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Description of Range Lands of Iran Range Problems in Iran Vegetation of Nevada

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DESCRIPTION OF RANGE LANDS OF IRAN

by

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

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Nasser Golesorkhi

INTRODUCTION

Aim and purpose of this report

Taming and husbandry of animals is undoubtedly the oldest industry in Iran. The productive range lands are one of the most important natural resources of the country.

According to recent statistics (Ardalan, 1955) there are, in Iran, about 31,378,000 head of sheep and goats which are almost entirely dependent upon natural ranges for food. If each animal consumes only one rial (1.5 cent) of forage each day, the annual cost of range forage used by sheep and goats will be about 11,450,000,000 rials or $144,000,000.

The importance of livestock products on the economical and industrial life of a country like Iran, where 75 to 80 per cent of its population is engaged with agriculture, can never be denied.

The quality and quantity of these products are continuously decreasing because of misuse of the range lands throughout centuries. Large portions of the productive grazing lands are already converted to true deserts.

Unfortunately, nothing has yet been done for the protection and management of these vital resources, although fundamentally conservation must be a strong doctrine in our religion.

This paper is a preliminary evaluation of the range lands in Iran. Because of lack of reliable information, it is neither complete nor free of errors, but it is hoped that it will open the subject for further studies in the future.

PHYSICAL DESCRIPTION OF IRAN

Iran in geological ages

Most geological studies of the plateau of Iran have come to the conclusion that this region was submerged during the third geological age (Pirnia, 1941). Toward the end of this age the plateau was exposed, but had an entirely different shape.

The Caspian Sea has always been located on the north as at present, but was at one time connected to the Black Sea and Oral Lake. Together they composed a large sea on the northwest of Asia, so that the Caucasian Ranges of mountains which now form the western coast of this sea were at one time located almost south of the Caspian (Pirnia, 1941).

Geologists believe that the Persian Gulf on the south of the plateau once had an entirely different shape. This gulf was connected to a large lake which covered the territories of Mesopotamia (Iraq), Syria, and extended to the mountains of Lebanon. Glaciers covered the entire area of Iran, Caucasia, Armanistan, and continued to central Asia in the end of the third period. During the fourth age heavy rains melted some of the glaciers; large bodies of water collected on the lowlands of the plateau. These heavy rains also washed soils from high elevations and deposited a thick layer of sediment on the valley bottoms and lower lands of the plateau (Pirnia, 1941).

Under this sediment there is a thick layer of gravel and sands. In some areas such as Zabol-Shooshter, Lorestan, etc., the depth of this layer is over 300 meters. The water of the lakes formed at the beginning of the fourth age was salty and resulted in reduced fertility of the plateau.

As quoted by Pirnia in 1941, Demorgan has stated that geological changes in western Asia and the plateau of Iran during the third geological age were more significant than the changes which occurred in Europe during the same period.

Geological formation

Little is known with certainty of the geology of wide areas of Iran, notably in the north and east. The search for oil has made the southwest the best known region. Recent investigation has provided information concerning the structures and deposits of the central plateau.

A pre-Cambrian land surface subsided locally in Cambrian times. Limestones and shales with rock salt and gypsum beds were laid down in the Zagros and in central Iran. Quiescent conditions during the Paleozoic era were interrupted by the subsidence which led to Devonian deposits in the northwest. In Permian times the country was covered by the great Tethys Sea with shore lines to north and south near the present frontiers of Iran, except for the great gulf covering the present site of the Caspian Sea. Within the Tethys Basin were laid down the thick Yuranic limestones of the Zagros.

In middle Cretaceous times intensive folding affected the Iranian area and narrowed the Tethys geosyncline, but heavy sedimentation still went on toward Mesopotamia, upper Cretaceous deposits, mainly limestones, being laid down in the southern Zagros region to a thickness of 3,000 feet. During the Tertiary period deposition continued but in a steadily shrinking sea. Renewed pressure from inner Asia in Pliocene times led to the intense folding which moulded the Zagros Ranges into their present form, a great series of parallel folds running northwest to southwest. The east-west folds of the Mokran and those with a southwest to northeast

trend reaching toward the Suleiman Mountains originated at the same period. In the northwest movement was mainly along the fault lines already established and was accompanied by intense volcanic activity.

Though there is still room for much disagreement over details, the broad picture of the structure of Persia seems tolerably clear. The central plateau, if not an actual fragment of either Angaraland or Gondwanaland, appears to have acted as though it were, transmitting to its margins the outward pressures originating from the former; i.e., from the northwest. Though the Zagros Ranges have a long geological history, they are mainly the result of these pressures as exerted in Tertiary times. The northern ranges, including the Alborz, have a similar origin, though too little is known of them to fix the age or detailes succession of the earth movements which formed them (Encyclopaedia Britannica).

Physical geography

This country with the total land area of about 164 million hectares, 628,000 square miles, or 425,244,000 acres is located between 24" and 40" parallel of latitude and 44 to 64 meridians of longitude.

All Iran is a plateau except the Mesopotamian belt which includes the plain of Khuzistan in the southwest at the head of the Persian Gulf; the lowlands surrounding the Caspian Sea; and the valleys of the Hari-Rud and Hirmand River on the Afghanistan border (Murrey, 1950).

The elevation of the plateau decreases from 1600 meters (5253 feet) to 1050 meters (3443 feet) from south to north. The lowest part of the plateau is in the Desert of Loot of 609 meters (2000 feet) (Pirnia, 1941).

This great plateau of roughly triangular shape in central Iran and continuing to some extent eastward into Afghanistan and northwest

Pakistan is bounded on the north by Alborz Mountain. At its eastern margin it breaks into subsidiary ranges extending across the Afghanistan frontier to the Hindukosh. On the southwest and south it is bounded by the complex series of chains of the Zagros Mountains, which extend from Kordestan in northwest Iran as far south as northwest India.

East of Bandar Abbas one branch of this fold system swings southward and reappears on the other side of the Gulf in Omman, while the other branch, of very different structural and stategraphical composition, continues eastward into Pakistan.

This central plateau includes vast areas of salt and sand deserts, generally barren, uninhabited, and considered as one of the hottest spots in the world (Campbell, 1926).

It would be incorrect to give the impression that Iran is a country consisting almost wholly of rocky mountains, snow-covered in winter and bare and forbidding in summer. Actually, all extremes from salt marshes to humid forests can be found in this country.

The Alborz Range of mountains is one of the great mountain chains of the world at an average height of over 10,000 feet. Six peaks are higher than 13,000 feet and one, Mount Damavand, a magnificent volcanic cone, is about 18,603 feet high.

The Zagros Range is in effect not a single mountain but a series of chains rising to 15,000 feet in maximum.

The green foothills, valley bottoms, and high vegetated ridges of this range support the most important grazing resources of Iran.

Climate

Generally speaking, Iran is a mountainous country. Therefore, great variations exist in its physical features, and as a matter of fact, the

climate changes from subtropical to true temperate within a short distance.

This striking variability in environment is due to several factors.

Latitude range. While the country consists of a rather compact land mass, the greatest dimension extends in a northwest, southeast direction covering some 15 degrees of latitude. This situation in itself results in a considerable difference in the length of the growing season. As an example, it might be noted that while fall-sown barley was heading out near Bushehre in early March, the fall-sown wheat at Khoy in northern Azarbayjan was still in tillering or stooling stage in early May, and spring grain was just being sown (O. C. I., 1949).

Altitude differences. There is a great variation in altitude at which farming and animal husbandry is carried on. Even in the central deserts, mountains are never out of sight. Thus, farming and livestock production is carried on from sea level along the Persian Gulf and Caspian Sea to elevations of 9800 feet or more above sea level in higher mountains. The variation in altitude or elevation influences such factors of environment as length of growing season, temperature extremes, annual precipitation, and sunlight intensity.

Those factors, in turn, determine the kinds of crops that can be grown, the season of livestock grazing, etc.

Temperature. The temperature is variable as a result of change in latitude and altitude. The fluctuation between the day and night temperature is not great in the coastal zones (Caspian Zone and Gulf Zone), while the significent difference between day and night temperature in the Plateau Zone (desert and steppe regions) is the unique characteristic of this area.

The annual and monthly mean temperature of certain areas which have reliable weather stations is shown in table 1. There are some unusual temperatures recorded on the high plateau of Iran: for example, 110° F. at 5000 feet and 93° F. at 8000 feet (Deh bid area).

Precipitation. The existing climatological data for Iran are not dependable because of several factors:

1. The number of the weather stations per unit of area is low. Actually there is only one weather station per 33,000 square kilometers. In a mountainous country like Iran, orographic effects play a great part in determining quantity and distribution of precipitation so that the local variation in precipitation is considerable.

2. Regarding topographical distribution of meteorological stations, all the existing stations are located below an altitude of 2,000 meters (6500 feet) in the comfort of valleys and in or near towns. As a result, there is no reliable information as to variation of precipitation with altitude. One serious feature arising from this lack of precipitation stations at heights above 6500 feet is that the lasting snowfall, which persists during the winter months, is not recorded at all, while the area above 6500 feet altitude amounts to 280,000 square kilometers. It is estimated roughly that the average annual precipitation over this area contributes about 30 per cent of the total national annual precipitation (O. C. I., 1949). The implements and apparatus used for measuring precipitation are old and not up-to-date.

The distribution of rainfall is very unsatisfactory, especially on the Plateau Zone. The precipitation falls during the period between October and May. One of the months from December to March might be the wettest month of the year. The per cent and distribution of snowfall is

Table 1. Variations of monthly mean temperature in Iran (Fahrenheit)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Lankoran	38	40	45	54	65	74	77	77	71	61	52	43	58
Mashhad	34	37	46	56	67	74	77	74	66	56	47	39	56
Teheran	35	41	49	60	70	80	85	84	77	64	53	42	62
Isfahan	35	41	49	59	68	78	82	79	73	62	50	40	60
Seistan	46	51	59	71	80	86	91	88	80	68	56	46	69
Hosseinabad	45	49	60	70	82	89	91	89	79	67	59	50	69
FAO 2	51	55	62	70	80	86	91	91	83	75	66	55	72
Bushehr	58	59	65	74	82	86	90	90	87	79	70	61	75
Jask	67	68	73	80	85	90	91	89	87	83	76	71	80

This table is reproduced from Vol. 17, Encyclopaedia Britannica.

Table 2. Annual rainfall in Iran

Station	Lat. N.	Lon. E.	Altitude (ft)	Period of observation (year)	Annual rainfall (inches)
Lankaran	38-46	48-51	-66	50	41.62
Marve	37-35	61-47	686	1	6.36
Urumia (Sair)	37-28	45-8	6,225	1	21.51
Resht	37-17	49-39	-50	2	56.45
Ashuradeh	36-54	53-55	-80	19	17.07
Asterabad or Gorgan	36-52	54-26	-70	7-8	16.28
Meshhad	36-16	59-35	3,107	26	9.22
Teheran	35-41	51-25	4,002	25	9.35
Isfahan	32-40	51-44	5,815	27	4.49
Seistan	31-0	62-0	2,000	9	1.88
Hosseinabad	30-52	61-23	1,600	3-5	2.20
Bushehr	28-59	50-53	14	44	10.39
Jask	25-44	57-47	13	28	4.51

This table is reproduced from Vol. 17, Encyclopaedia Britannica.

also very irregular and variable; in the maritime areas a fall of snow is naturally a very rare occurrence. In the highlands, on the other hand, areas above 4,000 feet are liable in any winter to be under snow weeks during December to April.

The intensity and frequency of rainfall is also very spasmodic and irregular. In some areas 50 per cent of the total annual precipitation falls in one day; for example, 5.53 inches is recorded at Bushehr (total 10.39 inches in one day, and more than one inch at Hossien Abad (annual total 2.20 inches). As will be discussed under the proper topics, precipitation is heaviest on the littoral of the Caspian Sea, southwest mountains, and at the head of the Persian Gulf. On the northern slopes of the Elborze Mountains, i.e., the Caspian Sea littoral, the rainfall averages about 21 inches and decreases southward.

According to O. C. I. (1949) Iran may be divided broadly into three major weather regions differing especially in rainfall.

1. Northwestern Iran and south Caspian littoral.
2. The mountain ranges and the plateau south and west of the Alborz Range.
3. The southern plains and the Persian Gulf area.

The topography is the chief factor in determining the distribution of rainfall, and as precipitation comes from the west or south, locations near the west or south edge of the mountain mass receive the earliest and also the largest amounts.

Wind. There are two major wind currents in Iran, one from the northwest which is the continuation of the currents of North America blowing above the Atlantic Ocean towards the Mediterranean Sea, Asia Minor, and finally to Iran and India (Pirnia, 1941).

The other current forms over the Indian Ocean and passes over Iran towards west and northwest Asia. The direction and period of the winds are northwesterly in fall and winter and southeasterly in the spring and summer. The velocity of the winds is destructively high in the east and southeast of the country (Kerman and Siestan area) and sometimes surpasses 70 miles per hour. These areas are subject to considerable wind erosion. Terrible sandstorms are very common.

The local windiness of the country is attributable to the juxtaposition of mountainous areas to vast flat tracts of low lying land, causing sudden changes of temperature in the atmosphere and air currents (Murrey, 1950).

Soil

Little is known in regard to the soil of Iran. In a reconnaissance survey made several years ago of almost all parts of the country with the exception of the northwest (Azarbayjan), two distinct groups of soils with variations of each were observed. The first group, in which the soils are under humid conditions, is quite distinct from those soils which are under arid conditions. A third group of soils may also be added by distinguishing those soils which have been developed in mountain conditions (Murrey, 1950). These major soil types will be discussed under the appropriate topics.

Two important soil problems are becoming very serious in Iran: (1) salinity and (2) erosion.

The chief obstacle to cultivation found so far in the soils of Iran is the presence of salt, particularly sodium chloride. In general the lands bordering the inland salt lakes are salted beyond toleration of normal plants. The soils of the southeast coast areas and the Mokran coast also contain a high proportion of salts. In Khuzistan in 1943,

analysis of soils from the Hamydieh areas showed total soluble salts to vary between 0.25 per cent and 4.05 per cent with a sodium chloride content rising as high as two per cent. The soils generally contain gypsum, sometimes in large amounts (Murrey, 1950).

The soils of Iran, in common with vast tracts in the Middle Eastern countries, are undergoing a steady process of erosion. This process is, in fact, found in almost all hill tracts throughout the world where vegetation is scanty due to light rain, great extremes of temperature, and high wind velocities.

In general, the factors of steepness of slopes, overgrazing, denudation of the vegetative cover for fuel, clearing of forests, lack of crop rotation, non-application of animal manure to the ground, etc., are together intensifying erosion in Iran (Murrey, 1950).

GEOBOTANICAL CLASSIFICATION OF RANGE LANDS IN IRAN

Although the flora of Iran seems to have been most thoroughly collected by foreign and native scientists, not so definite and reliable ecological classification exists today. Some ecologists have based their studies on climatic variations, while others have depended mostly upon the vegetation. Climatic classification cannot be accurate and on the other hand, because of severe over-use for many centuries, existing natural vegetation probably inadequately represents the potential condition of the country, a satisfactory ecological classification will require considerable research efforts.

The classification presented in this paper is based almost entirely upon climate and geology. This break-down will enable us to review some of the vegetational formations proposed by the former and present botanists.

Review of literature

There are controversial opinions on ecological classification of Iran. Tschermak (1950) divides the country into two major zones as follows:

1. Steppen V. Prarrian which consists of foothills, valley bottoms, plains, etc., of the central plateau, northwest and western Iran and eventually ends up by central Asiatic Turkistan desert.

2. Truken Wusten, which covers the south, southeast, and plain of Gorgan. This zone starts from the eastern part of the Arab-peninsula and extends eastward to Afghanistan and west Pakistan.

In this classification the Caspian area (with an elevation of about

85 feet below sea level) is included in the steppe region; apparently the author does not consider any regional climatic condition in this area and gives the impression that the restricted humid belt of the Caspian is a local or topographical change in the normal vegetation pattern of the whole zone.

Hardy (1925) thinks that the vegetation of western Iran (western slopes of Zagros Mountains) is strongly influenced by Mediterranean climate, and finally he concludes that the presence of the live-oak and the other evergreen hard-leaved trees and shrubs are the best indicator of this similarity and influences.

Drude (quoted by Campbell, 1926) includes the islands of the west coast of Africa, Azores and Canaries, and all of Asia-Minor as far as Persia and Mesopotamia in the Mediterranean Province.

Boissier* does not think that the steppe areas in Iran are quite sim lar to the Mediterranean regions, and he classifies this area as "true Oriental region" with its particular flora.

Rechinger (1939-1951) suggests another, more detailed classification which will be discussed in this paper.

All of the ecological reconnaissance studies have been concentrated on large sized plants such as trees, shrubs, etc., while grasses and forbs have been neglected almost entirely.

All of these investigators emphasize the importance of the endemic species of trees and in one case Rechinger (1951) names the grass and legume families as the indicator of the Mediterranean region in the west of Iran.

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*Information obtained from Dr. E. Esfandiari, former professor of Botany, College of Agriculture, University of Tehran.

As has been mentioned before, the pattern suggested by Rechinger (1939-1951) and Boyko (1955) will be followed in this paper, but for the convenience of discussion, the whole country can be divided into three major zones as follows: (1) Caspian Zone, (2) Gulf Zone, and (3) Plateau Zone (Plate I).

Caspian Zone

Description. This zone is a narrow margin laid down on the northern slopes of the Alborze Range of mountains bordered by the southern coast of the Caspian Sea. This area extends to the plain of Gorgan on the east and to the Aras River on the west. This river separates this zone from the green steppes of Russian Moghan and Iranian Azarbayjan.

The foothills and high elevations of the Alborze Mountains located on the south of this zone are covered mostly with magnificent deciduous forests.

