

PLANT DISTRIBUTION ON HILLS SURROUNDING KABUL, AFGHANISTAN

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ABSTRACT.—Afghanistan is an arid country with barren, rocky hills and mountains. Yet, 129 species of plants were collected from the hills surrounding Kabul. Along ten transects, between 2130 to 2310 meters in height the vegetation was examined at elevation differentials of 30 meters. Frequency and cover data were collected and Importance Values computed. Data were also taken on area of soil, solid, and broken rock and degrees of slope.

Eighty-four plant species were found with varying degrees of recurrence and 19 species were the dominants. The dominant species were well represented in eight transects. In two transects, numbers seven and eight, only 11 dominants were found. Correlations between total area of rock and of soil with cover were highly significant statistically. An effort was made to correlate plant species with elevations. Forty-six percent of the plant species were apparently not affected by elevation differences, since they were found at all elevations studied. In the lower elevational ranges to about midway, 33 percent of the species were found. Eighteen percent of the total species grew from midway to the upper elevations, with only 2 percent exclusively in the upper levels.

For the past one hundred years scientists and travellers have been making plant collections in various parts of Afghanistan. Some of the earliest were British explorer-naturalists. More recently there have been German, Russian, Austrian, French, English and American botanists in the field. In 1959, M. Pabot, a French plant ecologist, visited the

country for five months and made a rapid survey of the range lands. His collection of 1,800 plants was hastily classified and deposited with the Range and Forest Division of the Afghan Ministry of Agriculture.

Most of the plant collections which have been made have been sent to various parts of the world, and are not available for study in Afghanistan. The European collections are now, for the most part, gathered in Vienna, where Dr. Karl Reichenger and his associates are working on a systematic flora of the Iranian plateau, an area which includes sections of Afghanistan. A definitive work is being organized and should be completed within the next fifteen years. The Kyoto University Scientific Expedition to the Karakoram and Hindu Kush in 1955 (Kitamura, 1955, 1964) collected plants which are now in Japan. The Pabot (1959) collection is about the only extensive collection left in Afghanistan, for which no systematic keys are available.

The writer was granted permission to see the Pabot collection for half an hour, after many requests. There was a field list of the 1,800 plants M. Pabot collected. The plants themselves were untreated, unmounted, and stored in the original newspaper

drying wrappers in which they were placed after collection. They have been placed in closets where continual rat and insect damage is rendering the collection less useful every day.

As can readily be seen, little has been done with plant studies other than collection of plants and the beginning of a systematic flora for the area. During a two-year assignment in Afghanistan a study was begun of the distribution of plants on hills surrounding Kabul.

DESCRIPTION OF THE AREA

Most travellers to the rugged country of Afghanistan comment particularly on the bare hills of the country. Fraser-Tytler (1962), speaking of the mountainous aspect of this land, referred to the Hindu Kush as the entire main range of mountains which traverses the country

for 1000 kilometers from east to west. The Hindu Kush properly called (Fig. 1), however, takes off in a southwesterly direction from the Sarikoh and Muztagh ranges at a point in the glacial region of the craggy Pamirs (75° E. Long.; $37^{\circ} 45'$ N. Lat.). It gradually diminishes in altitude from 7000 meters, until opposite Kabul it is 5000 meters. One hundred sixty-five kilometers or so to the northwest of Kabul the Koh-i-Baba range, overlapping the western extremity of the Hindu Kush, prolongs the watershed west past Bamiyan.

Only in the Kunar Valley in Nuristan to the northeast of Kabul are the deep ravines and precipitous slopes clad in magnificent forests of deodar, pine and larch. Farther west towards Kabul the ridges are bare and brown, sparsely covered in places with coarse grass which affords seasonal grazing for the flocks of sheep of the nomads. The general impression is of a wild, desolate, little-known country, a country of great peaks and deep valleys, of precipitous gorges and rushing grey-green rivers; a barren, beautiful country of intense sunlight, clear sparkling air and wonderful coloring.

