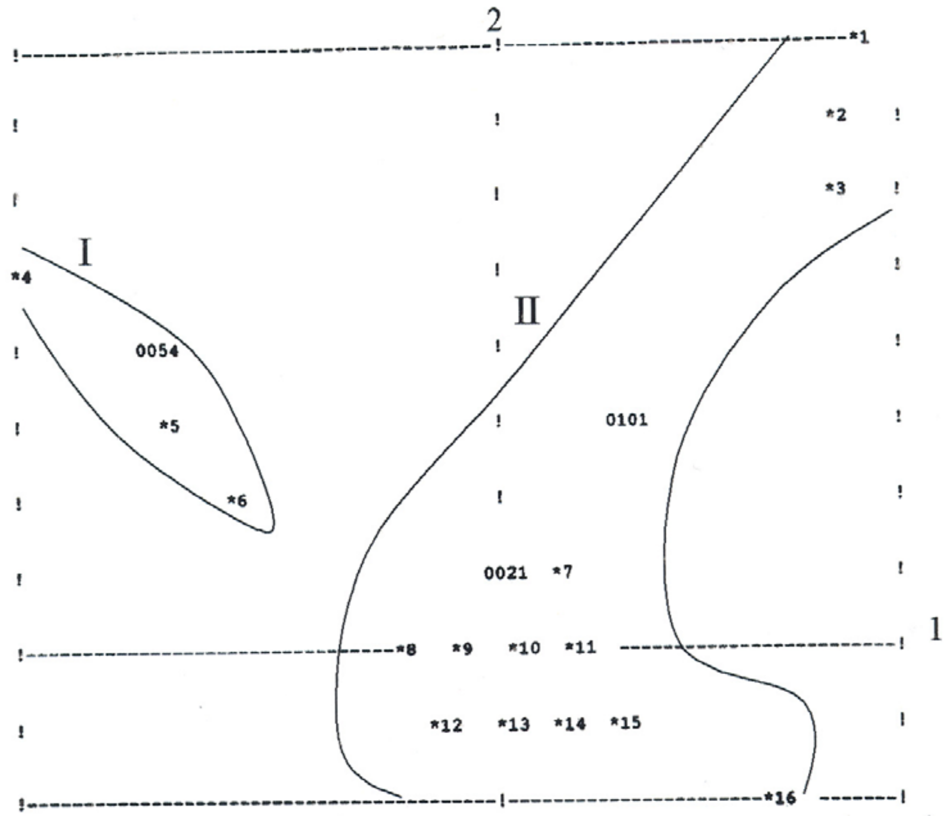

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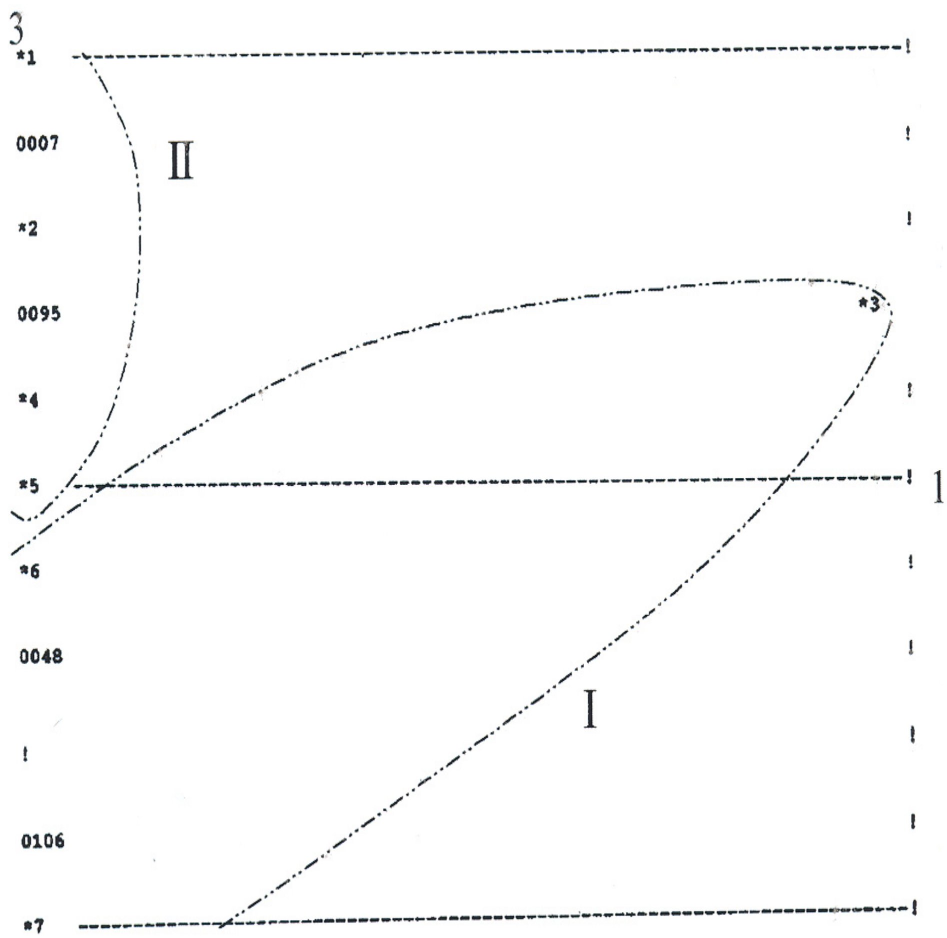
Fig. 12. Grouping releves on axes 1-2 obtained from F.C.A. by considering the ecological factor of slope degree.



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*7: 0136--0158-0155-0156-0157-

Fig. 13. Grouping releves on axes 1-3 of secondary analysis obtained from F.C.A. by considering the ecological factor of exposition in the range formation.

Slope degree: This factor has been effective as a principal ecological factor in the region. The ecological factor of slope degree divides some of the formations in the region as a principal ecological factor and subsequently, the formations of the region are divided into groups I and II (Fig. 12). Group I includes the hydrophilic grassy formation (releves 98, 145, 149 and 150) with *Ranunculus brachylobus var. major*, *Carex caucasica*, *Primula auriculata* and *Juncus inflexus* and the formation of hydrophilic forest in river margin (releves 6, 33, 50, 54, 55, 71, 125, 133, 135, 161 and 162) with species *Salix aegyptiaca*, *Salix alba*, and *Hippophae rhamnoides* with 5-10 slope degree and group II includes close and open forest, range and rocky formations with 10-50 slope degree.