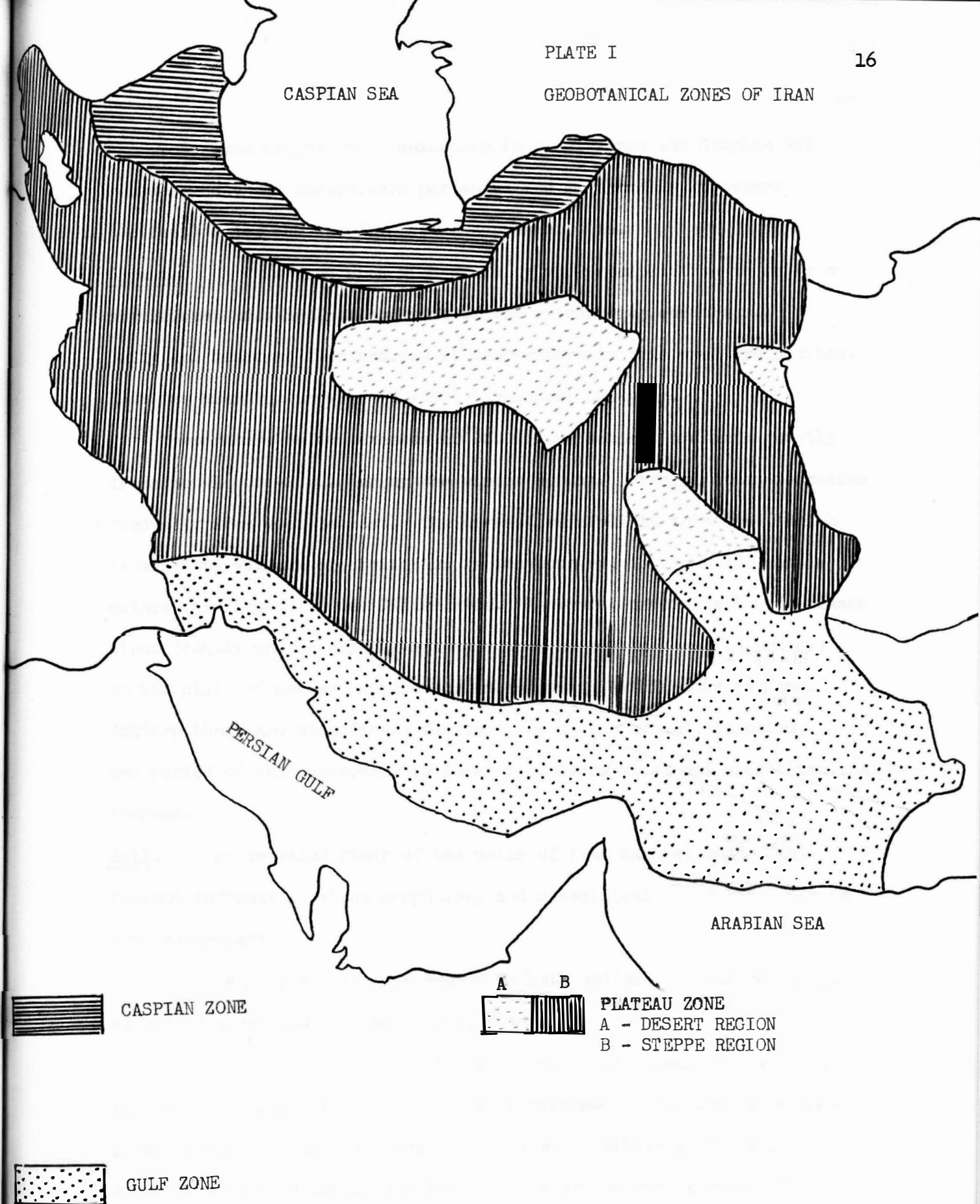
These forests have been severely overused and abused for centuries, especially in the past few decades. The virgin hardwood species have been replaced by dense stands of spiny brush and shrubs.

Generally speaking, the forests of this zone can be classified into two major groups: (1) Caspian forests and (2) Aras forests. There are 3,300,000 hectacres (8,154,000 acres) of forests in the Caspian area and 1,300,000 hectacres (3,212,000 acres) in the Aras area (Sabeti, 1948) (Sai, 1951). The major species of these forests will be discussed under another topic in this paper. At the present time, the dense forests can be found only on steep slopes of high elevations far from highways and populated areas.

These forests furnish the fuel needs for a large portion of the country as well as wood and timber.

PLATE I

GEOBOTANICAL ZONES OF IRAN



This zone is gradually enlarging in size, since the Caspian Sea recedes about two centimeters per annum and is actually 26 meters (85 feet) below the sea level at the present time.

Climate. This zone with high humidity and precipitation is quite a significant area in Iran and most of the neighboring countries. Daily and seasonal fluctuations of temperature in this area are limited. Relative humidity is high (80-100) throughout the year.

Temperature seldom exceeds 40° C. in the summer, and infrequently drops to -1° or -2° C. during the winter months. Precipitation decreases gradually from west to east. The highest rainfall in this zone, which is also the maximum precipitation in the country, is about 170 centimeters (55 inches) in the Gillan area. Eastward, precipitation decreases significantly and is usually not more than 40 centimeters (13 inches) on the plain of Gorgan and the Turkaman plain. Within this regional pattern there are significant fluctuations in the amount, duration, and period of rain according to local or topographical and microclimatical changes.

Soil. No detailed study of the soils of Iran has yet been done. Present information about morphology and classification of the soils is very elementary.

Soil development in this region is both sedimentary and residual, depending upon locality (Murrey, 1950).

As a result of variations in parent material, frequency, season, and amount of rainfall and many other environmental factors, some subzonal types of soils have developed in some localities. These subzonal types can be mostly distinguished under the two extremes of rainfall; for example, the soil at Gorgan plain (13 inches annual

precipitation) is developed as steppe type, while the soil at Lahijan (55 inches annual rainfall) is a lateritic type with highly acid reaction. With the exception of the lateritic types of soil ($_{p}$H. 5-5.5) the rest are calcareous.

The soil texture in this region varies from paddy clay (in some rice fields) to fine silt loam, and is underlined at variable depth by rock and fine sands.

The dominant colors of the soils when dry are gray-brown, brown, dark brown, and black, while the lateritic soil colors vary from reddish-brown to red. Generally speaking, the soils are highly fertile, and in areas not subject to erosion have a relatively good depth and high organic content. The acidity also decreases along with precipitation from west to east (Murrey, 1950).

Vegetation. It is difficult to give a true ecological picture of this area because extreme variations of ecological factors such as topography, soil, and climate occur within short distances. Some investigators such as Dr. E. Gauba*, Hardy, Drude, etc., have concluded that this zone has a Mediterranean climate and consider some endemic species as indicators of the Mediterranean elements.

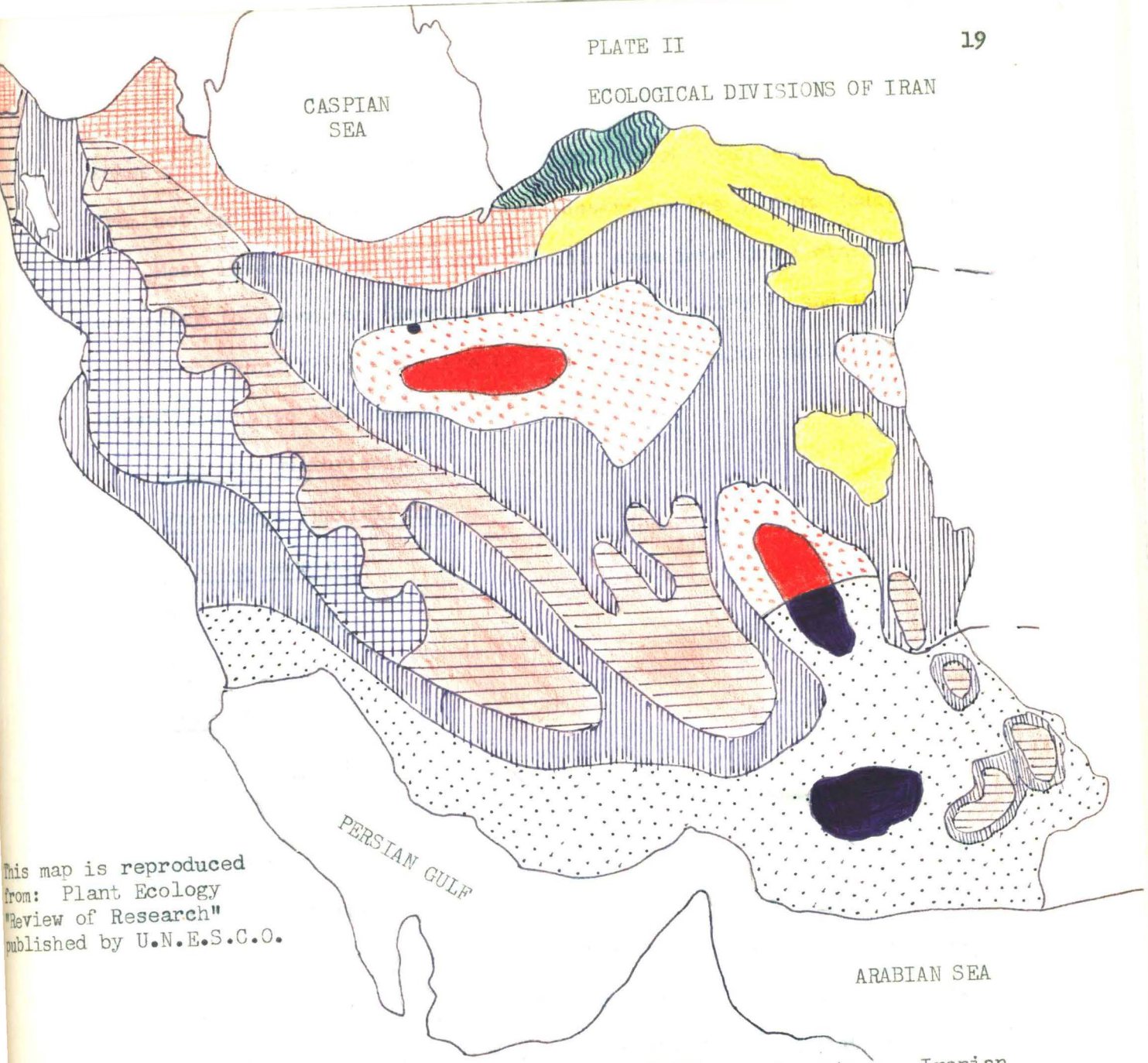
Rechinger (1939) and Boyko (1955) divide this zone into two ecological formations (Plate II): humid forest belt (Calchic Caucasian) or Hyrcano Calchian forests.

This formation covers the high rainfall areas on the western wing of the Caspian, extending to the Aras River in the northwest of Iran. This area is a true forest climax and according to elevation, different

*Dr. E. Gauba, formerly professor of Botany at the college of agriculture at Karaj, was captured and sent to Australia during the war and is still living in that country.

PLATE II

ECOLOGICAL DIVISIONS OF IRAN



This map is reproduced from: Plant Ecology "Review of Research" published by U.N.E.S.C.O.

Humid Forest belt
"Colchic - caucasian" after Krause
Hyrcano - Calchian after Rechinger

(a) Mauretano - Iranian
(b) Irano - Turanian Steppe

Arid border - forest belt (b - f. belt)
a(mauretano - Iranian)
b(Anatolie Iranian forest belt)

Central Asiatic or Turanian Steppe

Kurdic - Iranian mountain steppe
(Hockgebirgssteppe after Rechinger)

a b
Central Asiatic Semi-deserts (a) and desert (b)

Afghano - Iranian mountain steppes

a b
Saharo - Sindian Semi-desert (a) and desert (b)

zones and associations can be classified. These forests are protected from hot and dry winds of the central desert by the Allborz Mountains.

Most investigators have divided this area into three classes according to elevation (Rechinger, 1939) (Sabeti, 1948), and (Sai, 1951).

Rechinger (1939) names the following as the major species for elevations up to 1000 meters (3200 feet).

Albizzia julibrissin

Pterocarya fraxinifolia

Parotia persica

Diospyros lotus

Acer laetum

Acer inssignae

Gleditschia caspica

The climax vegetation of the low elevations has been severely disturbed and actually replaced by a thick stand of bushy and shrubby vegetation. Rechinger considers Quercus macranthera and Quercus castanaefolia as the dominant species for the zone above 1000 meters. A pure stand of Fagus orientalis can sometimes be found in this area.

On elevations above 2000 meters (6500 feet) the vegetation pattern changes completely, and high quality timber species give their place to Astragalus and eventually to grass lands. The species of these grass lands will be discussed in the next paragraph.

According to Rechinger, Albizzia julibrissin, Parotia persica, Gleditschia caspica, and Quercus castanaefolia are endemic species of this belt, while the Pterocarya fraxinifolia, Acer laetum, Diospyrus lotus, and Zelkova are indicators or Hyrocano calchian forests.

Some Mediterranean species such as Periploca gracea, Smilox, and

Tamus can also be found in this area.

Coniferous trees are seldom found in these forests. Taxus baggata is present on the wet sites and Cupressus sempervirence (var. horizentalis) occurs on drier sites. Pinus, Picea, Abies, and Rhododendron are absolutely absent. This is one of the significant evidences which separates these forest types from Calchic forests of Hindukosh mountains (Rechinger, 1951).

Many species are present in the understory of these forests. Some of them represent Euro-Siberrian elements such as:

Parietaria erecta

Prunella vulgaris

Mercurialis prenne

Asperula odorata

Deciduous forest is the climax vegetation of this area, and as soon as it is disturbed by fire, lumbering, farming, or other factors, shrubs, spiny bushes, forbs, and grasses cover the area rapidly.

There are 4,600,000 hectares (11,346,000 acres) of forests in this zone which can be divided in two major types:

1. Aras forests 1,300,000 hectores (3,212,000 acres)
2. Caspian forests 3,300,000 hectores (8,154,000 acres)

The major species of the Caspian forests have been briefly discussed before.

Aras forests. These forests are located on the southern slopes of the continuation of the Alborz Mountains into northwest Iran (Azarbayjan). They totally cover the area of 3,212,000 acres. These forests are not as dense as Caspian forests and appear as sparse communities on the favorable sites.

The dominant species of these forests is Juniperus polycarpus. Other important species are as follows (Parsa, 1935) (Sabeti, 1948), and (Sai, 1951):

Acer monspessulanum

Acer opulifolim

Amygdalus reuteri

Amygdalus aspartioides

Celtis caucasica

Cotoneaster numularis

Crataegus ambigua

Fraxinus oxyscarpa

Juniperus sabina

Pistacia vera

Pistacia mutica

Populus hybrida

Prunus divaricata

Ribes grossularia

Salix accomophylla

Salix purpurea

Sorbus aria

Central Asiatic or Turranian steppe. Originally this grass land climax is bounded by humid forest belts on the southwest, Afghano-Iranian mountain steppes on the east and southeast, and finally by Central Asiatic semi-desert on the north.

Rechinger (1939-1951) thinks that the Turranian elements are dominant all through this area. The presence of the different species of Agropyron and Bromus indicate the Turranian elements. This area

has been populated for many, many years and has always been considered as one of the best livestock areas in Iran.

The Turkaman tribes, apparently of Mongolian origin, have occupied this plain for the last several centuries. As a result of heavy use during thousands of years, the climax vegetation has almost disappeared in this area. Perennial species can only be found in some relicts which have been too far from the water. Present vegetation is predominantly annuals with low grazing value, with some good perennials. At present the major species on this plain are as follows (Parsa, 1935-1949-1955):

Agropyron cristatum

Agropyron sibericum

Agropyron intermedium

Agropyron tricopherum

Agropyron juncea

Bromus variegata

Bromus sp.

Cynodon dactylon

Festuca sp.

Phalaris minor

Phalaris sp.

Stipa tortilis, etc.

It should be mentioned that no detailed study has yet been made of the vegetation of this area. Almost all investigators have paid more attention to the forests rather than to this plain.

Range resources and management. According to the season of use, the whole Caspian zone can be divided into three major grazing belts:

1. Lowlands or winter pastures

2. Midlands or spring and fall grazing areas

3. Highlands or summer ranges

Winter pastures. The lowlands, consisting of brush, marshes, meadows, deserted and fallow agricultural lands, are considered as winter pastures. With some exceptions, the quality of the forage is not good in this type of pasture.

The Plain of Gorgan is classified as winter and early spring pasture. It should be emphasized that with the exception of Gorgan Plain, the other winter pastures are disturbed timber lands which have become covered with dense stands of shrubs and brushes. At present the major shrub species are as follows (Parsa, 1935-1949), (Sabeti, 1948), and (Sai, 1951):

Crataegus sp.

Malus pumila

Prunus spp.

Punicca granatum

Pyrus sp.

Sambucus sp.

The important grass species are:

Agrostic spp.

Bromus inermis

Bromus tomentellus

Bromus sp. (annual)

Cynodon dactylon

Dactylis glomerata

Hordeum bulbosum

Lolium prenne

Lolium multiflorum

Paspalum dilitatum

Phalaris tuberosa

Phalaris minor

Poa pratensis

Poa spp. (perennial)

Poa spp. (annual)

There are also good legumes growing in mixture with grasses in good pastures.

Medicago sativa

Medicago lupulina

Trigonella monatha

Trifolium pratense

Trifolium hybridum

Trifolium repens

Trifolium arvense

Trifolium resupinatum

Lotus corniculatus

Lotus sp.

The most abundant species of the marshlands are:

Typha minima

Typha angustifolia

Phragmites spp.

Carex sp.

Atrendinarea spp.

Cattle and sheep graze in this division until almost the end of March.

No grazing management is ever practiced here. Livestock, especially cattle, are turned loose on these pastures for the whole season. Some of the settled farmers who keep small numbers of cattle or sheep use these pastures for year-long grazing.

This division is located within limited degrees of elevation which starts from 26 meters (85 feet) below sea level (Caspian level) to 200 to 300 meters (600 to 1000 feet) above.

Spring and fall grazing areas. This belt, which is located between 500 and 2000 meters (1500 to 6500 feet) is almost entirely covered with a dense deciduous forest.

The grazing of livestock in this particular part of the forest has created serious problems for both foresters and livestock men.

The damage caused by grazing the young shoots and seedlings by livestock, especially goats, is very severe, while the accompanied trampling presents another serious problem. Fire is another hazard of considerable importance because of shepherds' carelessness in the bedding areas, or intentional setting of fire in the forest for converting the forests to more open grazing lands. Once started, such fire usually continued until the next rain storm.