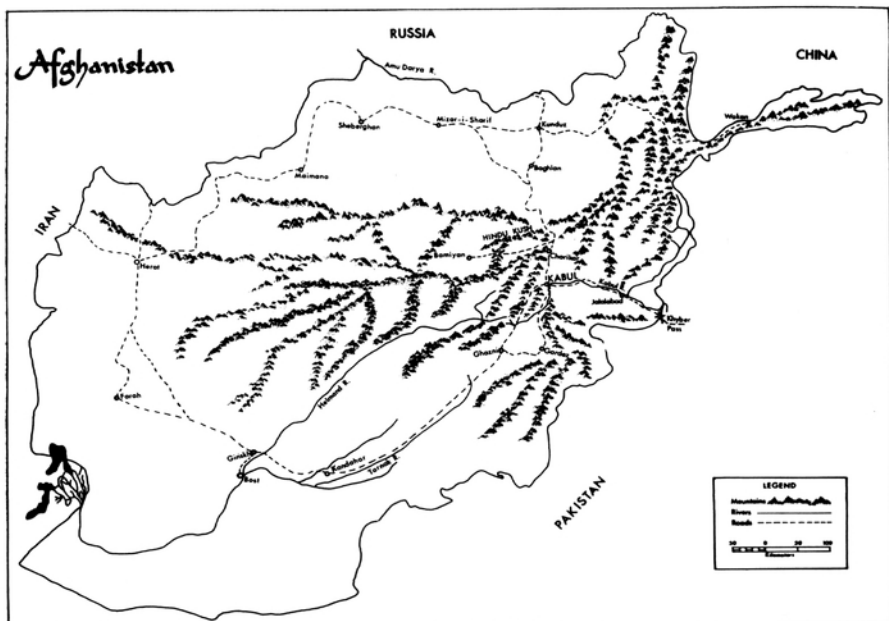


FIGURE 1.—A map of Afghanistan, showing the location of some of the principal cities and mountain ranges.

The present Kingdom of Afghanistan through which this massive range of mountains runs has an area of some 642,500 square kilometers, about the size of Texas and in the same latitude. Watkins (1963) describes the climate, which is quite different from that of Texas. Without a seacoast and far from any modifying body of water, its temperatures are extreme, influenced not only by seasonal winds but also by the variations in altitude from the lowlands (470 meters) to the highest mountains of the Pamirs and Hindu Kush which rise as high as 7,000 meters. The clear, dry air on a summer day makes the treeless plains swim with sparkingly deceptive mirages leading the traveller hopefully over more simmering miles of rock and sand in search of ever elusive water. No sea breeze or large moderating lake relieves the Helmand Valley, the Seistan Desert, or the low Amu Darya River basin along the north frontier. Forests have gone from most of the countryside, if they ever existed there. The summer sun, unmodified by rain for unbroken miles, beats mercilessly on the land, while cold winds, and, in the higher reaches, snow and ice lash the countryside in winter.

The annual rainfall for the Kabul area, according to 50-year records kept at the British Embassy, is 10-12 inches. Most of the rain comes during the month of April. Westerly winds bring the rain from the Mediterranean 5000 kilometers distant. During the summer there are occasional rain storms of very short duration, following the many dust storms. For all practical purposes, there is no additional moisture for plant life from the end of April until the December snows.

Temperatures in the summer rarely exceed 38° C in the Kabul area and may be as low as -10° C for short periods in the winter. During the fall, temperatures gradually are lowered until the winter range is reached. In the spring there is a gradual warming until maximum temperatures are reached in June.

Kabul, the capital, is located in the east, central part of Afghanistan. (Fig. 1) It lies at an elevation of 1830 meters and is surrounded by steep hills rising another 300 to 600 meters. (Fig. 2) The city completely surrounds an inner range of hills, having three main peaks and running in an east-west direction. The eastern edge of Kabul is bounded by another range called the Sher-i-Darwaza. The two ranges of hills are separated by

the narrow gorge of the Kabul River. The Sher-i-Darwaza rises at the Bala-sar Fort and continues southward for about eight kilometers, with three main peaks. To the south of this range are a few lower ridges, separating the Kabul valley from the adjoining Logar valley. To the southwest of Kabul and about eleven kilometers from the center of the city is a range of hills rising to a height of 2400-2500 meters. The Kabul valley stretches to the west nearly 32 kilometers from the city and is bounded here by the Paghman range, rising to a height of 5000 meters, and roughly parallel to the Sher-i-Darwaza. Lower hills, 150 to 300 meters above the valley floor, cut off the Kabul valley from the Pan-shir valley about 11 kilometers to the north.

These hills near Kabul are quite steep and rocky, with few large areas of soil. (Fig. 4) Most of the rock is a mica schist, ranging in color from black, through grey to reddish brown. The schist breaks quite readily into smaller, flat rocks. In the rock-strewn areas the majority of the rocks are 30 centimeters or less in diameter. There are also some igneous rocks such as granite and marble.

Most sites are greatly disturbed. The pressure of both man and beast on the present plants is extremely great. In the early spring the hills are pastured by sheep and goats. As the larger, unpalatable vegetation dies later in the season, it is cut and used for fuel. Rarely, except in mid-winter, does one find these hills free from men or beasts.

STUDY METHODS — FIELD DATA

In the fall of 1963, the author made a preliminary survey of plants on some of the hills surrounding Kabul. It was surprising to see how many living plants remained. There were some shrubs and many herbaceous species with spines. Some of the Compositae were blooming and seeding until the first part of November, a full two weeks after killing frosts had occurred in Kabul. These plants had survived a period of six months without rainfall and with daytime temperatures up to 38° C.

Two years later a transect was established on the Sher-i-Darwaza, reaching a height of 2220 meters. This was called transect 1. (Fig. 2) With the use of an aneroid barometer, thirteen plots were established with elevation differentials of every 30 meters along the transect.