Exposition: This factor has also been effective as determinant and differential ecological factor in the region. Both groups I and II could be separated in the range formation (Fig. 13). Group I includes southern, southwestern and southeastern expositions with *Astraglus verus*, *Cousinia chamaepeuce*, *Melica jacquemontii*, *Psathyrostachis fragilis*, *Stipa arabica ssp. arabica*, *Camphorosma monspeliaca*, *Salsola montana* and *Elymus longe aristatum* and group II includes northern, northwestern and northeastern expositions with *Artemisia chamaemelifolia*, *Diplotaenia cachrydifolia*, *Ferula ovina*, *Cervaria cervariifolia* and *Hippomarathrum microcarpum*.

In the flora of forest formation too, the ecological factor of exposition acted as a determinant factor. There are three groups which could be identified in the forest formation (Fig. 14). Group I includes southern, southwestern and southeastern expositions with *Carpinus orientalis*, *Crataegus meyeri*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica* and *Rosa canina* species. Group II includes the western exposition with *Prunus divaricata*, *Cerasus microcarpa*, *Ribes uva crispa* and *Cotoneaster multiflorus* Group III includes northern, northwestern and northeastern expositions with *Carpinus betulus*, *Quercus petraea subsp. iberica*, *Acer hyrcanum* and *Evonymus latifolia*.