Grazing cannot be entirely prohibited in this belt, because this transitional zone is vitally important to the stockmen from the standpoint of transition and forage both.

This presents a very serious problem at the present time, and no reasonable solution has been found as yet. The vegetation of this belt is mostly timber species with some good grass and legume understory. The grass and legume species are rather similar to those of winter pastures in the lower elevation and to the summer ranges in the upper elevations.

As a rule the following are considered to be the most important species in this belt:

Grasses:

Agropyron sp.

Agrostis sp.

Bromus inermis

Cynodon dactylon

Dactylis glomerata

Lolium prenne

Lolium multiflorum

Hordeum bulbosum

Poa pratensis

Phalaris tuberosa

Legumes:

Medicago sativa

Onobrychis sp.

Trifolium pratense

Trifolium repens

Trifolium hybridum

Under normal conditions the livestock graze in this belt from about the first of April to late May on their way to the summer ranges and from mid-September to November on their way back to winter pastures.

Summer ranges. Perhaps this belt should not be classified under the Caspian zone because of cold winters, frequent and heavy snowfalls, and type of vegetation. But while its moisture is furnished from the Caspian Sea, and on the other hand, its vegetation does not resemble very much the summer ranges in the other mountainous areas of Iran, it

seems appropriate to be discussed under the Caspian zone.

These ranges start from almost 2000 meters (6550 feet) elevation on the northern slopes of the Alborz Mountains. The ground is covered with snow for the better part of the year in this area, and some good drifts of snow can still be seen covering the top of the ridges through the summer. These ranges have good stands of grasses, legumes, forbs, and browses.

The herds graze on these ranges from early or mid-June to late August or early September, according to weather conditions. The major grass and legume species in this area are as follows (Parsa, 1935-1949):

Grasses:

- Agropyron cristatum
- Agropyron intermedium
- Agropyron orientale
- Arrhenatherum elatior
- Bromus inermis
- Bromus tomentellus (var. triaristata)
- Festuca sp.
- Pennesetum orientalis
- Poa bulbosa
- Secale cereale
- Stipa pulcherima
- Stipa gigantea
- Stipa sp.

Legumes:

- Astragalus sp. (several species)
- Lathyrus sp.

Medicago sativa

Medicago lupulina

Medicago hespida (minima)

Orobus sp.

Onobrychis cornuta

Trifolium pratense

Trifolium resupinatum (var. suaveolence)

Trifolium rhytidosemimum

Vicia peregrina

Vicia sp.

There are a good number of forbs species on these ranges, some of which are highly palatable.

Ferula ovina

Ferula coma

Ferula sp.

Heracleum persicum

Diplotaenia chachrydifolia

Mentha sp.

Rhum ribbes

Rumex sp.

Ziziphora rigida

Ziziphora sp.

The beans of some legume trees such as Gleditschia caspica provide good supplement in the winter throughout the whole Caspian area.

Gulf zone

General description. This zone, located on the north coasts of the Persian Gulf and the Oman Sea, extends from Khoozistan Plain in the

west, to Govator in the east and northwardly extends to the Kerman area. The Persian Gulf and Omman Sea Islands can be included in this zone.

The climatic conditions are very severe; therefore, the population is limited to very few natives which can endure the condition.

Climate. Almost all investigators have concluded that this zone is one of the hottest areas in the world. Campbell (1926) says, "The region at the head of the Persian Gulf is one of the hottest known and might be compared with Death Valley in South California."

The mean temperature varies from 58° F. to 67° F. in January and 91° F. in July, while the annual mean fluctuates from 75° F. to 80° F. from area to area. The belt between Bandar Abbas to Chah-bahar is significantly warmer and more humid than the western wing of Bandar Abbas. The humidity is almost stable during all seasons of the year on the east of Bandar Abbas, while it varies with the season in the western part of that area (Sabeti, 1948). The annual precipitation varies from two inches to 15 inches. The shortage of water, strong winds, very high temperature, etc., have limited agricultural activities to a minimum.

Reliable information is not yet available about the soil and even climatic conditions of this area.

Vegetation. Most of the foreign or native investigators have suggested different vegetational classifications for this area. Apparently the season and itinerary of their trips has been very influential in their classifications. Rechinger (1951), whose classification will be followed in this paper, suggests three ecological categories in this zone:

1. Saharo Sindian (semi-desert and desert)

Approximately 90 per cent of the zone can be classified as Saharo-Sindian.

This region covers almost the entire southern states of Iran such as southern Fars, Lar, Kerman, Mokran, and Baluchestan, and continues eastward to British Baluchestan, southern Afghanistan, and northern Pakistan. The low precipitation, high temperature (seldom below zero degrees centigrade) and the difference between day and night temperature are characteristics of this region.

Date palm (Phoenix dactylifera), which is claimed to be native to this area, is the best indicator of the region. Usually the northern distribution limit of this tree indicates the end and border of the Saharo-Sindian region.

Campbell (1926) also agrees that the coasts of the Persian Gulf might be the origin of the date palm.

The presence of the following species in the mountainous area of this region may be considered as a true indicator of the region:

Mannorrhops ritchieana (small palm)

Stochsia brahuica

Calotropis procera

Anabasis articulata

At the lower elevations the following species are dominant:

Cousinia stocksii

Acacia arabica

Acacia nubica

Acacia seyal

Euphorbia Iarica

Other important shrub species of this area which grow on the flats and elevations are the following:

Caparis decidua

Dodonaea viscosa

Haloxylon aphyllum

Neirium odorum

Prosopis specigera

Zyziphus spina-christi

Zataria multiflora

Tamarix stricta

Unfortunately, Rechinger does not mention the endemic species of grass in this area; he only states that there are many species of Graminae in this region. Two of them, Andropogon and Panicum, may be considered as indicative elements of Saharo-Sindian. Other species of grasses in this region can be named as:

Cynodon dactylon (in the oasis)

Festuca sp.

Hilaria sp.

Bromus sp. (annual)

No detailed studies have been done on the grasses and forbs of this region. Generally it may be concluded that the annuals are predominant. The perennial grasses have a very long dormancy during the hot months of the year, and as far as grazing is concerned, they can be used only for a short period during the winter months. Some of the shrub species listed above furnish good feed for sheep and especially goats during some months of the year.

2. Sudano-deccaniane

It is still the subject of debate whether this region can be classified as a true phytogeographic region in the southeast of Iran or whether it is showing up as some radiations in the Saharo-Sindian

region (Boyko, 1955). This region makes two entirely isolated relics or spots on the southeast (plate II).

The presence of some of the species which are the true indicators of Sudano-deccaniane region such as:

Leptodaenia pyrotechnica

Perip loea aphylla

Salvadora persica

Calotropis procera

Daemia cordata

These can serve as good evidences of the existence of that region in this area. The presence of mangroves such as Rhizophora and Avicennis on the shores of Lar and Mokran might be considered as another proof to the existence of this region.

No reliable information is yet available for the grasses and legumes of this area. Rechinger says some of the grass and legume species in this region are also good indicators of Sudano-deccaniane.

3. Hochgebirg steppe (Kurdik-Iranian Mountain steppe).

This region composes some isolated spots almost on the border of Pakistan in the southeast. Each one is surrounded by narrow margins of Irano-Turanian type of vegetation. This might be a good point to study, because the first region (Kurdik Iranian steppe) is the Zagros Mountain type, and probably these relicts can indicate a better climate and vegetation in the past. The second region, Irano-Turanian, which surrounds these relicts as a margin, is also the predominant region of the plateau of Iran. The elevations between Saravan and Zahedan are true examples of this region. The vegetative and other characteristics of these two regions will be fully discussed in the next chapter.

Plateau zone

The central plateau of Iran, with its wide range of climatic conditions, is of the greatest importance in agriculture and eventually the economic life of the country.

The green mountainous region of Azarbayjan, Kordestan, Lorestan, and the productive steppes of Khorassan, Fars, Esfahan, etc., may be included in this zone as well as the flat deserts of the southeast and central desert of Iran. This roughly triangle-shaped plateau should not be pictured as a flat area; rather, it is divided by many mountain ranges, narrow valleys, and wide deserts. The various branches of two great mountain ranges of Iran (Alborz and Zagros) cross the plateau and divide it into many small areas with distinct climatic conditions. Smaller mountains intrude into the interior part of the country, and even in the central deserts mountains are never out of sight.

For a better and more careful study, this zone will be discussed under two different regions: (1) desert region and (2) steppe region.

Desert region.

General description. There are three deserts on the plateau of Iran, the largest being located on the center of the plateau and called Dashte Kavir. The second one, called Kavire Loot, is on the southeast and actually is the continuation of the Saharo-Sindian semi-desert and Sudano-deccanian deserts of the south and southeast corner, while the third one is a semi-desert with smaller acreage located on the Afghanistan border on the east (Frye, 1953) and (Murrey, 1950).

Rechinger divides these spots into two, semi-desert and desert, and according to his statement, the deserts are surrounded by semi-desert (Plate II). These deserts are supposed to be the product of eroded salts

and generally are covered with a thick layer of salt, surrounding small salt lake. These areas, especially the central desert (Dashte Kayir) resemble the Great Salt Lake Basin in appearance (Frye, 1953) (Murrey, 1950).

As far as history records, these deserts have been bare and impassable. The very dry and hot weather, absence of water, dreadful sandstorms, and sometimes the salt marshes, have discouraged the efforts to explore these deserts.

Climate. Very little is known about the climatic conditions of the deserts. But from the figures obtained from the neighboring populated areas the actual conditions existing in the desert can be predicted or guessed. The precipitation which comes as rain is predicted to be about one-half inch. There are some years when no precipitation occurs at all. No snowfall is ever recorded. Precipitation in the surrounding oasis are very low, too; for instance, it is 1.88 inch in Siestan and 2.20 inches at Hosseinabad. As a general trend the Kavir Loot on the southeast is hotter and drier than the central desert. The mean temperature fluctuates from 45° F. in January to 91° F. in July in Siestan. There is no reliable information available for the interior parts of the desert. These areas are highly subject to wind erosion; large sand dunes willbe removed and reshaped within a mile in a few hours. Winds of high velocities and long duration are very common; for example, the Siestan area (which is, of course, not in the desert area and is only located in the neighboring land) and the southeastern part of Iran are known as 120 days wind and some very high velocities of 70 to 120 miles per hour have been recorded (Murrey, 1950).

Although these deserts are not the products of men's abuse and

climatic changes during the historic centuries, their extensions can obviously be noticed. Hardy (1925) states that "Siestan has been known as one of the most productive lands in Asia, but gradually, because of increasing drought, it has lost that importance, and at the present with the swampy tracts between the affluent rivers covered with jungle of tamarixes are similar to those of Tarim Desert."

Vegetation. The information about vegetation of this area is very elementary. Most of the writers name this area as a sterile land (Hardy, 1925), and this is true for most of these areas because of very high concentration of salt, drought, strong wind, etc. Grasses and forbs are almost absent. A few species of Atriplex, Alhagi, Salsola, Peganum, etc., can be found in some areas, but there are about 1,000,000 hectares (2,470,000 acres) of desertic forests estimated on these deserts. As a matter of fact, these forests are composed of very sparse and deformed species of some very drought resistant shrubs and brushes. The important species of these forests are as follows (Sabeti, 1948) and (Sai, 1951):

Haloxylon ammodendron

Haloxylon persicum

Caligonum persica

Tamarix angustifolia

Tamarix articulata

Tamarix florida

Tamarix manifera

Tamarix seratina

Sudlitza rosmarinus

Zygophylum atriplicoides

Steppe region. This zone is the most important area in Iran from the standpoint of farming and animal husbandry.

The Zagros Ranges of mountains in western Iran, following the north-south trend and continuing toward the southeast, is known as the backbone of livestock industry in Iran. The green foothills and valley bottoms of these mountains have been the subject of migratory grazing as long as history remembers. Almost all of the important tribes are scattered in this area.

The steppe region includes those portions of Iran which have not been described previously.

Climate. Considerable variations in climatic conditions occur within this region. Temperature fluctuates from -15° F. to 110° F. or more. Temperatures as high as 110° F. have been reported at the elevation of 5000 feet, and even 93° F. has been recorded at 8000 feet elevation (Dehbid). The mean temperature in January is between 30° and 35° F. and reaches 75° to 85° F. in July. Mean annual temperature fluctuates between 55° and 65° F.

Precipitation is very irregular and varies from five inches to 25 inches annually. Distribution of rainfall is very unsatisfactory. Precipitation starts in the second month of fall (November) and ends at the second month of spring (May), so there are actually five months of complete drought in the year. A major proportion of precipitation comes as snow. Many high peaks with eternal snow are visible from the lowlands.

This region is covered with many small chains of mountains, some of which are branches or sub-branches of the Zagros Mountains, while there are not definite names for the other elevations. Therefore, the regional climatic conditions are greatly modified by the local or topographical

changes in each particular area.

Soil. The soils of this region can be classified into two main types: (1) soils of arid and semiarid areas and (2) soils of mountainous areas. Soils of arid and semiarid regions are generally alluvium and aeolian deposits. The texture of these soils varies greatly from sandy loam to silt loam. They are generally underlain at variable depths by coarse gravel; clay soils may also be found here and there. The structure of the soil is generally rather unstable. The dominant colors when dry are very pale brown and brown with an admixture of red from the parent material in some small areas. The soils in this type are usually rich in mineral and poor in organic matter.

The soils in the mountainous areas are practically all residual soils. These soils are shallow in depth and not well developed. Texture varies from silty loam to very fine sandy loam. The color varies from brown, reddish brown, and red. Occasionally some grassland soils rich in organic matter and high in fertility can be found where vegetation has been but little disturbed (Murrey, 1950).

Vegetation. The vegetation of this area must be very carefully managed in the future. The extreme variations in topography support numerous vegetational sub-types. Imposed upon this is the severe use of past centuries which has changed the whole vegetational picture of the area.

Various workers have expressed different opinions as to how the vegetation of the area should be classified. Tschermak (1924) considered the entire area as one class and called it "Steppen-U-Prarien." He also included the humid belt of Caspian forests in this class.

Boisser* classified the area as "Region orientale proprement dite," or "the true oriental region," and suggests an independent and particular flora for it. Rechinger (1951) and Boyko (1955) have other opinions and suggest another classification and terminology which will be discussed in detail in this paper.

Rechinger (1951) describes the vegetational characteristics of this region as follows:

a. Absence of tree species composing forests. The number of these species are very few and can be found only on the foothills. The major species of this type are Juniperus macropoda, Pistacia mutica, and Amygdalus spp. These species are different in appearance and are deformed because of extreme xeric conditions.

b. The great number of species present (almost two-thirds of the entire flora of Iran, 9 to 10,000 species) can be found in this area.

c. The great number of endemic genera and species.

d. The great number species of a single genus. For instance, there are about 700 species of Astragalus and 260 species of Cousinia.

e. Presence of the different species of Chenopodiacae, Compositae, Labiacae, etc.

There are some 10 million hectacres (24,700,000 acres) of oak forest in this region covering the foothills of the Zagros Mountains in the west in addition to some 2,600,000 hectares (6,425,000 acres) of Pistacio forests covering the southern parts of the Zagros and the elevations of east and southeast Iran.

These forests have been badly disturbed. In many places they have been completely removed because of being cleared for fuel and

*As quoted by Rechinger and Dr. Esfandiari.

charcoal. The understory of these forests, especially the oak forests, have been subject to very heavy grazing, and because of mismanagement, all valuable species have been replaced by annual weeds.

Rechinger and Boyko determined four vegetation categories in this region (Plate II) as follows:

1. Kurdic-Iranian mountain steppes
2. Arid border-forest belt
3. Afghano-Iranian mountain steppe
4. Irano-Turanian steppe

Kurdic-Iranian mountain steppe. This sub-region covers the foothills and valley bottoms of the main branches of the Zagros Mountains. It starts from Azarbayjan and continues along with the Zagros range of mountains to the western part of the Kerman Province.

Richinger has named this sub-zone "Hochgebirgssteppe," with the general characteristics as follows:

a. The xerophitic sparse forest with the dominant endemic species of:

Quercus brantii

Acer cinerescence

Quercus infectoria

Amygdalus spp.

Crataegus spp.

Rhamnus spp.

b. The understory of these forests is very rich and in addition to the endemic species such as Phlomis Bruyviri, a good many Mediterranean species are present such as:

Trifolium speciosum

Trifolium purpureum

Trifolium globosum

Trifolium stellatum

Trifolium pilulare

Medicago spp.*

In addition to the species mentioned, other genus and species of the following families which are indicators of Mediterranean area are present:

Compositae

Companulaceae

Labiacae

Some species of these families are endemic, while the others are Mediterranean elements. There are also a good many species of Graminacae of which some are endemic.

c. The valley bottoms are mostly covered with the following species:

Populus auphratica

Salix acmophylla

The species mentioned are generally accompanied by:

Vitex pseudonegundo

Neirium odorum

Mirtus communis

Ficus spp.

In the drier valleys the species of Tamarix can be found. Boyko names the following species as the best indicator of this area and calls

*Rechinger mentions "medicago" as a Mediterranean endemic. It has been concluded by many investigators that Medicago is native to Iran and probably the significant endemic species of this area.

them "thorny cushion plants:"

Acantholimon spp.

Astragalus spp.

Tragantha spp.

Arid border-forest belt. This region is bordered on the north by the isolated spot of Irano-Turanian steppe, Kurdic-Iranian mountain steppe on the east, and again Irano-Turanian steppe on the west and southwest. From northwest this region continues to Turkey and covers the greatest proportion of that country under the term of Anatolic-Iranian border forest belt. The Mediterranean elements can be found most anywhere in this region. Boyko divides this belt into two sub-regions:

a. Mauretano-Iranian

b. Anatolic-Iranian border forest belt

Pistacia mutica, Quercus persica, are endemic species of the first sub-region and usually are associated with many other broad leaf forest trees. The second sub-region contains Quercus persica, Quercus aegilops, and Juniperus macropoda as the endemic species.

There is a dense forest on the high elevations and inaccessible areas of this region which continues southeastward toward the Kurdic-Iranian steppe and forms a sparse forest in that region, too. These forests are estimated at 10 million hectares (24,700,000 acres).

Quercus persica is the dominant species in these forests and is usually accompanied by the following species:

Acer cinerasence

Amygdalus reuteri

Celtis caucasica

Crataegus sp.