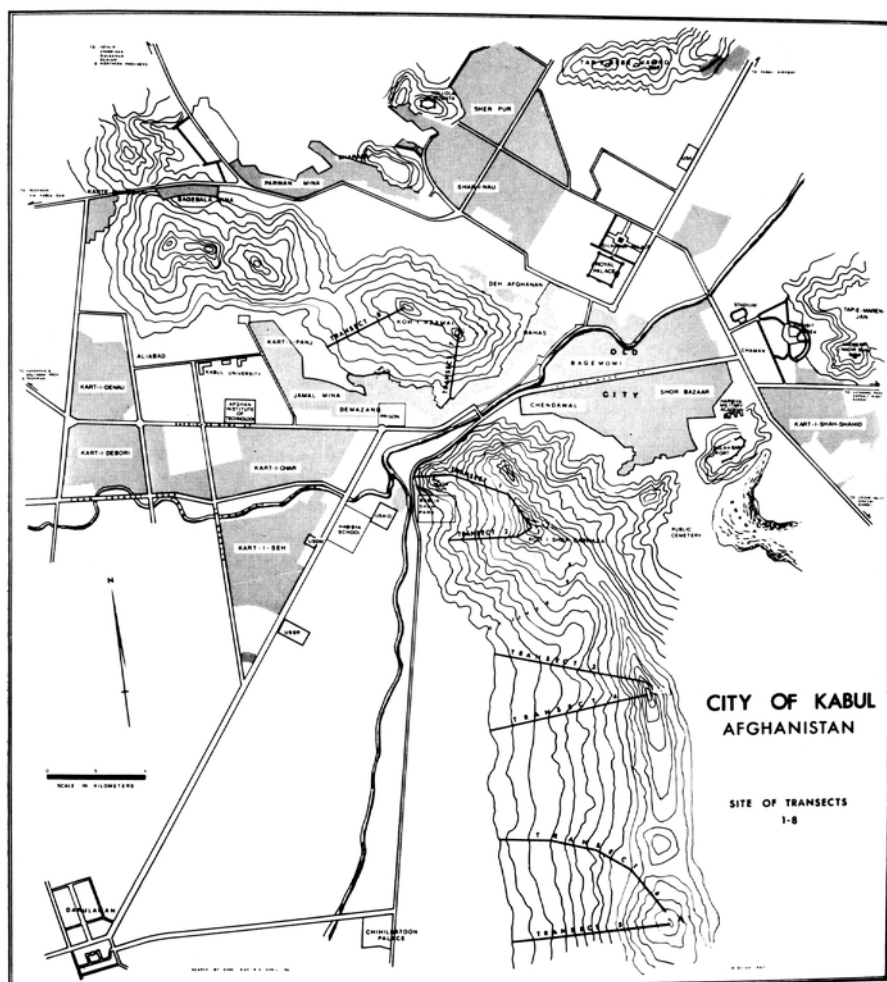


FIGURE 2. — A map of the city of Kabul, Afghanistan, showing the location of eight transects and some of the principal buildings and hills.

An area of 1 by 10 meters was sampled at each location. These sample plots, as far as possible, were located at right angles to the main transect which ran from the base of the hill to the top.

Frequency and cover data were taken. The plants were usually so scattered that no attempt was made to collect density data. A total of 107 different species were collected from this transect. These are listed in Table 5.

In the spring of 1967 nine additional transects were established with a total

of 107 study plots. Eight of these transects are shown in Figure 2. The ninth and tenth transects were located on a hill southwest of Kabul about 13 kilometers. These last two transects were selected because this was the only hill in the entire area with a few trees at the top. An additional 22 species of plants were collected from these nine transects, making a total of 129. (Table 5).

The number of study plots per transect varied according to the elevation of

the hill where the transect was located. Transects seven and eight were located on the hills surrounded by the city. The lower reaches were badly disturbed, so data were only taken between 1980 and 2130 meters.

In addition to frequency and cover data, the percentage of solid rock, broken rock and soil was taken at all study plots. The portion designated as soil was arbitrarily chosen for rock and mineral particles less than 5 centimeters in diameter. This "soil" was usually shallow and rocky. The angle of the slope in degrees was also estimated between each of the study plots.

The phenomenon of plants in a vigorous growing state after a six months period without rainfall raised the question of the source of the moisture for growth. The air is dry and there is little dew. Thus the rock itself was thought to be a possible source of water storage. Small, representative samples of the mica schist rock were collected and brought into the laboratory. Most of these have a large variety of lichens on them. The rock pieces were dried in an oven for 3 days at 120° C. Then they were immersed in water for 6 days, with daily weighings. The samples were blotted dry before each weighing. An increase in weight was found, which was probably due to water absorbed by the porous rock.

STUDY METHODS — DATA ANALYSIS

The Importance Value (Curtis and McIntosh, 1951) was calculated for some species. From among the total 129 species collected (Table 5), 83 were found in sufficient quantities for frequency data, but only 25 species for cover data (Table 1).

The survey of the area seemed to indicate a homogeneity of vegetation. The Importance Value was a method to show how representative the vegetation was on all the plots. Once the importance of species was established, the similarities of transects were tested by using Motyka's coefficient of community (as used by Bray and Curtis, 1957). This is expressed as:

$$C = \frac{2W}{a + b} \times 100$$

where a is the sum of the quantitative values of all the species in one stand, b is the sum of the quantitative values in another stand being compared, and W

is the sum of the quantitative values the two stands have in common for each species. This latter sum is made up from the least values of all the species which are common within the two stands being contrasted. A matrix or table of W values for a single transect as compared with all other transects was prepared.