This factor has been able to play a role as a differential ecological factor. The releves 29, 30, 131, 147(in group I) and 28, 148, 146 (in group II) have *Juniperus communis ssp. hemisphaerica* as dominant species. The species *Acer monspessulanum* ssp. *ibericum* in releves 28, 146, 148 is associated with *J. communis*; whereas, in releves 29, 30, 131, 147, the former species is not associated with this species.

Altitude from sea level: This factor has also been effective as principal and determinant ecological factor in the region. Altitude from sea level has been able to divide the formations of the region into two groups (Fig. 15). Group I has 1960-2600 meters and group II has 2600-3935m altitude. Group I includes the hydrophilic forest of the river margin (group IB), close forest (group IA1) and open forest (group IA2) formations. Group IA1 has *Carpinus betulus*, *Quercus petraea ssp. iberica*, *Acer hyrcanum* and *Evonymus latifolia* dominant species with 1960- 2400m altitude, group IA2 has *Crataegus meyeri*, *Carpinus orientalis*, *Colutea buhsei*, *Berberis vulgaris*, *Lonicera iberica*, *Rosa canina*, *Cotoneaster multiflorus* and *Prunus spinosa* dominant species with 2400-2600m altitude and group IB has *Salix aegyptiaca*, *Salix alba*, and *Hippophae rhamnoides* dominant species with 1960- 2600m altitude.

The four groups IIA, IIB, IIC and IID could be recognized in group II. Group IIA has *Bromus tomentosus*, *Artemisia chamaemelifolia*, *Cerasus pseudoprostrata*, *Rosa pulverulenta* and *Cotoneaster nummularioides* species with 2600-2800m altitude. Group IIB has 2800-3200m altitude. This group is divided into three groups of IIB1 (a part of