Ficus carica var. johnnis

Fraxinus sp.

Lonicera arborea

Myrtus communis

Pirus glabra

Pistacia kinjuk

Platanus orientalis

Pistacia mutica

Quercus lustitanica

Tamus communis

These forests have a very rich understory of forbs and grasses which will be discussed in the next chapters. As a rule these two sub-regions, Kurdic-Iranian steppe and arid border-forest belt, are rather similar in vegetation characteristics.

Afghano-Iranian Mountain steppes. This region covers actually a small area on the northeast corner of the country and is surrounded by humid forest belt on the west, central Asiatic or Turanian steppe at the north, and Irano-Turanian steppe in the south. This region continues eastward to Afghanistan and covers large areas in that country.

According to Boyko, the vegetation of this region is similar to Kurdic-Iranian steppe region with Afghanic elements dominant.

There are xeric forests in this region which continue and scatter into the Irano-Turanian region. These forests are the Pistacioes forests. They are very sparse and technically should not be called forest. The major dominant species are as follows in order of importance (Sabeti, 1946) and (Sai, 1949):

Pistacia khinjuk

Pistacia mutica

Amygdalus reuteri

Amygdalus scoparia

Tamarix palasii

Tamarix manifera

Irano-Turanian. This region covers the largest proportion of the steppe zone in Iran. It starts from the southern slopes of the Alborz Mountains and continues southeastward to the east passes of the Afghanistan border and covers some areas in that country. In the south it is bordered by deserts and semi-deserts (Saharo-Sindian) of the south and southeast. On the west this region is bordered by Kurdic-Iranian mountain steppe and actually has surrounded the Kurdic steppe thoroughly. This region continues westward from the south and makes a narrow margin on Iraq border and is bounded by border-forest belt. There is another isolated spot of this region in the northwest surrounding the lake of Rezaieh and actually acts as a barrier between the Kurdic steppe and its continuation into Turkey.

Rechinger designates this part as the "Irano-Turanian region; Iranian dominant," according to the European terminology.

Many of the other investigators have accepted this terminology, but because of the existence of some of the Mediterranean elements on the western part of this region, they think this region is strongly under the influence of Mediterranean climate; but according to Rechinger, this conclusion does not seem logical.

This region, Irano-Turanian, is described as having low precipitation, extremes in daily and annual fluctuation of temperature, a long drought season, and cold winters (colder than is normal in this geographic

latitude).

The plants usually have two dormant seasons in the year, one in the winter because of cold, and the other in the summer because of high temperature and drought.

Boyko divides this region into two sub-regions:

a. Mauretano-Iranian

b. Irano-Turanian steppe types (Iranian elements dominant)

The Mauretano-Iranian can be distinguished with:

Artemisia herba alba

Stipa tortilis

Zizyphus lotus

while the Stipa szowitziana, Artemisia herba alba are the dominant species of the Irano-Turanian steppe. The Mediterranean elements are rare or almost absent in this region.

Grazing resources and management. It has already been mentioned that this region is the most important grazing resource of Iran. All important and densely populated tribes such as Kurds, Bakhtiari, Ghashghai, Lor, and many other smaller tribes migrate back and forth in these mountains and lowland plains. The variations in climatic conditions and eventually in vegetation, because of topography, season, etc., regulate the distribution of these tribesmen and their herds in these ranges. Generally, two main types of ranges can be classified in this zone.

1. Summer ranges

2. Winter ranges

The distance of migration between the summer and winter grazing lands is sometimes over 300 to 400 miles, and the nomads accompany their herds by

foot all the way.

There is no definite area devoted to spring and fall grazing, and actually these two seasons will be spent between summer and winter ranges.

Summer ranges. These ranges are generally located between 1500 meters (4900 feet) to 3000 meters (9800 feet). Each tribe has his particular range and camp for a short period of time and move their herds and tents back and forth within a short distance during the summer months.

No ecological studies have as yet been started in these ranges for type classification, etc., but in order to have a better picture of the area, the major species of grasses, legumes, other forbs and browses will be listed on the following pages (Parsa, 1949-1955).

Grasses

1. Agropyron cristatum
2. Agropyron intermedium
3. Agropyron orientale
4. Agropyron smithii
5. Agropyron juncea
6. Agropyron tricophorum
7. Agrostis sp.
8. Alopecurus pratensis
9. Alopecurus agrestis
10. Arrhenatherum elatior
11. Andropogon ischaemum
12. Avena fatua
13. Aristida tortulus

14. Bromus inermis
15. Bromus tomentallus (var. trearistata)
16. Bromus japanicus
17. Dactylis glomerata
18. Festuca ovina
19. Hordeum fragilis
20. Hordeum bulbosum
21. Poa bulbosa (var. vivipora)
22. Pennesetum orientalis
23. Secale cereale
24. Stipa pulcherrima
25. Stipa pennata
26. Stipa gigantea
27. Stipa tortulus

Legumes

1. Lathyrus aphaca
2. Lathyrus annus
3. Lathyrus szovitsii
4. Medicago sativa
5. Medicago lupulina
6. Medicago hispida (var. minima)
7. Medicago orbicularis
8. Lotus corniculatus
9. Lotus goebelii
10. Orobus hirsutus
11. Onobrychis sativa
12. Onobrychis marchaliana

13. Onobrychis gauba
14. Trigonella teheranica
15. Cicer sp.
16. Trifolium pratense
17. Trifolium rhytidosemimum
18. Trifolium radiocosum
19. Trifolium campestre
20. Trifolium resupinatum (var. suaveolence)
21. Trifolium hybridum
22. Vicia villosa
23. Vicia peregrina
24. Glycyrrhiza glabra

There are many species of Astragalus present on these ranges; some of them have noticeable grazing value, some are poisonous, and most of them have industrial importance.

Other forbs and browses

1. Alyssum alpestre
2. Alyssum campestre
3. Alhagi sp.
4. Artemisia camaemelifolia
5. Allium sp.
6. Cersiuem lapaceum
7. Chenopodium album
8. Diplotaenia chachrydifolia
9. Ferula ovina (coma)
10. Ferula asa feotida
11. Echinops ritro

12. Echinops persica
13. Echinops khorassanica
14. Heracleum persicum
15. Lactuca persica
16. Mentha sylvestris
17. Ziziphora rigida
18. Ziziphora tenuior
19. Plantago major
20. Peganum harmala
21. Verbascum sp.

Winter ranges. The ranges located between 600 meters (1900 feet) and 1200 meters (4000 feet) are the winter ranges. The grasses dry up in early spring in these areas and remain dormant until after the first rain in the fall.

Generally the winter ranges are more deteriorated compared to summer ranges, and because precipitation is very low and the most important influencing factor, the improvement of these ranges, is very difficult.

Although the list of the species alone is a poor indicator of the ecological conditions, since there is no classification suggested yet, the scientific names of the important grasses, legumes, and other forbs and browses of this area will be listed on the following pages (Parsa, 1949-1955).

Grasses

1. Agropyron cristatum
2. Agropyron sp.
3. Aristida plumosa

4. Alopecurus litoralis (grows in salty lands)
5. Bromus sterillis
6. Bromus variegata
7. Cynodon dactylon
8. Eragrostis sp.
9. Festuca sp.
10. Hordeum murinum
11. Oryzopsis holciformis
12. Poa bulbosa
13. Sorghum halapensis
14. Stipa sp.
15. Trisetum florescence

Legumes

1. Astragalus teheranicus
2. Astragalus glaucacanthus
3. Ebbenus stelatus
4. Hedysarum halophyllum
5. Lathyrus sp.
6. Melilotus officinalis
7. Medicago sativa
8. Onobrychis sp.
9. Trifolium alexandrinum
10. Trifolium stelatum
11. Trifolium globosum
12. Trifolium arvensis
13. Trifolium resupinatum (var. suaveolence)
14. Trifolium pratense

15. Trifolium repens
16. Glycyrrhiza glabra
17. Goebellia alopecuroides

Other forbs and browse

1. Artemisia herba alba
2. Artemisia scoparia
3. Alhagi camelorum
4. Alhagi maurorum
5. Centaurea virgata
6. Eremurus spectabilis
7. Ephedra distachyon
8. Euphorbia sp.
9. Hulthemia persica
10. Mentha longifolia
11. Ferula aliacea
12. Peganum harmala
13. Phlomis sp.
14. Salsola carinata
15. Salvia sp.
16. Verbascum sinesense
17. Zyziphora sp.

SUMMARY

1. Iran is a true mountainous country with a total area of 425,244,000 acres.
2. The triangular-shaped plateau of Iran is bounded by Alborze Mountain on the north and the Zagros Mountain on the west, south, and southeast.
3. Alborz is one of the great mountain chains of the world at an average height of over 10,000 feet. Zagros range is in effect not a single mountain but a series of chains rising to 15,000 feet in maximum.
4. Because of wide range in latitude and altitude differences, and also because of the rough topography, the climate is variable in the various parts of the country.
5. Orographic effects play an important part in determining quantity and distribution of precipitation so that the local variation in precipitation is very great.
6. Very strong winds cause serious wind erosion and limit the agricultural activities to a minimum in the east and southeast of Iran.
7. Little is known about the soils of Iran. Two major problems in soil management which are becoming very serious are salinity and erosion.
8. Wide variation in climatic conditions has produced numerous different plant communities; therefore, the existing information about ecology of Iran is neither complete nor reliable.
9. The information about lower vegetation such as grasses, forbs,

browses, etc., is more inadequate because almost all of the investigators have paid more attention to the taller and bigger plants.

10. The classification presented in this paper is based almost entirely upon climate and geology, and according to this classification Iran is divided into three major zones, as follows:

    a. Caspian Zone

    b. Gulf Zone

    c. Plateau Zone

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RANGE PROBLEMS IN IRAN

by

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of the requirements for the degree

of

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TABLE OF CONTENTS

LIST OF TABLES

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Nasser Golesorkhi

INTRODUCTION

A glance at history

Some four thousand years ago what is now Iran was invaded by Arians from some still controversial area thought to be middle or north-central Asia (Fry, 1953).

These people possessed knowledge of animal taming and husbandry. They soon dominated the Cassens (Kissi) and Mards (Amards) who were natives to the area in which they settled (Pirnia, 1941).

The word "Arian" slowly changed to "Airia," "Airian," "Airan," "Eiran," and eventually to "Iran" (Pirnia, 1941).

Since forage was needed for their animals, the Arian tribes concentrated on the excellent rangelands of western, northern, and northeastern Iran (Azarbayjan, Kurdestan, Hamadan, Gillan, Khorasan, etc.). It was here that they established their first Medes Kingdom in 800 B.C.

Iran as a path between East and West

This country with its vast grazing lands has been subjected to many invasions, and to some extent constitutes a buffer zone between East and West.

The Arian people came to the grazing lands of western Iran about 4000 years ago. Since then, there have been many other invasions from the East.

The Sakaha, or Saks, invaded the northwest, west, and southwest of Iran about 672 B.C. Their invasions continued up to the Danube River in central Europe. Herodotus called them Scythie and believed they originated from western China and Turkistan (Pirnia, 1941).

The Mongolians in the twelfth century A.D. destroyed everything on their way from the northeast Iran to central Europe and formed the largest empire that history ever recorded (from the Sea of China to the banks of the Danube) (Wells, 1949).

All invasions have not been from the east. Alexander the Great's conquest in 333 B.C. and the Arab invasion in 641 A.D. came from the west. These were major invasions. There also have been many, many local and minor invasions.

None of these invaders were definitely heading for Iran. The goal of the eastern invaders was the destruction and plundering of the Near East and central Europe, while the dreamland of the western conquerors was India. Iran has only served as a path for the invaders.

History of grazing in Iran

Taming and husbandry; the oldest industry. Lowdermilk (1953) writes: "In the Zagros Mountains that separate Persia from Mesopotamia, shepherds with their flocks have lived from time immemorial, when the memory of man runneth not to the contrary." From time to time they swept down into the plain to bring devastation and destruction upon farming and city peoples of the plains. Such was the beginning of the Cain and Abel struggle between the shepherd and the farmer. Xenophon, an early Greek writer says: "Animal husbandry, land reclamation, irrigation, and tree planting are the doctrines of religion in Persia and are named as activities that Ahooramazda (God) likes" (Pirnia, 1941). When Herodotus reported the commerce situation in Iran, he said: "The products of Hamadan and Garrous are good horses and beautiful rugs." Also when he reports of taxes and tax payers, he mentions: "Some of the taxes used to be paid in the shape of livestock, for example, Capadokieh

(one of the western states in old Persia) offered 1,500 horses, 2,000 mules, and 50,000 head of sheep to Darius the Great as annual taxes (Pirnia, 1941).

Importance of saddle and draft horses in local and international invasions. The role of the horses and other draft animals in the tribal and international invasions in early historic days is very obvious. The distances that early conquerors covered in their invasions were many thousands of miles. Saddle horses and draft animals have had the most important roles in their conquests. Herodotus reports of 300,000 horses in Neysayeh Ranch (one of the crown ranches in old Persia) before Alexander the Great's invasion of Iran.

Darius the Great praised the good horses of Persia in most of his memorial manuscriptions. In the first verse of the memorial manuscript found in the canal between the Red Sea and Nile River dug in 609 B.C., drained and cleaned by Darius in 514 B.C., it says: "Ahooramazda is the great God who granted me the kingdom of a country which has good horses and good men." Also in the third verse of the manuscript found at Persopolice (520 B.C.) he says: "This is Pars Country (Persia) Ahooramazda granted to me, it is beautiful and has good horses and nice people." Again in the third verse of manuscript found at Sousa (the winter resort of Hacha-manid) says: "Ahooramazda has created good horses and nice men in this land for me."

Herodotus praised the Medes (Medic) horses and says the Medic horses are very fast and well built (Pirnia, 1941). Today horses, mules, donkeys, buffaloes, and camels are very common and vitally important transportation means in the mountainous areas of the west, north and northwest and the deserts of the southwest, south, and southeast of the

country.

Ancient methods of husbandry. The nomadic system of livestock husbandry is undoubtedly the method which has been practiced from very early days in Iran.

Meds or Mads were actually a large tribe migrating between summer ranges at Hamadan and Kurdestan and winter ranges on the plain of Koozestan during winter months.

Sousa was the winter capital of Hakhamanesh. Darius the Great built huge castles for his winter resorts in this area. This migratory system of animal husbandry did not change as time advanced, and still is practiced and accepted as the backbone of livestock industry in Iran and most of the other Middle East countries.

The continuous local struggle between the tribes for green grass resulted in the appearance of new Royal dynasties in various favorable range countries. The green plains and mountains of each part of the country have been the dominion of a particular powerful tribe. Many other small tribes were under the protection of each big tribe. After the Arab invasion, because of the lack of security and continuous confusion and rebellion, the tribes divided into smaller and more isolated subtribes. Fear of the Mongolian and Taymurian invasions made the problem more severe. The subtribes broke down to smaller subtribes which took refuge in the high and isolated mountains. As quickly as one of these tribes became strong enough, it invaded another, and if successful, formed a local feudalisme, or a national dynasty, which was soon conquered by another tribe. This is the reason that since the Arab invasion (641 A.D.) a great many dynasties have appeared in the history of Iran and none of them lasted more than 150 to 200 years.

These never-ending local struggles trampled and deteriorated the ranges severely along with thousands of years of overgrazing.

Present conditions and practices

Land uses. Iran has a total land area of approximately 164,000,000 hectares (425,244,000 acres, or 628,000 square miles). The breakdown of the land is illustrated in table 1.

At the present time the following three important groups of owners own the total land acreage in Iran:

Shrine domains 25%

Public and Royal domains 10%

Individual and nomadic ownership 65%

Livestock. As it will be emphasized later, livestock and animal products are the most important aspect and source of income in the economical life of the country. There are three major systems of husbandry practiced in Iran:

a. Farm livestock. Almost all of the farmers keep a few animals for various purposes. Oxen are the most common draft animal for agricultural purposes; donkeys serve as the best transportation means in the villages. In mountainous areas the donkey is replaced by the mule. In desert regions, the camel replaces the donkey. Other animals such as sheep, goats, cows, poultry, etc., are sources of cash income for the farmers. This is the money with which the farmer pays for his cash purchases.

These animals live on the poor stand of grass, brouse, and forbs of the neighboring deserts or foothills, wheat or barley stubble, straw, and occasionally some alfalfa or sanfoin hay. These animals are generally in a poor condition, and only the resistant native breeds can

Table 1. Land uses in Iran

Land uses	Area in hectare	% of total
Forests	18,000,000	11.00
Grazing lands outside of forest	10,000,000	6.11
Cities, roads, and railroads	2,000,000	1.22
Under cultivation	19,000,000	11.62
Potentially cultivable	33,000,000	20.17
Desert and other waste lands	81,600,000	49.88
Total land area	163,600,000	100.00

(Sai and Hadary, 1949)

tolerate the very severe living conditions.

b. Dairy farm animals. In the vicinity of the large cities there are usually dairy farms which take care of the dairy needs of the city. Dairy cows are usually of the small native breeds, and produce a very small quantity of milk. In the summer, spring, and fall, they live on small cultivated pastures which originally are planted for hay. The species used for hay and pasturage are only legumes. Barley and occasionally oats are almost the only two grasses used for livestock feeding. Common legumes planted for hay and pasturage are: alfalfa, sanfoin, and clovers, while different species of Lathyrus, Vigna, and Vicia are cultivated for winter supplements.

c. Nomadic husbandry. The majority of the animals belong to nomads. The present nomads are the descendants of early livestock men and warriors who still practice the same old routine migratory system of husbandry.

Perhaps this regular seasonal migration is the key and secret of the present small capacity left in the ranges. Although nomads are scattered throughout the country, the Zagros Mountains are the most heavily populated and form the territories of the important tribes. These tribes form about 20 to 25 per cent of the total population.

The majority of the nomadic stocks belongs to the leaders of the tribes. Sometimes the tribesmen are rich enough to run their own herds, and in that case, they must pay a kind of tax or grazing fee to the leaders.

The distance between the winter grazing lands and summer ranges is sometimes over 400 to 500 miles. The better parts of spring and fall seasons are actually spent on migration.