There have been a number of methods devised for ordering the transects. The purpose of such an ordering is to place the transects in a sequence according to their similarity. Clausen's (1957) method seemed best adapted for the purposes of this study. As shown in Figure 3, transect 1 and transect 8 were the reference points of the gradient.

The percentages of rock, soil, cover and degrees of slope were compared by elevations or plots (Table 2) and correlations were made between these parameters. Table 3 shows these comparisons by transect. The basic outline of the transects is shown in Figure 4.

RESULTS AND DISCUSSION

Most of the plants found on the hills were relatively small, and thus the relative cover values were considerably smaller than the relative frequency values. However, since this was true in most of the study plots, the differences are representative of the vegetation of these transects. As Table 1 shows, average cover was only 5.5% for the entire area.

The Importance Values of these species were from 5.64 to a low of 0.87. There was an average difference of 0.19 in the Importance Values of the first 19 species, so these were considered the dominant plants. The difference between *Stachys* and *Thalictrum* was 0.84 in Importance Value, so this was used as the division point between dominants and non-dominants. The remaining six species (Table 1) normally appear in the spring, and they do not persist throughout the entire growing season as do the dominants. The Importance Value of the dominants was 85.88

ORDINATION

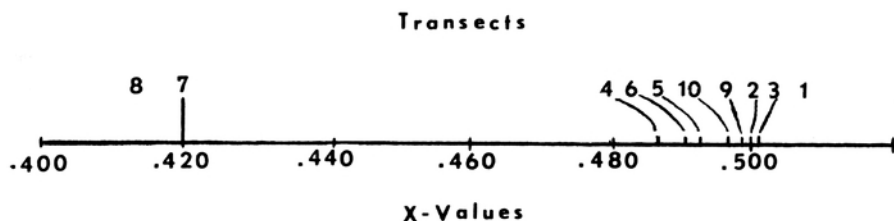


FIGURE 3. — X-values for the ordination of ten transects located on hills surrounding Kabul, Afghanistan.

for all transects, while that of all other vegetation was only 29.59.

The ordination of the transects was completed with the formation of a matrix of X values (Clausen, 1957). The results are shown in Figure 3. Transects 1 and 8 were the reference points, showing the greatest dissimilarity. Transect 7 was close to Transect 8 in X value. All of the other transects were very close in X values, showing a high degree of similarity in vegetational composition. There was an average X value difference of only 0.002 between transects 3, 2, 9, 10,

5, 6 and 4 and an average X value difference of only 0.067 between transects 4 and 7. A highly homogeneous plant composition in all transects is indicated from these data.

Comparisons were made of percentages of rock, soil, cover and degrees of slope by elevations (plots) and by transect. The means for both kinds of comparison are very close. (Tables 2 and 3). Transect 1 was generally steeper than all other transects, while transects 4 and 10 were slightly steeper than transect 9. The plots at the lower elevations were

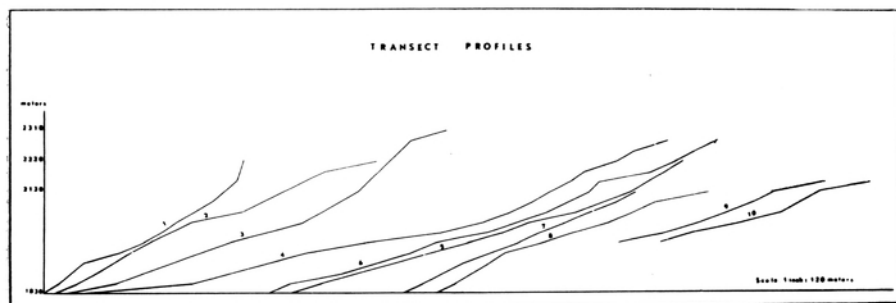


FIGURE 4.—Profiles of ten transects located on hills surrounding Kabul, Afghanistan.

TABLE 1.—IMPORTANCE VALUES OF THE DOMINANT SPECIES FOUND ON TEN TRANSECTS ON HILLS NEAR KABUL.