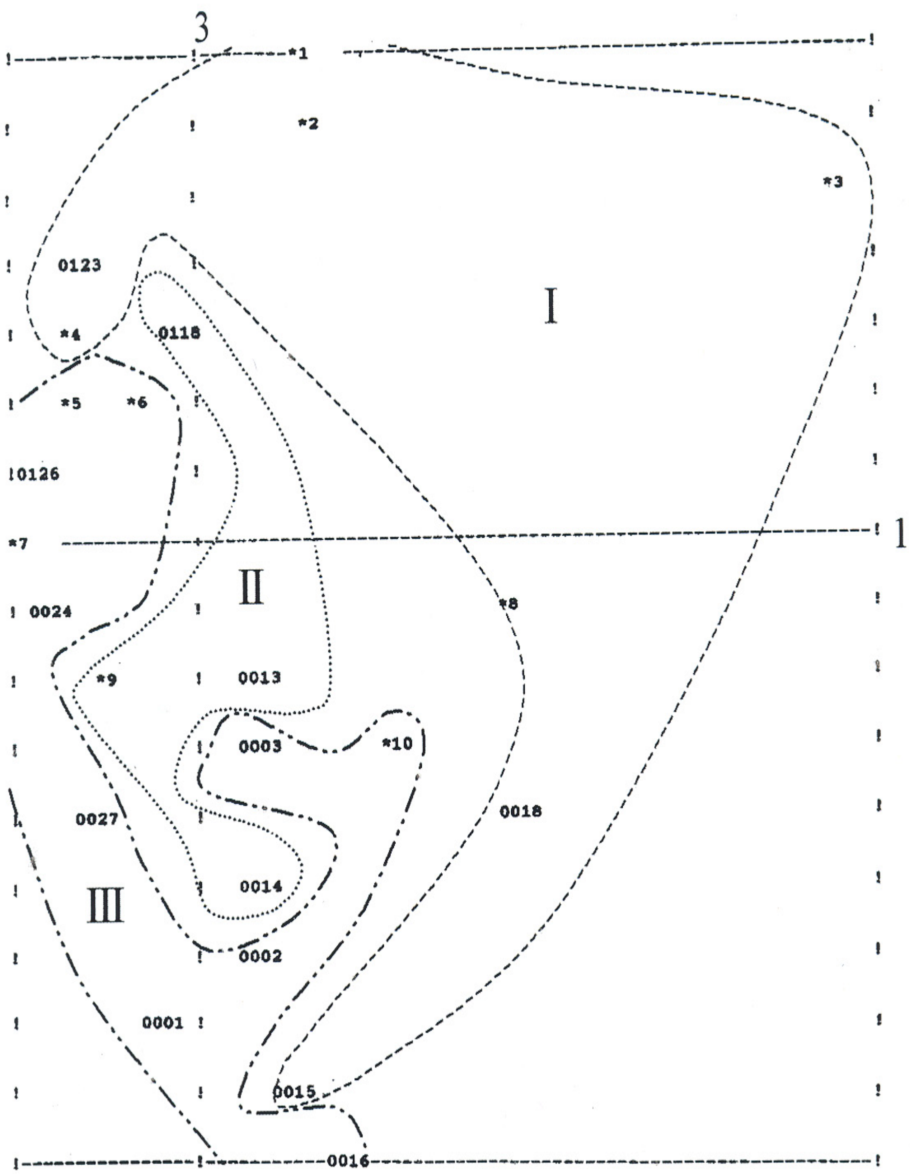

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Fig. 14. Grouping releves on axes 1-3 of secondary analysis obtained from F.C.A. by considering the ecological factor of exposition in the range formation.