The management practices are very simple and primitive. For instance, some plants are considered as indicators that when they appear in the late season, the time for migration has arrived. These indicator species are generally annual grasses like species of Bromus, Hordeum, etc. Sometimes annual weeds will serve as indicator species. Certain climatical changes, animal behavior, etc., provide means for predicting future climatic conditions and eventually time of range readiness.

d. Classes of livestock. Statistics concerning the number of livestock in Iran are rather confusing. Most of the figures presented are approximations. Usually these figures do not match with other figures presented by another agency.

Recent statistics presented by Ardalan (1955) are based on the following resources of information:

1. Local inquiries.
2. The number of animals vaccinated.
3. Amount of animal intestines exported or locally used.
4. Amount of wool produced.

It is rather difficult to conclude whether these figures are reliable, but lacking better information, they will be used in this paper (table 2).

The censusing methods mentioned have been employed for sheep, goats, and cattle, while the figures presented for larger animals and poultry are based on rough estimations.

Most of these animals are concentrated in the provinces of Azarbayjan and Khorasan and in the ranges of the Zagros Mountains of the west and south.

The provincial distribution of animals can roughly be estimated as

Table 2. Livestock population of Iran

Class of animal	Number
Sheep	21,650,000
Goats	9,728,000
Cattle	3,155,000
Buffaloes	194,000
Donkeys	1,300,000
Horses	480,000
Mules	95,000
Camels	100,000
Hogs	22,000
Poultry	25,000,000

follows: 50 per cent of the oxen, mules, and camels and about 25 per cent of the donkeys, cows, sheep, and goats are found in the fertile province of Azarbayjan. Khorasan owns approximately 20 per cent of the donkeys, 12 per cent of the horses, 25 per cent of the sheep, and 15 per cent of the goats. Concentrations of the sheep and goats are found in Kurdestan, Lorestan, Fars, the other Zagros, and submountain regions. There are many horses in the Caspian area, but a considerably small proportion of other animals.*

Sheep and goats. Sheep and goats dominate the livestock population in Iran. The sheep are generally fat-tails except in the Caspian area, where long-tail sheep are common. They provide multiple products such as milk, meat, and wool. In the south and northeast sections of the country, the fleece of the Karakul sheep is a product of primary importance. Persian Lamb (skin) has almost an international reputation.

Sheep and goats constitute the principal livestock of the tribesmen. The remarkable tolerance of these animals to severe conditions makes them a good migratory animal, although the tribal system of livestock husbandry is primitive, lambing, watering, milking, shearing, etc., are all carried on in accordance with a regular seasonal schedule. It is unfortunate that the number of goats are increasing every year. This is the best index to the rapid deterioration of the ranges. As palatable forbs and browse decrease by over-use and conditions become too severe for sheep, only goats are able to survive. The wool of the native breeds is long wool which is the best for rug manufacture.

*Information obtained from Animal Husbandry Service, Ministry of Agriculture, Iran.

Goat hair is generally used for weaving of the tribal tents.

Cattle and buffalo. Since there is little demand for beef, cattle can be divided into two groups: (1) dairy animals, (2) draft animals. A favorable market for dairy products, especially milk, has been absent until recent years. With the development of the national and some private dairy plants, these products are assuming their proper importance.

Oxen are the most common draft animal in agriculture. In many areas cultivation is almost impossible without these animals. Buffaloes are very limited in number and are usually kept for milk and draft.

Donkeys and mules. The donkey is probably the most important transportation means in the rural areas of Iran. The native breed is small in size, but very strong and possesses considerable endurance. A good donkey can carry 100 kg steadily for a long period of time. The mules are rather exceptional in being extremely strong and enduring. They are the greatest help to the nomads and farmers in the extensive mountainous areas of Iran.

Occasionally these two animals are used for agricultural drafting jobs in some areas.

Horses. At present, horses are not as important as they once were. Seldom they are employed for agricultural drafting purposes. However, they are extensively used for other drafting jobs. Only nomads and the Army are currently interested in horses. There are three major breeds in the country: Sturdy, Turkaman, and Arab. The last two are very good saddle horses, while the first one is used for saddle and draft (Murrey, 1950).

Camels. The importance of this tolerant and enduring animal as a means of transportation has decreased considerably during the last few

few decades. Nevertheless, the camel is still widely employed in the hot deserts of the south, southeast, east, and central part of Iran.

Long caravans of heavily loaded camels can still be seen in the cold and mountainous areas of Azarbayjan.

Importance of livestock products in national economy

Iran is undoubtedly a truly agricultural country. The general climatic conditions, geographical location, 4000 years of adventurous history, religion, traditions, diet, problems of security, ancient and present nomadic livestock husbandry, and many other reasons have developed a peculiar agricultural civilization in Iran. Over 75 to 80 per cent of the 20,000,000 population of this country, in one way or another, are engaged with agriculture. Tribesmen compose a good proportion of this percentage and have a leading role in national economy. Although the greatest proportion of the people are living on farms, livestock products are qualitatively and quantitatively considered to be the most important resource for the national diet and economy.

Meat, especially mutton, is one of the major items of the diet. Approximately 1,800,000 head of sheep, 1,500,000 head of goats, and 200,000 head of beef are slaughtered every year for internal consumption.*

The grease obtained from melted butter is preferred over the vegetable oils and is almost the only type of fat used. More than 43 thousands metric tons of this grease is produced every year. This quantity is almost sufficient for the internal consumption.

Although milk is not a very popular item in the diet, other dairy

*Information obtained from veterinary service, Ministry of Agriculture of Iran.

products such as yogurt, cheese, and a few other native products are very commonly used. The total milk production has been estimated to be 1,530,000 metric tons annually. Poultry products such as dressed poultry and eggs are important items in the diet. About 15,000 tons of dressed poultry and 35,400 tons of eggs are annually produced for internal consumption (Sai and Hadary, 1949).

Although because of the religious prohibition there is not a great demand for pork. Still good pork is available in the markets of big cities.

The famous Persian rugs are woven from the long wool sheared from sheep. Annual wool production is estimated to be 17,000 tons most of which is used in rug manufacture. At the present time, rugs are the second most important export item (Murrey, 1950).

In addition to the 17,000 tons of wool, 5,000 tons of goat hair and 250 tons of the expensive Kashmir wool are produced every year (Zahedi, 1955).

A comparison between the cash value of animal products and farm products emphasizes the vital importance of livestock to daily economic life of the nation. According to recent statistics (Sai and Hadary, 1949) the annual total value of animal products such as meat, dairy, wool, etc., is estimated at 15,000,000,000 rials (approximately $183,000,000) while the value of farm products like wheat, barley, rice, cotton, etc., is not more than 12,000,000,000 rials (approximately $146,500,000).

Although the quality and quantity of these materials is decreasing significantly, because of the shortage of forage on the depleted ranges, these grazing lands, with their valuable sources are the best

evidence of an unbelievable high potentiality during the last 40 centuries.

Zahedi (1955) in an official report stated:

> If we consider only 1 rial (1.5 cent) as the daily minimum diet requirement for sheep and goats grazing year long on the open ranges, they consume forage equivalent to 11,450,000,000 rials ($144,000,000) every year, and of course this is in addition to the amount utilized by the other classes of livestock and game animals.

The figures presented may illustrate the importance of animal husbandry and grass land in the economy of a country like Iran, where industry is not properly developed. The influence of present husbandry methods, especially the nomadic system on distribution of population and on the social life of the country should not be neglected either. Isolated cities with practically no other source of income but livestock are the direct result of this type of civilization. These cities may be populated only a few months of the year.

The scattered small towns located on the way of the regular nomadic migrations are another evidence of the strong influence of nomadic systems on distribution of population.

RANGE PROBLEMS

Livestock production dates from primitive times. In the beginning grazing animals subsisted without difficulty upon the native vegetation. As the population increased, more animals were produced. In many areas, they became so numerous as to jeopardize forage growth and other uses of the land. Because of the vital importance of conservation, it recently became evident that careful husbandry and management are necessary for continuous economic livestock production.

Although the very first grazing of livestock had its beginning in this part of the world, livestockmen are still in the most primitive stage, insofar as grazing is concerned.

In spite of the high potential productivity of range lands in Iran, the number of animals these lands will support and also the quality and quantity of livestock products are decreasing continuously. Perhaps it has been because of the amazing productivity and very large acreage of the range land that the importance of proper utilization has been almost forgotten in the past centuries.

There are many national, international, political, economical, social, traditional and technical factors responsible for mismanagement of range land in Iran. Some of these problems will be discussed in the following pages. A better understanding of the subject will be possible if it is divided into two parts:

1. Administrative problems
2. Technical problems

Administrative problems

Systems of ownership. The different and variable systems of range ownership in Iran is one of the most important factors which generally limits the proper execution of any national program for range improvement.

Each owner uses his range mostly according to his personal taste and other factors influencing his economical condition. This often results in the abuse of the range.

The national or provincial agencies such as the Forest Service, Range Department, Ministry of Agriculture, Department of Nomads Affair, Royal Domain Service, Public Domain, and others have very little control or supervision upon the utilization of range lands. These agencies only collect the grazing fees. There is no uniform national law for administration of the range lands at the present time. Each organization has its particular system and regulations for fee collection. Conservation and management are almost completely neglected in all of these regulations.

Generally speaking, ownership of range land in Iran can be classified into five categories as follows:

a. Public domain ranges

b. Shrine ranges or religious domain

c. Royal domain ranges

d. Individual ownership

e. Nomadic ownership

Public Domain ranges. The public domain and royal domain together include about 10 per cent of the total arable range and forest land in Iran. Public domain owns three to four per cent of it, while Royal domain composes six to seven per cent of the total lands (Frye, 1953). The public domain ranges belong to the government and actually the Ministry

of Agriculture is administratively responsible for fee collection, etc.

The technical (conservation and management) points of view are completely forgotten, because of lack of dependable technicians. The fee collectors are not technically aware of their responsibility, and unfortunately the organization also bases the success on the amount of money collected, for the more they collect, the better they have performed their jobs.

The grazing lands are leased on yearly or longer terms. Leasing agreements are concerned only with period of lease and annual fee. Leases contain no stipulations as to the number of animals to be placed upon a particular area.

Carrying capacity of these ranges was roughly estimated a couple of hundred years ago. Carrying capacity, if mentioned as a condition of the lease, is based upon this ancient estimate.

Religious domain (shrine lands). More than 25 per cent of the total agriculture land in Iran belongs to religious organizations.

These lands are bequested to the numerous shrines. Income from these lands is supposed to be spent for the improvement of the publicly needed resources such as water development, school building, helping the poor, etc. At present, most of the income is used to finance religious schools and the other religious activities. Religious domain is scattered all over the country and generally consists of highly productive range lands, forests, and arable lands. These lands will be leased for short or long terms (between one and seven or more years). The religious leaders who generally are not aware of the importance of conservation and management of these resources, are responsible for management of

these lands. Generally the ranges under the ownership of the religious domain are in the poorest condition.

Royal domain ranges. The Royal family owns about six to seven per cent of the total agricultural lands in Iran. There are extensive mountains, plains, and forests subject to grazing, as well as numerous farms under Royal ownership.

Although there is a particular office in the Ministry of Royal Court handling the affairs of these domains, because of lack of sufficient and qualified technicians, these lands are not in better condition than the previously discussed Public and Shrine domains.

More than 50 per cent of the total land in the Caspian area come under this category. All of the lands in this area are subject to grazing during the various seasons of the year. Lack of control over grazing in the forests has created the most dangerous problem for the management of the precious hardwood forest of this area.

In recent years a program has been started to distribute the Royal domain lands among the farmers and peasants. Already several thousand acres have been distributed.

The proper execution of this program and giving ownership of the land to individual farmers and peasants will probably point the way for the proper development of the arable lands and the protection and management of the forest and range lands classified under this category.

Individual ownership. If the ranges owned by the leader of the tribes be considered as individual ownership, 60 to 65 per cent of the total agricultural lands in Iran can be classified under this category. The breakdown of this percentage is not clearly known. These individuals

are a few land owners in each province who own vast areas.

They lease their ranges to the nomads or other herders for certain periods of time or occasionally graze it with their own livestock. The condition of these ranges is not any better than those under the previously discussed categories.

These owners frequently are not settled in their lands and as a rule do not know anything about the technique and management of livestock, range land, and the other phases of agriculture.

Nomadic ownership. As has been discussed before, a great number of tribesmen are practicing the ancient migratory system of husbandry, practically all over the country. Under the nomadic ownership, the pastures generally have been owned by the leaders of the tribe for many centuries through inheritance. Occasionally the range land is the property of the tribe. Individuals who own livestock pay an annual fee per head to the leaders.

The animals owned by all members of the tribe graze in the pastures belonging to the tribe. Nevertheless, each livestock owner pays a small fee to the leader for protection and handling the administrational affairs.

Compared with other systems of ownership, the nomadic ownership seems more conservatory and promising, even though it is not a good system by itself. These livestock men are at least aware of the importance of grass and green pastures for their animals, as a result of many years of bitter experiences of heavy loss because of drought, severe cold, etc.

In none of the systems described above are the owners particularly interested in conservation or management of natural range resources.

the ranges are usually leased for one year. No consideration is given to the operator who has used an area for a number of years and who might possibly be a little interested in proper utilization in order to have better or at least the same grass for the next year.

Because of the mentioned facts, the execution of uniform national regulations for management of grazing lands is extremely difficult, if not impossible.

Grazing fees. The amount and type of grazing fee differs according to the different systems of ownership. It is collected sometimes in livestock products such as grease, wool, cheese, etc. Sometimes under local arrangements and agreements, it is collected in cash.

There is not a uniform system or standard rate for fee collection. The old traditions and arrangements that have been in force for many centuries are highly respected in each area and especially among the nomads.

On public domain ranges, which is almost the only official standard, there was one rial (one-eightieth of a dollar) per head for sheep and goats and 1.5 rial for the larger animals until 1948. In 1948 the rates appearing in table 3 replaced the old ones.

The rate doubled for animals coming from neighboring countries. Since 1950, equal fees are charged for foreign and native herds.

It will be noticed that the smallest fee is considered for goats which gives the impression that the government wants to encourage goat herders even though in other areas it is believed that goats are most damaging to native range.

Lack of cooperation between farmer and livestock producers. As a

Table 3. Grazing fees on public domain ranges*

Class of animals	Amount in rials	Amount in cents
Camel	50	60
Mare	40	50
Horse and mule	30	36
Cattle and buffalo	25	30
Sheep and donkey	5	6 (about)
Goat	4	5

*Information obtained from Public Domain Office, Ministry of Agriculture, Iran.

result of the nomadic system of livestock husbandry, animal husbandry and cultivated farming are two absolutely isolated agricultural practices in Iran.

The precious animal manure is wasted or used as fuel by nomads, while the fertility of the farm lands decreases very rapidly because of lack of fertilizer. No rotation of crops in cultivated farming is practiced at all, because there is no sound demand for winter feeds such as hay, silage, and cultivated pastures in other seasons. On the other hand, very heavy losses occur to the nomad's livestock just because of lack of adequate food during the winter time, especially in the cold regions.

Dairy cattle in the vicinity of the large cities depend almost entirely on hay and pasture feeding. Village livestock also feed generally on grain stubble, straw, and occasional grazing on nearby ranges.

But as far as nomadic husbandry is concerned, the hope for integration, or at least cooperation between farmers and nomads, in the near future is not very great, although it presents a very threatening problem both for livestock men and farmers.

Foreign stocks. Iran is bounded by Turkey and Iraq on the west and Afghanistan and Pakistan on the east, of which all are nomadic livestock countries.

Because of old traditional agreements, some herds of the neighboring countries are permitted to graze on border ranges for limited periods during certain seasons of the year. In addition, there are many instances where foreign herds cross the border illegally and frequently this results in local struggles between the native tribesmen and the

foreign herdsmen. In any event, this practice causes a severe localized over-grazing, because the permitted stocks are prohibited to graze deeper into the country, and unpermitted ones prefer to stay closer to the border line in order to be able to return to their home countries in case of emergency.

The occasional struggles between foreign and native tribesmen cause a serious trampling on the ranges which hardly can be corrected even by long term management plans. This condition also exists on the Russian border on the north and northeast, especially in Turkaman area.

Nomadic traditional prejudices. Some of the nomads are limited in number, and compared with other tribes, own smaller numbers of livestock, even where the territory they have inherited is quite large. These nomads would not let the herds of the other tribes graze on their lands even if a considerable amount of money were offered as a grazing fee. On the other hand, there are densely populated tribes, with a large number of livestock, but with limited territory for grazing. They are greatly in need of more grazing land.

Severe drought conditions are experienced occasionally, but fortunately, this does not affect the stock practices of the tribesmen. In drought years they do not change their management program nor reduce the number of animals even though they lose a large number of livestock.

The importance of the tribe in general and the individual tribesman is indicated by the number of sheep or goats owned. The urge is strong to maintain as many animals as possible. This traditional prejudice is inherited from the time of feudalism and respected very highly by nomads.

Lack of inventories. Although livestock products rank highest in the national income, it has always been considered as of less importance

than other fields of agriculture. Generally speaking, no appropriate attention has yet been paid to the importance of statistics and surveying in Iran.

Records of the size, carrying capacity, actual stocking rate, and even location of range land are based upon estimates made at least two centuries ago. The nomads know the boundaries of their territories quite well. Each tribe or area uses its own measuring units, and these are usually not the same as those used by other tribes or in other areas. For example, a term used in one area might have the meaning of one-tenth of a hectare, while in another area it indicates an area of one hectare. This condition exists for weights and distances also. Therefore, there is no uniform system for measurement to facilitate the collection of inventories.

The information on the plant species, ecological zones, and livestock population are not adequately complete. Most ot the time they are contradictory, with the same data presented by another official agency.

The shepherds know most of the plants by local names. They are also aware of the rate of palatability of the range plants. No attempts have yet been made even to collect and assemble this very elementary information.

Collection of reliable information by a survey is the only basis for any improvement program for the future.

Lack of regulations. The existing regulations for grazing and management of range lands are very inadequate. As a matter of fact, there are no conservational regulations, except one for the protection of forests.