Species	Transects										
	1	2	3	4	5	6	7	8	9	10	Av.
<i>Cousinia</i> Sp. 1.....	2.6	5.1	5.0	6.1	4.8	4.8	10.1	10.0	3.7	4.2	5.64
<i>Bromus</i> Sp. 1.....	3.4	4.8	4.6	5.9	4.6	4.1	9.9	9.7	3.7	4.1	5.44
<i>Bromus</i> Sp. 3.....	3.2	4.7	4.2	5.8	4.6	4.1	9.9	9.7	3.6	4.1	5.39
<i>Bromus</i> Sp. 2.....	3.2	4.7	4.1	5.6	4.3	3.9	9.7	9.6	3.5	3.9	5.25
<i>Artemisia</i> Sp. 1.....	3.4	4.8	2.8	6.6	4.7	4.6	8.3	8.1	3.7	4.2	5.10
<i>Polygonum</i> Sp. 1.....	3.5	4.4	3.3	4.2	4.0	4.3	9.7	9.7	3.6	4.1	5.08
<i>Cousinia</i> Sp. 3.....	3.7	2.5	4.9	4.6	4.7	4.8	8.4	8.2	3.7	2.9	4.84
<i>Cousinia</i> Sp. 2.....	1.3	4.9	4.6	3.6	4.5	3.7	9.7	9.7	3.4	2.8	4.78
<i>Stipa szowitsiana</i>	2.9	3.9	3.7	4.6	4.6	3.6	8.2	8.1	3.7	4.1	4.74
<i>Nepeta bracteata</i>	2.6	4.7	2.4	4.4	2.0	2.3	8.1	8.0	3.5	4.1	4.21
<i>Artemisia</i> Sp. 2.....	3.2	4.6	2.5	1.5	1.1	.....	9.6	9.6	3.4	1.9	3.74
<i>Lactuca</i> Sp. 1.....	2.6	4.8	4.3	5.3	4.4	4.2	.....	.....	2.9	4.1	3.26
<i>Astragalus paghmenensis</i>	3.2	4.3	4.7	5.3	3.1	3.7	.....	.....	3.4	4.0	3.17
<i>Tulipa systola</i>	2.7	3.8	4.1	4.2	4.3	3.9	.....	.....	3.4	3.3	2.97
<i>Filago spatulata</i>	3.3	4.4	3.2	4.4	4.0	2.3	.....	.....	3.5	4.0	2.91
<i>Carex stenophylla</i>	2.4	2.5	2.8	7.0	1.4	3.8	.....	.....	3.6	2.2	2.57
<i>Eremurus stenophyllus</i>	2.6	2.4	3.2	3.1	3.9	3.9	.....	.....	1.7	2.7	2.35
<i>Euphorbia</i> Sp. 1.....	3.2	3.8	3.1	3.0	1.1	2.1	.....	.....	2.7	3.3	2.23
<i>Stachys parviflora</i>	1.3	0.8	3.5	3.4	2.7	3.2	.....	.....	3.3	3.9	2.21
<i>Thalictrum</i> sp.....	0.7	2.4	3.4	2.6	1.9	2.7	.....	.....	.....	.....	1.37
<i>Achusa italica</i>	2.1	1.4	1.8	0.7	1.1	1.9	.....	.....	2.7	1.9	1.36
<i>Anemone</i> sp.....	1.3	1.8	0.8	2.8	1.9	3.1	.....	.....	0.5	0.6	1.28
<i>Ferula barbeyia</i>	3.3	3.9	2.1	0.8	0.5	2.1	.....	.....	.....	.....	1.27
<i>Corydalis</i> sp.....	1.3	1.8	2.3	0.4	1.9	1.6	.....	.....	0.5	.....	0.98
<i>Delphinium cyphoplectrum</i>	1.8	2.1	1.4	0.4	1.1	1.9	.....	.....	.....	.....	0.87
Sub Totals.....	64.8	89.3	82.0	96.3	77.0	80.6	101.6	100.4	67.7	70.4	83.01
Other Plants.....	41.0	17.6	21.9	14.3	27.4	27.0	1.9	3.0	36.5	33.9	22.46
Bare Ground.....	94.2	93.1	96.1	89.4	95.6	92.4	96.5	96.6	95.8	95.7	94.53
Totals.....	200	200	200	200	200	200	200	200	200	200	200

TABLE 2.—COMPARISON OF PERCENTAGE OF ROCK, SOIL, COVER, AND DEGREES OF SLOPE BY ELEVATIONS (PLOTS).

	Plot Numbers																Correlations		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16		Mean	
Rock.....	47	66	76	77	75	75	78	77	78	87	77	88	84	88	94	85	78	Rock:cover	.955
Soil.....	53	34	24	23	25	25	22	23	22	17	23	12	16	12	6	15	22	Soil:cover	.947
Cover.....	10	5	6	6	5	6	5	5	4	4	4	3	4	4	2	3	5	Cover:slope	.587
Angle Slope.....	17	23	24	19	20	18	20	20	27	29	33	38	33	33	33	15	25	Slope:rock	.814

TABLE 3. — COMPARISON OF PERCENTAGES OF ROCK, SOIL, COVER AND DEGREES OF SLOPE BY TRANSECT.

	Transects										Mean
	1	2	3	4	5	6	7	8	9	10	
Rock.....	75	67	88	70	83	83	83	82	73	78	77
Soil.....	25	33	12	30	17	17	17	18	27	22	23
Cover....	6	6	4	8	4	4	4	4	4	4	5
Angle Slope...	40	27	28	19	21	21	24	23	17	19	24

generally less steep than those above 2,100 meters (Plots 9 through 15), where there was a marked increase in steepness. Transect 3, which was the longest and highest, was also the flat-

test, having an average angle of slope of just 15 degrees.

There was a highly significant statistical correlation between cover and soil and a highly significant negative statistical correlation between rock area and cover. The correlation between angle of slope and cover was not significant statistically. (Table 2.)