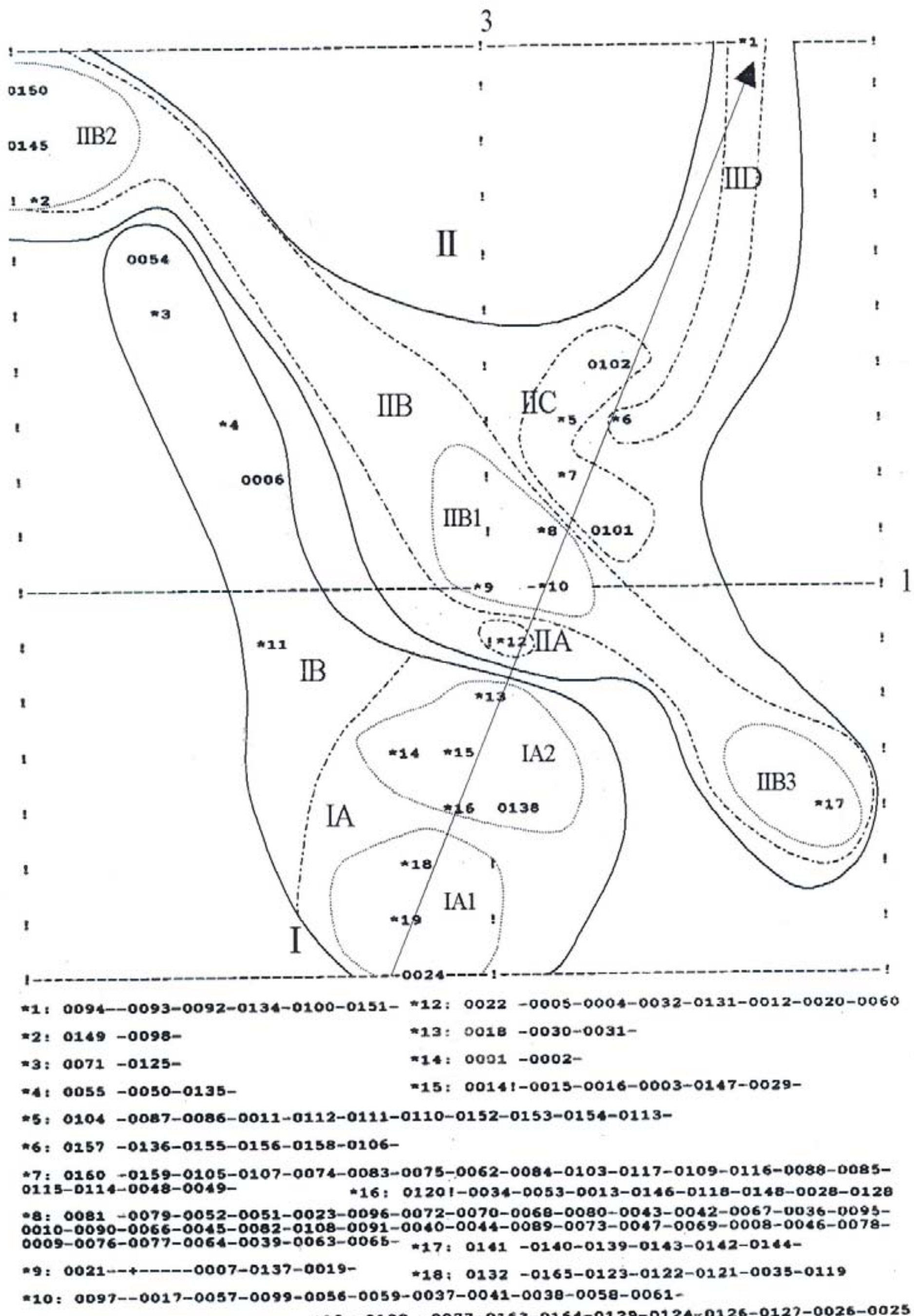

Fig. 15. Grouping releves on axes 1-3 obtained from F.C.A. by considering the ecological factor of altitude from sea level.

range formation) with species *Acantholimon hohenackeri*, *Alopecurus textilis*, *Diplotaenia cachrydifolia*, *Elymus longe aristatum* and *Agropyron pectiniphorme*, IIB2 (hydrophilic grassy formation) with species *Ranunculus brachylobus var. major*, *Carex caucasica*, *Juncus inflexus* and *Primula auriculata* and IIB3 (rocky formation) with species *Parietaria judaica*, *Satureja isophylla*, *Alyssopsis mollis*, *Arabis caucasica* and *Silene commelinifolia*. Group IIC has species *Bromus tomentellus*, *Cousinia multiloba*, *Acantholimon erinaceum*, *Camphorosma monspeliaca* and *Trifolium radicosum* with 3200-3500m altitude and group IID has species *Jurinella microcarpa*, *Myosotis lithospermifolia*, *Physoptychis gnaphaloides*, *Stipa lessingiana* and *Androsace villosa* with 3500-3935m altitude from sea level. Therefore, this factor has been effective in separation of the flora of the range formation from the other formations and division of flora of this formation.

Discussion

The present study showed that different ecological factors do not have similar importance and effect in the region; in such a manner that a number of ecological factors have been effective as principal factors that are: moisture, pH, OM%, OC% of soil, altitude and slope degree. They have been able to affect on formations; some factors could be effective as determinant factors; including: moisture, texture, pH, EC, OM%, OC%, lime % of soil and exposition. These factors have been effective in the separation of the flora of a formation. Some factors are effective as differential ecological factors; including moisture, PH, EC, OM%, OC%, lime % of soil and exposition. These factors have been effective in the separation of a part of flora of a formation.

The present study shows that in studying the vegetations and determining ecological factors, employing ecologic and phytosociologic criteria as eco-phytosociology (Atri, 1996) are not only suitable and exact in the data collection stage to determine the placement of releves, but also it is able to provide results which conform and agree to the rules that govern the nature in the analysis and result interpretation stage.

Acknowledgements

We are grateful to Dr. A. A. Maassoumi and Dr. V. Mozaffarian for helping to determine some of the species. We would like to thank the staff of Tehran University, Agriculture Higher Education Center and Research Institute of Forests and Rangelands for providing us with various facilities which made this research possible.

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(Received for publication 17 February 2003)