No national or even provincial regulation is available for management or control of grazing, watershed, wildlife, and soil conservation at the present time. The nomads in each area have some local or tribal traditional regulations for renting more pastures, grazing, exchange of livestock products with farm products, etc. Therefore, legislation is another important elementary step for the proper management and conservation of the range lands.

Technical problems

Improper use. Although the range lands of the whole country have been severely overgrazed for long periods of time, there are still many areas which have received very light, if any, use. This lack of uniformity in grazing has caused severe spot overgrazing in the more accessible areas. Generally speaking, the following practices are responsible for improper use of the range lands in Iran.

Lack of adequate transportation. There are still some areas which are not available or accessible by herds and tribesmen. These areas are mostly found on the high rocky mountains of summer range.

Lack of water. Lack of water in some areas, especially on winter ranges is a serious limiting factor to proper distribution of animals. Use of shallow wells or windmills is not yet practiced in this part of the world, so the stockmen depend only on the springs and the other natural water resources.

Improper time of stocking. Sometimes the climatic conditions do not exactly match with the seasonal migration of the nomads. In most instances, although it is understood that the ranges are not ready for grazing, there is no other choice, but to graze an area too early. The animals trample and graze the young plants in their earliest stages of

life. This early grazing is more destructive when it occurs during rainy periods.

The question of range readiness must be watched more critically in a country like Iran, where sheep and goats are the most common classes of livestock. Sheep are a low grazing and selective animal, but goats graze almost everything. Therefore, after a few years of continuous early grazing, the unpalatable species replace the desirable ones. These undesirable species (Clycyrrhiza glabra, Goebelia alopecuroides, Peganum harmala, and Euphorbia spp.) can be seen on almost any range in Iran.

Forest grazing. This problem is primarily a forestry problem rather than range. In the forested areas of the north, northwest, and west, the herds must graze in the forest for some period of time. These forests are located on the foothills between summer and winter ranges, and as a transitional pass between summer and winter ranges.

Land conversion. The importance of farm machinery has recently been recognized in Iran. The potentiality of the cultivated lands are so low, because of continuous farming, that both land owners and farmers prefer to plow the plain lands which have not been cultivated before.

Therefore, the tractors are mostly employed for the plowing of the fertile grasslands which have not been cultivated before.

This agricultural reform has created a serious problem for the ranges. There are also other factors encouraging the land owners to extend their arable lands by plowing some more acres of range land. For example, there has been a good market for cotton, wheat, and other farm crops in the past few years, so everybody has tried to plant more cotton, especially on the fertile plains which are located in the good

rainfall areas and are capable of dry farming.

The Plains of Gorgan on the northeast and Moghan on the extreme northwest (Russian border) have suffered most from this savage cultivation.

The operators of these lands are neither native of the area, nor owner of the land. These lands are leased for certain periods of time; therefore, the operators try to obtain the highest income in the shortest period.

The destructive results of this type of farming can be obviously seen in the shape of eroded gullies, floods, invasion of annual weeds, severe starvation, and heavy losses of livestock. The number of sheep in the Gorgan area has decreased around 300,000 within the period 1940-1950, because thousands of hectares of fertile range lands have been converted to desert in this area.* It can be positively concluded that this system of farming is threatening both animal husbandry and farming in the same time.

Another type of land conversion occurs on the summer range of the migratory tribes. Tribesmen plow some land in their summer resort and plant winter wheat or barley in early fall before they move to their winter resort. They harvest the crop next summer when they return to the same place.

This farming, of course, continues on a new piece of virgin land in the next year, and it can be seen how fast the good perennial species will be replaced by annual and non-palatable species.

Erosion. During the mid-summer of 1954, there occurred some unusual

*Information obtained from Caspian provincial office of Agriculture.

rain storms in the vicinity of Tehran. These periodic storms with their high intensities and short durations caused the most horrible flash floods ever recorded in Iran. In the night of July 14, 1954, more than 5,000 persons were killed at Emamzadeh Davood located on the north of Tehran, by a flood caused by a storm with a duration of less than 40 minutes. One week before this flood occurred, more than 400 persons were lost at Fasham village on the northeast of Tehran. Some minor floods with 30 to 40 persons killed in each happened in the other localities north of Tehran, or on the southern slopes of Alborz Mountain.* These floods are the most natural and expected events almost anywhere in Iran.

Generally speaking, the responsible factors can be itemized as: (1) steepness of slopes, (2) lack of proper rotation in farming, (3) non-returning of the animal manure to the soil, (4) clearing of the forests, (5) overgrazing, and (6) clearing of the shrubs.

Steepness of slopes. It has been mentioned before that Iran is a true mountainous country. The bare rocky steep slopes can be frequently seen, especially in the southern slopes of Alborz and the eastern slopes of Zagros Mountains.

Lack of proper rotation in farming. Almost all of the arable lands in Iran are severely overused. Rotation is almost unknown to the farmers. The lands are planted to wheat or other crops year after year, only two or three years fallow system is common in some areas.

There are three primary reasons for this lack of rotation: (1) lack of adequate demand for forage crops, which must be planted in rotation; (2) inadequacy of the native plows in eradication of the deep roots of

*From daily local papers.

the legumes for the next cultivation; and (3) lack of sufficient irrigation water.

Non-returning of animal manure to the soil. The cultivated lands are very low in organic matter because of being over-used for crnturies. With few exceptions, almost all of the animal manure is used for fuel in the villages. They make big sun-dried cakes in summer, and store them for winter.

Clearing of the forests. More than 89 million cubic feet of wood is annually cut from the Caspian forest for fuel purposes, and this is in addition to 53 million cubic feet of timber (Murrey, 1950). The harvesting of this amount of wood, especially for making charcoal, associates with the wastage of at least the same amount.

The danger of flood in the Caspian area is not very important, because its fertile alluvial soil and appreciable amount of precipitation always keeps a good vegetation cover on the ground. But the destruction of these forests might well produce catastrophic results in the agricultural lands, both by flooding and siltation of irrigation channels.

In the semiarid and desertic forests, this clearing results in dangerous floods and complete absence of vegetation cover.

Overgrazing. The continuous overgrazing of at least 40 centuries has almost completely denuded the lands of some of the arid parts of the country. Generally speaking, goats have been the most destructive animal for this denudation, because all of the thistles, brushes, forbs, and grasses which are not palatable to cattle and sheep are heavily grazed by goats.

The successive erosion and runoff has washed the soil completely and made the reproduction or regrowth of any plants impossible. Consequently,

vast areas are converted to true desert and these are also a dangerous source of floods. Barren lands on the sides of the roads to Shiraz, Kerman, Khora san, etc., are all the products of overgrazing and successive erosion and runoff.

Clearing off the shrublands. Although Iran is one of the richest oil resources of the world, very little oil is used for fuel because of its very high cost, especially for the farmers and nomads. Probably transportation is the most influential factor in the high cost of oil. The question of transportation still remains as the most limiting factor in the case of coal. At the present time the most common fuels are charcoals, animal dung, natural vegetation of the forests, range lands, fallow lands, and even deserts. In addition to the unavailability of oil, gas, and coal, the traditions and customs are also a strong limiting factor. Educating the people to use other things, instead of what they have been using for ages, would be a long and very slow process.

Before 10 years ago, almost all of the fuel used for baking the native breads was furnished entirely from the bushes and thistle of the range lands. Thistle picking has been a common and very regular job in the past, and has a good place in the national folklores and legends. Still, in many areas, it is considered as a common job. The vegetation of some areas has been eradicated for other purposes, and although these areas have not been very large, this has caused local floods.

The insect Auragaster integericeps is the most destructive pest for grain crops in Iran. This widely spread insect, after laying eggs in the field in the spring, migrates to the mountains and spends the summer, fall, and winter under the bushes of Artemisia, Hulthemia, Astragalus, Verbascum, etc.

Burning is one of the methods of controlling this insect, which, unfortunately, has been widely employed. Through burning to destroy this insect, some range land has been denuded of vegetation. Reproduction in these burnt mountains is very slow and in many cases impossible because of severe aridity, and actually these potential watersheds are converted to true flood sources.

The fertility of the arable lands is also decreasing very rapidly because of accelerated erosion, especially in the areas with rough topography. Cultivation is generally practiced along the slopes, because the plowing would be easier that way with the oxen. Contour farming is almost unknown.

At the present, erosion is the most threatening factor for agriculture in Iran. Every once in two or three years a severe shortage of irrigation water in summer follows the spring floods, because of denudation of watersheds in the mountains. Areas are recorded that have had drought for seven successive years.

Lack of hay and supplements. Feeding hay and supplements is not widely practiced in Iran. Hay is fed customarily only to dairy cows, saddle horses, and occasionally to oxen.

A serious factor in the agricultural economy, and one which causes the numbers of livestock to vary markedly from one year to another, is the annual loss due to the severe winter or drought in the summer. These severe winters do not only occur in the mountains, but they generally cover most parts of the Iranian Plateau.

During the winter of 1948-1949, more than 20 per cent of all animals in the country perished from the cold and lack of food. Moghan Steppe, on the extreme northwest, was the subject of heaviest loss. The

tribesmen lost almost 80 to 90 per cent of their animals and as far as the official records are concerned, at least 1,200,000 out of 1,600,000 sheep, which perished in that area.

There were also considerable losses in the winter of 1949-1950 and mortality in this year is estimated at 1,220,000 sheep and goats and 130,000 cattle (Murrey, 1950). This story repeats very often in different intervals in the same or other areas.

The possibility of mowing and bailing the good stand of the natural forage for emergency circumstances is very great. The Steppes of Gorgan, Moghan, and Mehran are the best natural pastures with a rich stand of grasses. The Turkamans in Gorgan mow these grasses, press, and tie them together and use them for building of their huts, but do not feed them to their livestock.

The government has recently started a hay bailing demonstration project in order to demonstrate the possibility of hay production to the stockmen. The nomads do not or cannot practice that because of the following factors:

1. Lack of necessary facilities to transport hay for some hundred miles.
2. Lack of mowing, bailing, and preserving equipment.
3. Lack of proper education and understanding of the importance of hay and supplement.

Parasite infestations. Recent studies (Ardalan, 1955) shows that between 15 and 20 per cent of the total livestock number will die of diseases every year if serious control does not take place. At the present time, most of our ranges, especially those located on the wet lowlands, or Alpine tundras, are badly infested with parasites. As an

example, all of the winter ranges in the Caspian Zone are seriously infected with the parasite of different diseases.

Liver fluke is the most common range parasite disease in Iran.

Although the veterinary service of the Ministry of Agriculture of Iran is a relatively well equipped organization, still no serious efforts have been made for the control of the parasite in the ranges.

SUMMARY

1. What is now known as Iran has been a fertile land with vast possibilities for animal husbandry. This land was invaded by Arians who possessed the knowledge of taming and husbandry of the animals about 4,000 years ago.
2. This country has always been the subject of invasions from east and west, while none of the invaders were definitely interested in the country itself.
3. Grazing of livestock has been practiced on the green steppes of the Zagros Mountain (west and southwest of Iran) from time immemorial.
4. This country has always been praised for having good horses. Herodotus reports of 300,000 horses in one of the Royal ranches before the invasion by Alexander the Great of Iran.
5. The frequent invasions have created a particular form of feudalism or nomadic civilization in Iran. Because of successive and unceasable invasions, the big tribes split to smaller, isolated sub-tribes, scattered in the various parts of the country.
6. There are 425,244,000 acres of land in Iran. Forests and range lands cover 17.11 per cent of this acreage.
7. The livestock are kept under three conditions in Iran: (1) farm livestock, (2) dairy farm cows, and (3) nomadic husbandry.
8. There are 36,724,000 head of domestic animals in Iran, of which the sheep with 21,650,000 head compose the largest portion.
9. At the present time more than a few hundred tribes and sub tribes are living in Iran, of which Kurds, Lors, Bakhtiaries, and Ghashghaies

are the most important.

11. Over 75 to 80 per cent of the total population in Iran in one way or another are engaged with agriculture. Nomads compose 20 to 25 per cent of the population.

12. The value of the animal products per year is 3,000,000,000 rials, or $37,500,000. This is more than the value of other agricultural products; therefore, the importance of animal husbandry in the social and economical life of a country like Iran is very obvious.

13. Generally speaking, the obstacles to range management in Iran can be classified under two broad groups, as follows:

    a. Administrative problems

    b. Technical problems

14. The administrative problems are as follows:

    a. System of ownership

    b. Grazing fees

    c. Lack of cooperation between farmers and livestock producers

    d. Foreign stocks

    e. Nomadic traditional prejudices

    f. Lack of inventories

    g. Lack of law and regulations.

15. Technical problems can be classified as:

    a. Improper use of the range

    b. Conversion of grazing land to cultivation

    c. Erosion

    d. Lack of hay and supplements for livestock during times of the year when the range is not productive

    e. Parasite infestations.

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VEGETATION OF NEVADA

by

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Report No. 3 submitted in partial fulfillment
of the requirements for the degree

of

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in

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

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Nasser Golesorkhi

INTRODUCTION

The existing information of climatic conditions, soil and topography, indicate that there is some similarity between the arid and semiarid areas of Iran and the state of Nevada, western Utah, and eastern California.

The present paper is an elementary introduction to the vegetation of Nevada.

It is neither complete, nor free of errors. It is only hoped it may serve as a pattern for the future ecological studies in Iran, for myself, or for other field technicians.

PHYSIOGNOMY OF NEVADA

Location

The state of Nevada, with the approximate area of 70,700,000 acres (110,540 square miles), is located between 35° and 42° parallel of latitude and 44° to 64° meridian of longitude. It is bounded on the north by Oregon and Idaho, on the east by Utah and Arizona, and on the south and west by California.

Its extreme length from north to south is 483 miles, and its extreme width from east to west is 320 miles.

The Colorado River separates it from Arizona as a natural boundary.

Physical features

With the exception of the southeast and northeast corners, Nevada is located wholly within the Great Basin, with a floor of 4,000 to 5,000 feet above sea level. This plateau, however, is not a flat plain, but consists of many buttes, mesas, and isolated mountains.

The trend of these ranges is generally north and south, and their elevation from the level of the plateau differs from 1,000 to 7,000 feet. The width of these mountains varies from 5 to 20 miles at the base, and the valleys have almost the same width.

Generally speaking, the total area of the valleys equals the total mountainous area in these ranges.

A range of mountains is located on the northeast with a general east and west trend. This range parts the water between the tributaries of the Humboldt River in the Great Basin region and those rivers which flow to the Snake River in Idaho and Oregon.

The mean elevation of the state is 5,500 feet and, with the exception

of the dip to the Colorado River in the south, the entire state lies above the 2,000-foot line.

Generally speaking, the topography of Nevada is characterized by a series of mountain ranges and intermountain valleys which extend through the state in a general northeast by southwest direction (Encyclopaedia Britannica).

The Sierra Nevada, which is located on the western rim, sends into the state a single lofty spur, the Washoe Mountains. At the foot of this range there is a depression with the approximate altitude of 3,850 feet above sea level. From this depression eastward, the general level of the plateau rises to an elevation of 6,000 feet, near the eastern border of the state. The mountain ranges also increase in height and importance as far as the East Humboldt Range, a lofty mass about 60 miles west of the Utah boundary.

This range is the steepest and the most rugged range of mountains within Nevada. Some of the peaks of this range attain the height of 11,000 to 12,000 feet (Encyclopaedia Britannica).

Climate

Temperature. It is quite difficult, rather impossible, to make a general statement about temperature or other climatical factors of Nevada, because of the sharp elevation and the topographic differences. Until 1954, there have been 136 meteorological stations in the whole state (Climatological Data, 1951-1953). The comparative data of 1889-1953 obtained from five stations (Elko Weather Bureau Airport; Ely Weather Bureau Airport; Las Vegas Weather Bureau Airport; Reno Weather Bureau Airport; and Winnemucca Weather Bureau Airport) can indicate a relatively true picture of average temperature changes in the whole state.

According to these data, January has always been the coldest month of the year, with a mean temperature of 29.7° F. for the 64-year period. The lowest temperature ever recorded has been -50° F., which was recorded in the winter of 1937. July is the warmest month of the year in this state, with a mean temperature of 72.6° F. for the period of 1889-1953. The highest temperature ever recorded has been 120° F., which was recorded in the summers of 1942 and 1949 (Climatological Data, Nevada, 1951-53).

Billings (1953) believed that the number of the Weather Bureau stations is not sufficient, especially in the Great Basin area, which is 500 miles wide. He finally concluded that the distribution of these stations is not satisfactory either, and most of them are located in the fertile and flat valley bottoms.

According to Billings (1954), the climatic data for the Great Basin region is so inadequate that no altitudinal temperature trends can be determined.

An experiment conducted by Billings (1949-53) in the Pinion Juniper zone of Nevada has shown that the temperature inversions can be noticed in the mountains of Nevada, especially in the drier sites where vegetation is more scarce. Maximum temperatures in the valley bottom and at the 4,825-and 5,640-foot levels are almost identical.

This experiment has also shown that the minimum temperature in the valley bottoms covered with sage brush are as much as 10° to 19° F. colder than those on the slopes 400 to 1300 feet above. These inversions seem to be present for most of the year and also occur in small valleys within the range itself.

Precipitation. As it is mentioned before, most of the weather recording stations are located in the valleys or on the lower slopes of the adjacent mountains. They are generally within a rather narrow elevation range.

The records obtained from these stations provide good data for precipitation in the valleys, while they are totally inadequate for showing the climatic changes on higher elevations.

Only very few of these stations are located at elevations above 7,000 feet, although records from snow surveys, which give an indication of total precipitation, were available from a few high elevation locations. The precipitation on the mountain ranges becomes greater with increasing elevation, but the total precipitation also varies with the exposure of the site in relation to the other ranges (Hardman, 1948).

Data collected for a period of 64 years (1889-1953) from the five main stations mentioned before indicate that July, with a rainfall of 0.39 inches, is the driest month of the year, while December, with an average of 1.69 inches, can be considered as the wettest month.

According to these data, the average precipitation in the whole state has been 9.70 inches.

The average amount of snowfall for the whole state runs to 34.3 inches annually (table 1).

Tables 2 and 3 show the distribution of precipitation in each county of the state and also indicate the acreage of land located in each precipitation zone.