One of the problems of the area as far as plants are concerned is the lack of water during the prolonged periods of drought. In an attempt to find a source of water storage, the lichen-covered rocks were soaked in water after being air dried in an oven. Water was absorbed at the rate of 0.023 grams per hour for the first 44 hours, and then at the rate of 0.001 grams per hour for an additional 97 hours. There was no gain after this

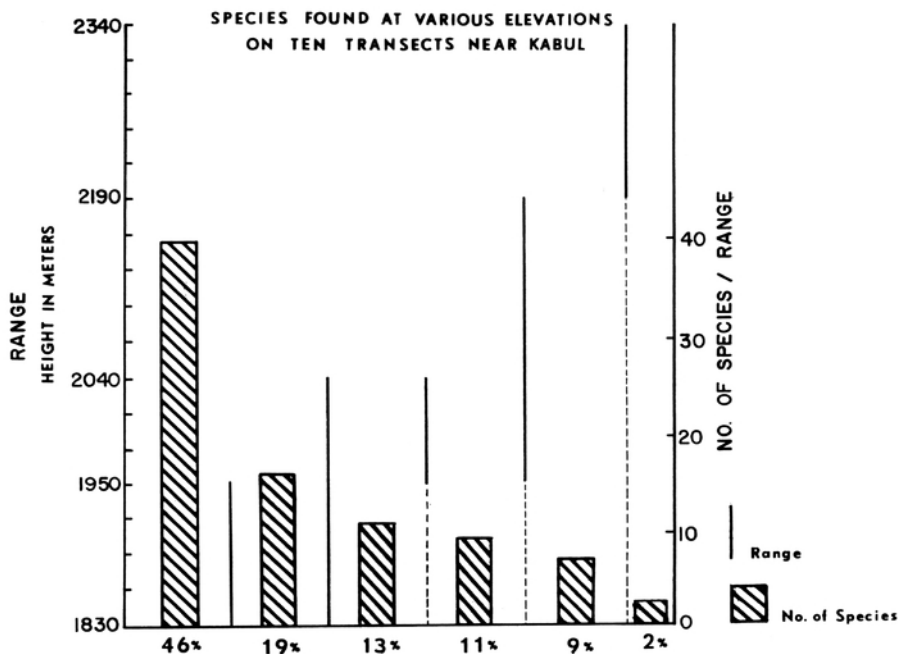


FIGURE 5. — Percentages of species found at various elevational ranges on ten transects near Kabul, Afghanistan.

TABLE 4.—SPECIES FOUND AT VARIOUS ELEVATIONS ON TEN TRANSECTS NEAR KABUL.

I. Species at elevations from 1830 to 2310 meters. (39 species)	
† <i>Cousinia</i> sp. 1.	<i>Anemone</i>
† <i>Bromus</i> sp. 1.	<i>Ferula</i>
† <i>Bromus</i> sp. 3.	<i>Corydalis</i>
† <i>Bromus</i> sp. 2.	<i>Delphinium cyphoplectrum</i>
† <i>Artemisia</i> sp. 1.	<i>Scrophularia striata</i>
† <i>Polygonum</i> sp. 1.	<i>Astragalus</i> sp. 1.
† <i>Cousinia</i> sp. 3.	<i>Allium desertorum</i>
† <i>Cousinia</i> sp. 2.	<i>Cruciferae</i> sp. 5.
† <i>Stipa szowitsiana</i>	<i>Gagea conjugens</i>
† <i>Nepeta bracteata</i>	<i>Iris</i> sp. 1.
† <i>Artemisia</i> sp. 2.	<i>Senecio</i> sp. 1.
† <i>Lactuca</i> sp. 1.	<i>Verbascum</i>
† <i>Astragalus paghmenensis</i>	<i>Lithospermum apulum</i>
† <i>Tulipa systola</i>	<i>Goebelia alopecuroides</i>
† <i>Filago</i> sp.	<i>Matthiola ozyceras</i>
† <i>Carex stenophylla</i>	<i>Senecio</i> sp. 2.
† <i>Eremurus stenophyllus</i>	<i>Achillea</i>
† <i>Euphorbia</i> sp. 1.	<i>Iris</i> sp. 2.
† <i>Stachys parviflora</i>	
<i>Thalictrum</i>	
<i>Achusa</i>	
II. Species at elevations from 1830 to 1950 meters. (16 species)	
<i>Astragalus</i> sp. 3.	<i>Calepina</i>
<i>Alyssum afghanicum</i>	<i>Cruciferae</i> sp. 1.
<i>Poa bulbosa</i>	<i>Hypochoeris</i>
<i>Erysimum</i> sp. 1.	<i>Ranunculus falcatus</i>
<i>Erysimum</i> sp. 2.	<i>Ranunculus oxyspermus</i>
<i>Descurainia</i>	<i>Alhagi</i>
<i>Fumaria vaillantii</i>	<i>Veronica bilobia</i>
<i>Hordeum</i>	<i>Haplophyllum filifolium</i>
III. Species at elevations from 1830 to 2040 meters (11 species)	
<i>Linaria ascolonia</i>	<i>Malva neglecta</i>
<i>Arabidopsis</i>	<i>Erodium bryoniifolium</i>
<i>Gallium pauciflorum</i>	<i>Nepeta</i> sp. 1.
<i>Gallium setaceum</i>	<i>Polygala</i>
<i>Euphorbia arvalis</i>	<i>Poa sinaica</i>
<i>Lamium</i> sp. 1.	
IV. Species at elevations from 1950 to 2040 meters (8 species)	
<i>Astragalus</i> sp. 2	<i>Polypodium</i>
<i>Allium mirum</i>	<i>Cynanchum arnotianum</i>
<i>Eremurus anisopterus</i>	<i>Astragalus</i> sp. 4.
<i>Amygdalus spartiodies</i>	<i>Gagea</i> sp. 1.
V. Species at elevations from 1950 to 2190 meters (7 species)	
<i>Crassulaceae</i> sp. 2.	<i>Geranium dissectum</i>
<i>Ephedra</i>	<i>Polygonum</i> sp. 2.
<i>Statice gilesii</i>	<i>Artemisia</i> sp. 3.
<i>Gramineae</i> sp. 3	
VI. Species at elevations from 2190 to 2310 meters (2 species)	
<i>Cousinia</i> sp. 4.	<i>Tulipa</i> sp. 1.

† Dominant plants.

time. The resulting 1.3 percent gain in weight, due to the absorption of water, is equivalent to 44 liters of water absorbed per cubic meter of solid material. This may be a significant factor in the retention of water over long dry periods, in addition to amounts of water held in the soil. However, further investigation is needed, as the rock samples were quite small.

Some of the plant species seemed to be found in elevational zones. (Fig. 5.) The lists of species by elevational range are given in Table 4. From the group of 83 species for which data were collected, 39 species, including the dominants, were found at all elevations (1830 to 2310 meters). There were 16 species which were found only at lower levels, up to 1950 meters. Another group of 11 species ranged from 1830 meters to 2040 meters. A fourth group of 8 species was found between 1950 and 2040 meters, with 7 species found from 1950 to 2190 meters. A sixth group of only 2 species was found between 2190 and 2310 meters.

TABLE 5.—PLANTS COLLECTED ALONG TEN TRANSECTS IN KABUL, AFGHANISTAN DURING 1965 - 1967

BETWEEN 1830 - 2310 METERS

Collection Number	Plant Name
38	EPHEDRACEAE <i>Ephedra intermedia</i> Shrenk et May
53	POLYPODIACEAE <i>Polypodium</i> L. sp.
11	GRAMINEAE <i>Bromus</i> L. Sp.1
76	<i>Bromus</i> L. Sp. 2

TABLE 5.—Continued.

Collection Number	Plant Name
	GRAMINEAE—Concluded.
98	<i>Bromus</i> L. Sp. 3
12	<i>Poa bulbosa</i> L.
62	<i>Poa sinaica</i> Stend.
57	<i>Hordeum glaucum</i> Stend.
72	<i>Stipa szovitsiana</i> Trin.
64	Gramineae Sp. 1
77	Gramineae Sp. 2
131	Gramineae Sp. 3
	CYPERACEAE
40	<i>Carex stenophylla</i> Wahlenb.
	LILIACEAE
48	<i>Eremurus stenophyllus</i> (Boiss. et B.) Baker
49	<i>Eremurus anisopterus</i> Regal.
13	<i>Tulipa systola</i> Stapf.
130	<i>Tulipa</i> L. sp.
18	<i>Allium desertorum</i> Forsek.
41	<i>Allium mirum</i> Wendelbo
8	<i>Gagea conjungens</i> (Pasch.) Wendelbo
122	<i>Gagea</i> Salisb. sp.
6	Liliaceae sp.
	IRIDIACEAE
112	<i>Iris</i> L. Sp. 1
129	<i>Iris</i> L. Sp. 2
	POLYGONACEAE
33	<i>Polygonum polyinermoides</i> Jaub. et Spack.
123	<i>Polygonum</i> L. sp.
	CHENOPODIACEAE
59	<i>Chenopodium botrys</i> L.
	CARYOPHYLLACEAE
47	<i>Arenaria griffithii</i> Boiss.
86	<i>Gypsophia antari</i> Post.
104	<i>Silene villosa</i> Forssr.
	RANUNCULACEAE
25	<i>Delphinium cyphoplectrum</i> Boiss.
102	<i>Delphinium persicum</i> Boiss.
45	<i>Ceratocephalus falcatus</i> (L.) Pers.
31	<i>Ranunculus falcatus</i> Linn.
39	<i>Ranunculus oryspermus</i> M. B.
117	<i>Anemone</i> L. sp.
119	<i>Thalictrum</i> L. sp.
124	Ranunculaceae sp.

TABLE 5.—Continued.