The figures in tables 2 and 3 reveal that almost 90 per cent of the total area (over 70,000,000 acres) is located in the zones which have

Table 1. Monthly distribution of precipitation in Nevada (average of 64 years 1889-1953)

Month	Rain	Snow
January	1.15	9.0
February	1.04	7.4
March	0.97	5.8
April	0.78	2.8
May	0.85	1.2
June	0.52	0.1
July	0.39	T
August	0.47	T
September	0.41	0.2
October	0.65	0.8
November	0.78	4.2
December	1.69	12.9
Annual total	9.70	44.4

Table 2. Estimated acreages in various precipitation zones by counties in Nevada (000's are omitted from acreage figures)

County	Precipitation zones						Wgt. Avg. Prep. in.
	0-5	5-8	8-12	12-15	15-20	20 or up	
Churchill	1,410	923	754	156	10	5	6.7
Clark	3,065	1,812	156	72	33	11	5.3
Douglas		16	158	132	101	76	14.7
Elko	229	827	5,407	2,734	1,428	337	12.0
Esmeralda	590	660	716	154	47	17	7.8
Eureka	105	211	1,827	443	68	6	10.3
Humboldt	889	1,072	3,144	957	178	35	9.4
Lander	129	1,263	1,925	275	59	10	9.1
Lincoln	1,613	2,240	2,020	704	153		7.9
Lyon	377	428	176	173	94	39	8.5
Mineral	628	670	707	281	45		7.9
Nye	2,687	3,666	3,849	1,085	329	92	8.2
Armsby			35	32	17	24	15.5
Pershing	724	1,779	1,001	384	24		7.7
Storey		15	20	100	26		13.0
Washoe	242	595	2,321	655	396	122	10.9
White Pine	178	1,020	2,871	1,366	178	24	10.3
Total for zones	12,866	17,197	27,087	9,708	3,186	798	
The State							9.0*

*Weighing the precipitation, it is assumed that the less than 5" zone has an average annual precipitation of 4 inches, the 5" to 8" zone has $6\frac{1}{2}$"; the 8" to 12" zone has 10"; the 12" to 15" zone has $13\frac{1}{2}$"; the 15" to 20" zone has $17\frac{1}{2}$" and plus 20" has 25".

This table is reproduced from "The precipitation of Nevada" by Geo. Hardman (1948), Reno, Nevada.

Table 3. Percentage of land in rainfall zones by counties in Nevada

County	Precipitation zones					
	0"-5"	5"-8"	8"-12"	12"-15"	15"-20"	+20"
Churchill	43.6	28.3	23.0	4.6	0.3	0.2
Clark	59.5	35.3	3.2	1.3	0.5	0.2
Douglas		3.3	32.4	28.0	20.7	15.6
Elko	2.4	7.5	49.3	25.0	3.0	3.1
Esmeralda	27.0	30.2	32.8	7.0	2.0	1.0
Eureka	3.9	7.9	68.6	16.7	2.7	0.2
Humboldt	14.2	17.1	50.0	15.3	2.8	0.6
Lander	3.5	34.5	52.8	7.5	1.5	0.2
Lincoln	24.0	33.3	30.0	10.5	2.2	0.0
Lyon	29.3	33.3	13.7	13.4	7.3	3.0
Mineral	26.8	28.7	30.7	12.0	1.8	
Nye	22.9	31.3	32.9	9.3	2.8	0.8
Ormsby			32.4	29.6	15.7	22.3
Pershing	18.5	45.5	25.6	9.8	0.6	
Storey		9.3	12.4	62.1	16.2	
Washoe	5.5	13.7	53.6	15.2	9.2	2.8
White Pine	3.2	18.0	51.0	24.2	3.2	0.4
State	18.1	24.3	38.3	13.7	4.5	1.1

This table is reproduced from "The Precipitation of Nevada" by Geo. Hardman (1948).

an average annual rainfall below 20 inches.

Forty-two (42) per cent of the state is in the belt of less than eight inches, and only one per cent (approximately 800,000 acres) is located in the zone which receives more than 20 inches of precipitation (Hardman, 1948).

Soil

Nevada has a very variable topography; therefore, environmental factors such as temperature and precipitation vary abruptly from area to area. Because of the interreactions of these complicated factors and vegetation influences, the soils of this state are extremely heterogeneous. Some mountainous areas receive high precipitation and, therefore, produce luxuriant vegetation and deep, black soil.

On the other hand, in the lowland areas, because of poor drainage and constant leaching from adjacent hillsides, the soil becomes saline and sometimes alkaline.

Although the different soil types of Nevada will be studied in the following pages, it should be kept in mind that the local variation in soil types is strikingly great.

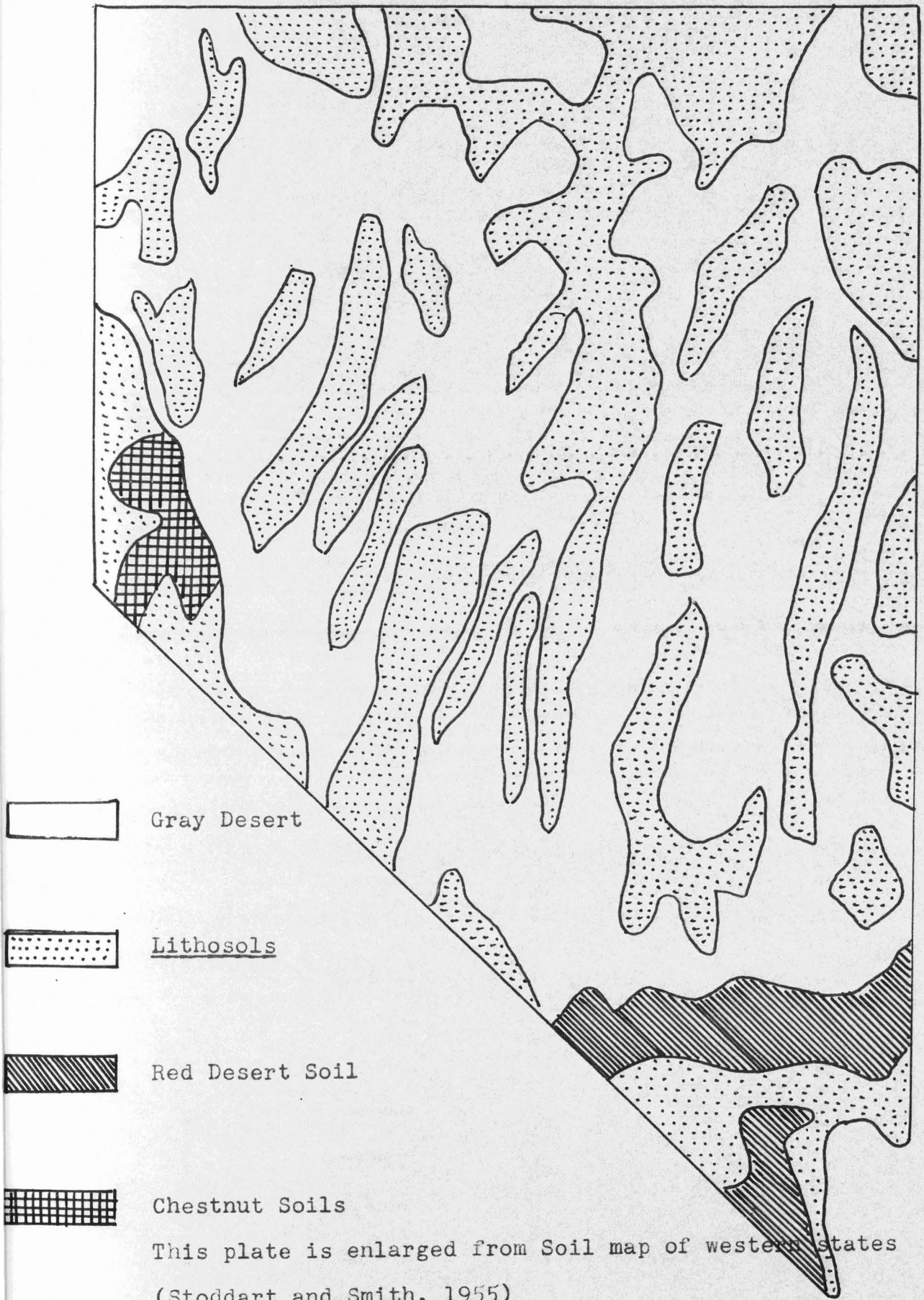
Stoddart and Smith (1955) propose the following soil types for this state (Plate 1):

1. Gray desert soil
2. Lithosols
3. Red desert soil
4. Chestnut soil

Gray desert soil. The soil of the greatest portion of the state is of this type. The color of the surface soils are gray or

PLATE I

Soil Types of Nevada



Gray Desert

Lithosols

Red Desert Soil

Chestnut Soils

This plate is enlarged from Soil map of western states (Stoddart and Smith, 1955)

very light brown because of low organic content, while the subsoils are gray and rich in lime concentration. Since the climate is dry, soluble salts are abundant. The vegetation of these soils is mainly Atriplex. These soils are low in production and highly subject to water and wind erosion.

Lithosols. Because of the slow process of soil development in arid climates, the lithosols or rocky soils of the arid regions have no profile development. In many places the parent material, or bedrock, is exposed. This type of soil is found on the low elevations of the mountainous areas of Nevada. The lithosol soil is extremely heterogeneous. The soils are shallow and stony with the depth of practically zero to several feet. The color varies from light gray to brown or red, and even to black. The vegetation of the lithosols varies greatly. Vast lava beds, rock outcrops, and steep topography produce almost no vegetation. Generally speaking, these soils are very erosive and low in productivity.

Red desert soil. This soil type forms only a small narrow margin in the extreme southeast part of the state. The color varies from red to pink at the surface and pink to white at the lower layers. Because of low precipitation and absence of leaching, these soils are highly concentrated with soluble salts. These soils are highly erodable and non-productive.

Chestnut soil. This type forms only a small isolated area in the extreme southwest corner of the state. They are typically dark brown, or gray brown on the surface, and underlain by a calcareous layer. The soil is productive enough for dry land wheat cultivation. The uncultivated lands in this type are generally covered with sagebrush.

Water resources

Nevada undoubtedly occupies the most arid part of the United States. The moisture for this state is derived mainly from general westerly storms. But the Sierra range of mountains, with its high elevation, controls the deeper penetration of moisture into the state. Although the summer convectional storms are locally beneficial, they are not generally very important. These unexpected storms sometimes cause serious local floods, especially in the low rainfall areas.

Generally speaking, only a very small percentage of the state is located in the high rainfall zones, but from the standpoint of water yield, they are extremely important.

These small watersheds on the top of the high mountains collect the snow, which are the source of streamflow during the summer season.

An unfortunate fact for this dry state, where farming is entirely dependant on irrigation, is that the greater part of the drainage area of the Truckee, Carson, and Walker rivers lies outside Nevada.

As far as water yield is concerned, the following factors are of major importance:

1. The surplus moisture above that needed to satisfy the normal requirements of the plant cover plus the direct evaporation losses from the soil is very small for those areas which receive less than 20 inches of precipitation.
2. The surplus available for runoff increases very rapidly with increased precipitation. Therefore, a comparatively small area with a total precipitation well above 20 inches will usually yield more surface runoff than a similar area whose total

annual precipitation barely exceeds 20 inches (Hardman, 1948).

The mountains are largely composed of limestone. The limestone mountains usually absorb the runoff surface flows, and they usually produce good numbers of springs around their base. This is the characteristic of the area through central and southern Nevada (Hardman, 1948).

The drainage basins of this state can be classified as follows:

Washoe Mountain basin

This mountain is a branch of the Sierra Nevada. A relatively flat plain with the average elevation of about 3,850 feet is located at the bottom of this mountain. This plain receives the drainage of the eastern slopes of the Sierra.

Humboldt Range basin

The Humboldt River is the most important of the Great Basin streams. It flows in a southwest direction for 290 miles and drains 7,000 to 8,000 square miles.

This river empties into the Humboldt Lake, and its overflow goes into the Carson Sink.

Truckee, Carson, and Walker basin

These rivers drain the eastern slopes of the Sierra Nevada and eventually end up with the Alkaline Lakes.

The Alkaline Lakes are a number of lakes different in size. The largest one is Pyramid Lake (30 miles long and from 4 to 13 miles wide). The second largest is Walker Lake, with the same length, but only 6 to 7 miles wide.

The smaller lakes are formed from floods, torrent waters of

the valleys, and usually are dried during the summertime.

The drainage area of Snake River is about 5,000 square miles. In this basin, the Owyhee, Little Owyhee, Salmon, and Bruneau Rivers are the most important streams.

In the southeast the Virgin River from Utah, which crosses the northwest corner of Arizona, flows southwest for 60 miles and forms another drainage basin. This river finally joins the Colorado River.

The Colorado River flows for 150 miles southeast toward the Gulf of California (Encyclopaedia Britannica).

ECOLOGICAL CLASSIFICATION

Although the climatic conditions in most parts of Nevada are not favorable for vegetation growth; with the exception of Alkali Flat, no portion of the state is actually devoid of vegetation, even in the dryest seasons. The vegetational resources of this state have been under a very severe use within the last 200 years. The good stands of conifers on the foothills and valley bottoms of Washoe Mountains have been deliberately cut to provide timber for the mines. The grasses and palatable forbs in the Great Basin area have almost vanished because of severe overgrazing. The climax picture of the vegetation of some areas has changed because of overuse and, consequently, has caused controversial opinions and interpretations as far as ecological classification is concerned.

Review of literature

Dice (1943) divides the whole state of Nevada into two major biotic provinces: (1) Artemisian, which almost entirely covers the entire state, and (2) Mohavian Province, which occupies a small area on the extreme southeast of Nevada.

Artemisian Province. This province covers southeastern Oregon, southern Idaho, northeastern California, and western Utah, as well as most of Nevada.

As quoted by Dice (1943), this area is named "Utah Region" by Cooper (1859) and "Great Basin Sub Region" by Merriam (1890). The Shoshonee Region adopted by Cooper (1859) covers some parts of this

province. Davis (1939) has given the name of "Northern Great Basin Biotic" area to the northern parts of the province, which lies in Idaho.

Dice thinks these nominations are all objectionable and proposes "Artemisian Province." He believes this province has essentially the same limits as the "Basin Sagebrush" of Weaver and Clements (1929) and Region 9 of Aldous and Shantz (1924).

Dice describes this area as numerous separate interior basins of which only a very few have drainage to the sea.

Many isolated mountains can be seen in this area. These mountains are generally well covered by vegetation and their upper parts usually bear conifer forests. Hot summer and a moderately cold winter are the characteristics of this province. The dominant species of the lower elevations is sagebrush (Artemisia tridentata). The other important associating species are:

Atriplex confertifolia

Atriplex conescens

Chrysothamnus nauseosus

Grayia spinosa

Tetradymia spinosa

The tolerance to alkalinity is characteristic of the area; however, in the very high salt concentration areas the mentioned species will be replaced by:

Sarcobatus

Salicornia

Distichlis

Juniper and Pinon occupy the lower elevations of the mountains, while species of Pinus and Abies cover the higher elevations.

Mohavian Biotic Province. According to Dice (1943), this province covers the Mohave Desert, Death Valley, the adjacent desert valleys, and deserts of the southern part of Nevada, southeastern Utah, and northwestern Arizona.

The topography of this province is of desert type; the mountains are rocky and rise abruptly from their outwash aprons and alluvial fans.

Precipitation is very low and there are periods of as much as 24 months without measurable precipitation.

One period of 32 months without precipitation has been recorded.

The low, open, and very uniform stand of Larrea tridentata and Franseria dumosa are the dominent species of the lower level of this province.

Along the upper edges of the northern part of this province is a belt in which Yucca brevifolia and such characteristic shrubs as Grayia spinosa and Tetradymia spinosa are prominent. At a still higher level is a belt of Juniper and Pinon.

Merriam (quoted by Daubenmire, 1938) considered the whole area west of 100th meridian as the lower Austral zone and according to him, this zone extends from Texas to the valley of Sacramento.

It should be mentioned here that Merriam's classification is entirely based on temperature and humidity, of what temperature is still more influential than humidity.

Daubenmire (1947) divides the xerophytic vegetation of North America into four following categories:

Xerophytic forest

Chaparral

Grasslands

Desert formation

The fourth category, "desert formation," occupies the largest proportion of Nevada. According to Doubenmire, the pinon juniper vegetation of the West is the first xerophytic formation that appeared in North America which gradually has attained a wider distribution. Weaver and Clements (1938) include the vegetation of southern Nevada in the basin sagebrush formation. According to these authors, the brush vegetation of the lower elevations in Nevada is Pinus juniperus association, while the dominant associations of the upper elevations which cover the eastern slopes of Sierra is Pinus abies association.

The contribution of Billings to vegetation of Nevada is more than the other investigators.

According to Billings (1954), the vegetation of the Great Basin, in order of aridity from south to north, consists of the following three zones:

1. Creosote brush (Larrea-divaricata) zone
2. Shadscale (Atriplex-confertifolia) zone
3. Sagebrush (Artemisia tridentata)--grass zone.

According to him, the associations of mountainous areas are very variable because of sharp changes in altitude, precipitation, temperature, and soil. Regardless of the local variations, the mountainous areas of the Great Basin can be divided into three major zonal series--Sierran series on the west, Basin Range series in the middle, and Wasatch series

on the east. The descriptions of these zones will be briefly studied in the following pages.

Stoddart and Smith (1955) present four major botanical regions for Nevada (Plate II). Since this classification is the most recent and is based on the previous studies of the many other investigators, it may be employed as a general pattern for discussion in this paper.

Geobotanical regions

Moisture is the most limiting factor for plant growth in a dry area like Nevada; therefore, to a major extent, the total average annual precipitation determines the species of native plants, the rate of their growth, and their distribution. However, there are other factors such as elevation, slope, seasonal distribution of precipitation, extremes, and mean temperature which influence the growth and distribution of the natural vegetation.

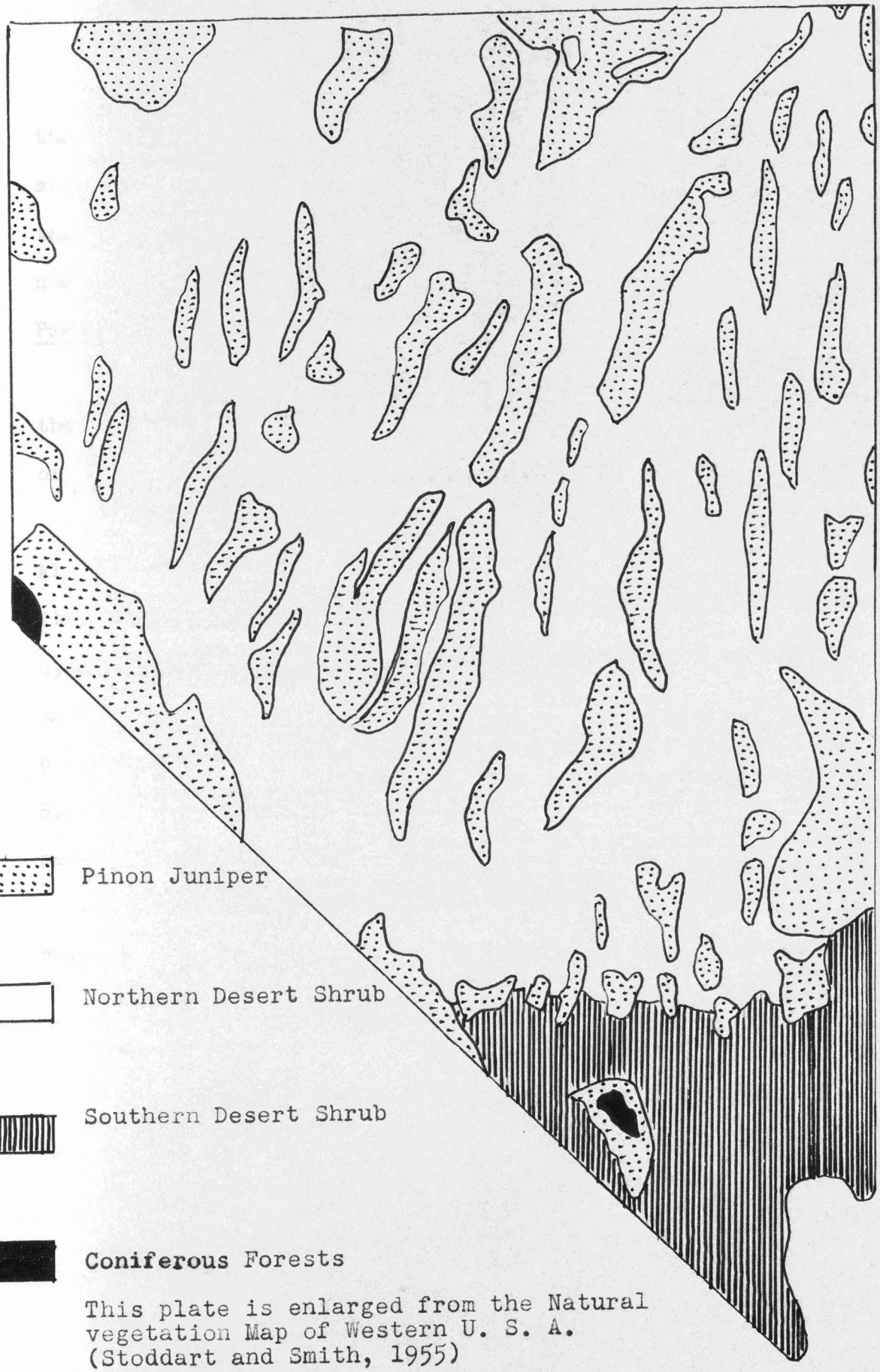
Edaphic factors also play an important role in distribution and zonation of vegetation in this state.

According to Stoddart and Smith (1955), the following four ecological regions occupy the state of Nevada.

1. Coniferous Forest Region
2. Pinon-Juniper Region
3. Northern Desert Shrub Region

Coniferous Forest Region. This region occupies only a very small area on the extreme southwest corner of the state, on the border of California. Elevation of this area reaches to 12,000 feet above sea level.

Extremely cold winters and short growing seasons of summer are characteristic of this region.



Pinon Juniper

Northern Desert Shrub

Southern Desert Shrub

Coniferous Forests

This plate is enlarged from the Natural vegetation Map of Western U. S. A. (Stoddart and Smith, 1955)

Precipitation varies from 15 to 100 inches per year. Because of the rough topography, the plant communities in this region vary within short distances. The coniferous forest of Nevada is the continuation of the northwest forests which cover western Washington, Oregon, and northern California. The dominant vegetation are the various species of Pseudosuga, Pinus, Picea, and Abies genera.

In addition to the coniferous forest region on the southwest, the slopes of the Sierra Nevada mountains are covered with a good stand of forest trees.

Weaver and Clements (1938) have given the name of "Sierran Sub Alpine Forests" to this zone. The northern limit of this area is Alaska. Its altitude rises steadily from Alaska southward from 2,000 feet to 4,000 feet at the north, 5,000 to 8,000 feet in the central portion, and finally 7,000 to 10,000 feet in the Sierra Nevada. The total annual precipitation is between 50 and 75 inches and it is the highest in Sierra Nevada. A half to nearly all of this precipitation may fall as snow, and total snowfall sometimes exceeds 50 feet in depth.

According to Weaver and Clements, the characteristic dominant species of these forests are as follows (in order of abundance):

Tsuga mertensiana

Pinus contorta

Pinus albicaulis

Pinus balfouriana

Larix lyallii

Abies magnifica

Picea engelmanni

Abies lasiocarpa

Pinus flexilis

Of these, Tsuga mertensiana and Pinus contorta are the most abundant species from Alaska to Sierra Nevada. In the Sierra Nevada Tsuga occurs with Abies magnifica, Pinus contorta and Pinus monticola.

Billings, in his recent work, Nevada Trees (1954), has listed 220 species and varieties of trees for the state of Nevada, of which 79 are native. According to him, the forests occupy 12.3 per cent or roughly 8,650,000 acres of the total acreage of the state.

In this classification, he has also included the pinon-juniper in the forest zone. Including the Pinon-Juniper Region, which will be discussed in the following pages, Billings (1951-1954) proposes three general categories of vegetation for higher elevations of Nevada.

Sierran Series. In the extreme western part of the state, the Carson Range exhibits a zonal series which is Sierran.

The lowest zone in these forests is the pine-fir association with the dominant species of Pinus jeffreyi, Pinus ponderosa, Pinus lambertiana, Abies concolor, and Libocedrus decurrens. This zone is located between 5,500 and 7,500 feet elevation.

The elevation between 7,500 feet and 8,500 feet is covered by red fir association with the dominant species of Abies magnifica, Pinus monticola, and Pinus contorta var: latifolia. Above this elevation up to the elevation of 9,300 feet is occupied by the lodgepole pine and mountain hemlock association with the dominant species of Pinus albicaulis, Pinus contorta var: latifolia and Tsuga mertensiana and Pinus monticola.

Elevations between 9,300 feet and timber line, 10,300 feet, are

occupied by the Whitebark pine association with the dominant species of Pinus albicaulis. Elevations above timber line are covered by Sierran alpine tundra association with the major species of Oxyria digyna, Phadiola integrifolia, Ranunculus oxynotus, etc.

Wasatch series. The mountain ranges of eastern Nevada from the Jarbidge Mountains of Elko County, south to the Charleston Mountains of Clark County, show modifications of the Rocky Mountain type of zonation.

In this zone, the following associations can be seen with increasing of elevation:

Pinus-Juniperus woodland association with the dominant species of: Pinus monophylla, Juniperus-osteosperma, Juniperus scopulorum, and Quercus gambelii.

Pinus ponderosa forest association with the dominant species of Pinus ponderosa.

Pseudotsuga-Abies association with the dominant species of Pseudotsuga taxifolia and Abies concolor.

Picea-Abies sub alpine association with the dominant species of Abies-lasiocarpa, Picea engelmannii, Pinus flexilis, or Pinus aristata.

The numerous isolated mountains of the central and western parts of the state, such as Toiyabe, Toquima moniter, Wassuk and the White Mountains of the Nevada-California border southwest of Tonopah, etc., have the simple and distinct vegetational pattern of the Great Basin area.

The Pinon-Juniper reaches its upper limit between 7,500 and 8,500

feet. Above this zone, the Artemisia-Cercocarpus association with the dominant species of Artemisia tridentata and Cercocarpus ledifolius forms a shrubby treeless vegetation between 8,500 and 10,000 feet of elevation. The elevation above this zone is occupied by a sub-alpine forest association with the dominant species of Pinus flexilis and Pinus aristata.

In all the zonal series, mountain streams are bordered by various species of Populus, Salix, and Betula accidentalis, Alnus tenuifolia, Alnus densiflora, Prunus virginiana, var: demissa, etc.

Pinon-Juniper Region. This region covers the elevations between 4,000 and 6,000 feet of the various isolated mountains of Nevada. Typically, this region consists of low growing trees (20 to 24 feet high).

Physiography and distribution. This region is characteristic of the southern ranges and generally occurs north of the 42° latitude. This region does not extend to the West Coast and also does not cover large areas east of the Rocky Mountains. Precipitation does not usually exceed 16 inches per year.

The soil is generally poor and almost sterile, because of low moisture accompanied with very high temperature.

In most areas, it seems that the Juniper has invaded the range lands as a result of fire and over-grazing (Stoddart and Smith, 1955).

Vegetation. The dominant species of this region are:

Pinus edulis

Pinus monophylla

Juniperus monosperma

Juniperus osteosperma

Juniperus pachyphloea

Juniperus scopulorum

In the northern parts of this region species of Purshia tridentata, Artemisia tridentata, Cercocarpus spp. can also be seen in the mentioned plant communities.

The following species of grasses do also grow in small and isolated communities on the more favorable sites:

Agropyron spicatum

Agropyron smithii

Bouteloua gracilis

Bouteloua curtipendula

Stipa spp.

Hilaria jamesii

Oryzopsis hymenoides

Bromus tectorum

Northern Desert Shrub Region. This region, which is also names "Intermountain Shrub Region" or "Basin Sagebrush Climax" (Weaver and Clements, 1938) covers the greatest portion of the state.

Physiography and distribution. This region actually lies between the Rocky Mountains, Sierra Nevada, and Cascade Range. It has a very uniform topography and, therefore, the climate and edaphic conditions are highly variable. Poor drainage, associated with low precipitation, results in accumulation of salts in the depressions and, consequently, the vegetation composition varies within limited change in elevations.

Soils are generally shallow and rocky. Distribution of precipitation is very unsatisfactory and tends to be more abundant in the non-growing seasons. The summers are usually hot and dry and winters cold and severe. Generally speaking, the plants have almost two dormant

periods in one year and growth is actually confined to a short period during spring months.

This region has a relatively short frost-free growing period.

Vegetation. The vegetation of this region consists chiefly of deciduous shrubs (Shantz and Piemeisel, 1940). Because of the low precipitation, the majority of the plants are deep rooted semidesert shrubs. The shrubs almost entirely belong to compositae or chenopodiaceae families. Shantz and Piemeisel, 1940, propose the following communities for Escalante Valley, Utah. With very slight differences, these communities are the indicators of vegetation of the Northern Desert Shrub in both Utah and Nevada.

The plant communities are divided into two major classes, as follows:

Plant communities on non-saline soils

Sagebrush association	A. tridentata
Galleta association	Hilaria jamesii
Little rabbit brush association	Chrysothamnus
Winter fat association	Eurotia lanata
Four wing salt brush community	Atriplex canescens
Juniper association	Juniperus utahensis

Plant communities on saline soils

Shadscale association	Atriplex confertifolia
Greasewood association	Sarcobatus vermiculatus
Salt grass association	Distichlis spicata
Pickleweed association	Allenrolfea occidentalis
Red Samphire community	Salicornia rubra

Salt sage community — *Atriplex falcata*

According to Weaver and Clements (1938) and Stoddart and Smith (1955), the dominant species of this region are as follows, in order of abundance:

Artemisia tridentata

Artemisia nova

Atriplex confertifolia

Chrysothamnus nauseosus

Chrysothamnus viscidiflorus

Chrysothamnus stenophyllus

Sarcobatus vermiculatus

Gutierrezia sarothra

Atriplex nuttallii

Eurotia lanata

Ephedra spp.

Almost pure stands of a single species are not at all unusual.

In addition to the mentioned species of shrubs, the following species of grasses and forbs can also be found on the more favorable sites:

Grasses

Agropyron spicatum

Sitanion hystrix

Oryzopsis hymenoides

Hilaria jamesii

Stipa comata

Agropyron smithii

Elymus cinereus

Poa secunda

Poa spp.

In the sagebrush type, the early maturing Bromus tectorum invaded the range lands because of over-grazing.

Forbs

With the exception of some locally important species, forbs are not strikingly important in this region. Sphaeralcea coccinea is almost the only forb species found on the drier sites.

On the more favorable sites and moist foothills the species of Balsamorhiza spp., Lupinus spp., Wyethia spp., and Aster spp. are present. The areas subject to over-grazing soon will be invaded by Salsola and Halogeton glomeratus, which is a new invader poisonous forb. Based on climatic and edaphic variations, Billings (1949) divides this region into two zones of sagebrush and shadscale.

The shadscale zone is characterized by a much drier climate and gray desert soils. Sagebrush zone has a more favorable climate with darker and often brownish soils. He finally concludes that shadscale can be considered as a distinct vegetation zone by itself.

Southern Desert Shrub Region. This region is also named "The Desert Shrub Climax" by Weaver and Clements (1938).

Physiography and distribution. As a whole, this region is the vast area between western Texas, southern New Mexico on the east, with southwestern Arizona, southern California, and southern Nevada on the west. This region is almost intermediate in character between Chaparal Region and Sagebrush Region. It is more similar to the latter as far as climatic condition is concerned (Weaver and Clements, 1938).

This region is the most xerophytic formation of the vegetation of North America. The characteristic feature which distinguishes this region from the other regions mentioned is its open community structure. The bushes are usually 20 to 50 feet apart and never form a canopy. The precipitation is between three and six inches annually (Weaver and Clements, 1938).

The problem of low precipitation gets more complicated and severe for plant growth when it is accompanied by extremely high evaporation of 120 to 150 inches per year. In Nevada, California, and western Arizona, precipitation falls largely in winter, while there are two rainy seasons in the other parts of this region. Hot summers and mild winters are characteristic of this region. Temperature between 110° F. and 115° F. is rather common during the summer months. Because of mild winters, the frost-free period is appreciably long and a temperature below 25° F. seldom occurs (Stoddart and Smith, 1955).

Vegetation. The vegetation of this region is distinguished by its large number of species and variability in growth habits. Fleshy plants are very common and, with their shallow roots, store enough water in their hydrophylic storage cells for their sustenance.

Many plants leaf out in the wet season and defoliate when draught occurs. The annual plants escape the draught by their early maturing ability, and their dormant seeds pass the hot and dry period.

Weaver and Clements (1938) propose the following associations for this region:

Larrea-Franseria association

Acacia-Prosopis association

Larrea-Flourensia association

Agave-Dasylirion association

Cereus-Fouquiera association

According to the same authors, the whole region is Larrea-Franseria formation. In better words, like the Basin Sage formation, or Northern Desert Shrub Region of which only one plant, Artemisia tridentata, was the dominant species in the whole region.

Shantz and Piemeisel (1924) in their studies of the vegetation of the Southwestern Desert Region suggest the following communities:

Yucca mohavensis-Ferocactus acanthodes association

Covillea glutinosa-Franseria dumosa association

Covillea glutinosa association

Atriplex polycarpa association

Dondia torreyand association

Distichlis spicata association

Carnegiea gigantea-Cercidium torreyanum association

Atriplex linearia association

Dondia intermedia association

Allenrolfea accidentalis association

Minor communities:

Atriplex canescens Prosopis glundulosa association

Washingtonia filifera-Prosopis glundulosa association

Pulchea sericea Atriplex lentiformis association

Atriplex canescens

Atriplex fasciculata

Atriplex lentiformis

Prosopis glandulosa

It should be mentioned here that this study has only covered a relatively small area in southeastern California, southern Nevada, and southwest and central Arizona. Actually, the studies have been more concentrated on Coachella Valley, California, and Gila Valley, Arizona. Search Light and Las Vegas, Nevada; Death Valley, California; etc., have been the subject of less detailed studies.

Stoddart and Smith (1955) present the following species as the most dominant in this region in order of abundance:

Larrea divaricata

Franseria dumosa

Opuntia cereus

Ferocactus spp.

Echinocactus spp.

Prosopis juliflora (on the moist bottom lands)

Prosopis odorata (on the moist bottom lands)

Atriplex polycarpa (on the alkali sites)

Acacia gerggii (upland species)

Acacia constricta (upland species)

Calliandra eriophylla (upland species)

Flourensia cernua (upland species)

Cercidium microphyllum (upland species)

Olneya tesota (upland species)

Canotia holocantha (upland species)

Fouquieria splendens (upland species)

These species are actually indicators of the previously mentioned associations.

Many annual and some perennial species of herbaceous plants are present understory of these bushes of which the Erodium cicutarium and Plantago purshii are the most important.

The important perennial grasses in this region are:

Muhlenbergia porteri

Hilaria mutica

Hilaria rigida

This is a point of interest to mention, that the grasses and the understory species have been comparatively less subject of studies than the larger size plants such as various shrubs, etc.

SUMMARY

1. The state of Nevada, with the approximated area of 110,540 square miles (70,700,000 acres) is the most arid area in the United States of America.
2. Low precipitation, high temperature, poor soil, and high salinity have created the most unfavorable conditions for plant growth in most parts of this state.
3. Many small and isolated or continuous ranges of mountains can be seen on the vast deserts of Nevada; therefore, the vegetational pattern changes very abruptly within short distances.
4. Different ecologists proposed different life zones for this state. The ecological regions discussed in this paper is a resume of almost all the studies previously done.
5. The plant communities of Nevada discussed in this paper are classified under four major ecological regions as follows:
    a. Coniferous Forest Region
    b. Pinon-Juniper Region
    c. Northern Desert Shrub Region
    d. Southern Desert Shrub Region
6. Roughly about 12.3 per cent of the total land area in the state of Nevada is covered by forests.
7. About 220 species and varieties of trees are identified in this state, of which 79 species are native.

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