Collection Number	Plant Name
	PAPAVERACEAE
44	<i>Papaver macrostomum</i> Boiss. et Huet.
	FUMARIACEAE
32	<i>Corydalis</i> Medic. sp.
23	<i>Fumaria vaillantii</i> Lois.
	CRUCIFERAE
19	<i>Alyssum afghanicum</i> Reich.
56	<i>Alyssum</i> L. sp.
105	<i>Diplotaxis</i> De. sp.
16	<i>Arabidopsis</i> (De.) Heynh. sp.
22	<i>Descurainia</i> Webb & Benth. sp.
14	<i>Erysimum</i> L. Sp. 1
15	<i>Erysimum</i> L. Sp. 2
50	<i>Matthiola flavida</i> Boiss.
17	<i>Matthiola oxyceras</i> De.
24	<i>Calepina</i> Adans. sp.
84	<i>Cardaria draba</i> (L.) Desv.
27	Cruciferae sp. 1
106	Cruciferae sp. 2
107	Cruciferae sp. 3
108	Cruciferae sp. 4
116	Cruciferae sp. 5
	CRASSULACEAE
126	<i>Sedum sexangulare</i> L.
114	Crassulaceae sp. 1
115	Crassulaceae sp. 2
	SAXIFRAGACEAE
55	Saxifragaceae sp.
	ROSACEAE
110	<i>Amygdalus spartiodies</i> Spach.
	LEGUMINOSAE
3	<i>Goebelia alopecuroides</i> (L.) Bge.
4	<i>Astragalus paghmenensis</i> Sirg. et Reich.
5	<i>Astragalus</i> L. sp. 1
70	<i>Astragalus</i> L. sp. 2
92	<i>Astragalus</i> L. sp. 3
109	<i>Astragalus</i> L. sp. 4
95	<i>Alhagi</i> Adans. sp.
97	<i>Trigonella</i> L. sp.
	GERANIACEAE
121	<i>Geranium dissectum</i> L.
82	<i>Erodium bryoniifolium</i> Boiss.
	RUTACEAE
111	<i>Haplophyllum filifolium</i> (Spach.) Boiss.

TABLE 5.—Continued.

Collection Number	Plant Name
	POLYGALACEAE
100	<i>Polygala chinensis</i> L.
	EUPHORBIACEAE
61	<i>Euphorbia arvalis</i> Boiss et Heldr.
65	<i>Euphorbia allepica</i> L.
99	<i>Euphorbia turcomanica</i> Boiss.
83	<i>Euphorbia</i> L. sp.
	MALVACEAE
78	<i>Malva neglecta</i> Wallr.
	UMBELLIFERAE
35	<i>Ferula barbeyi</i> Post.
68	<i>Prangas popularia</i> Lindl.
	PRIMULACEAE
63	<i>Lysimachia punctata</i> Walt.
	PLUMBAGINACEAE
120	<i>Statice gilesii</i> Hemsl.
	ASCLEPIADACEAE
37	<i>Cynanchum arnottianum</i> Wright
	BORAGINACEAE
28	<i>Lithospermum apulum</i> L.
29	<i>Anchusa italica</i> Ritz.
	LABIATAE
52	<i>Meehania cordata</i> (Nutt.) Britt.
9	<i>Nepeta bracteata</i> Benth.
93	<i>Nepeta</i> L. sp.
46	<i>Lallemantia royleana</i> Benth.
66	<i>Lamium</i> L. sp. 1
79	<i>Lamium</i> L. sp. 2
20	<i>Stachys parviflora</i> Benth.
101	<i>Monarda</i> L. sp.
	SCROPHULARIACEAE
74	<i>Verbascum</i> L. sp.
60	<i>Linaria micrantha</i> (Car.) Hoffmgg. et Link
26	<i>Linaria asclonia</i> Boiss. et Kotschy
85	<i>Scrophularia striata</i> Boiss.
10	<i>Veronica bilobata</i> L.
128	<i>Tripogon spicatus</i> (Nees.) Ekman
	RUBIACEAE
43	<i>Galium pauciflorum</i> Bunge.
67	<i>Galium setaceum</i> Lamk.
51	<i>Rubia gedrosiaca</i> Bornm.

TABLE 5.—Concluded.

Collection Number	Plant Name
	DIPSACACEAE
69	<i>Scabiosa olivieri</i> Coult.
	VALARIANACEAE
118	<i>Valeriana</i> L. sp.
	CAMPANULACEAE
90	<i>Campanula</i> L. sp.
	COMPOSITAE
1	<i>Cousinia</i> Cass. sp. 1
2	<i>Cousinia</i> Cass. sp. 2
21	<i>Cousinia</i> Cass. sp. 3
125	<i>Cousinia</i> Cass. sp. 4
7	<i>Artemisia</i> L. sp. 1
113	<i>Artemisia</i> L. sp. 2
127	<i>Artemisia</i> L. sp. 3
30	<i>Hypochoeris</i> L. sp.
42	<i>Senecio coronopifolius</i> Desf.
36	<i>Senecio</i> L. sp.
94	<i>Lactuca orientalis</i> Boiss. et Kotschy
71	<i>Lactuca</i> L. sp.
75	<i>Filago spatulata</i> Presl.
80	<i>Reichardia picroides</i> (L.) Roth.
81	<i>Koelpinia linearis</i> Pall.
88	<i>Achillea santolina</i> L.
96	<i>Aaronsohnia</i> Warbg. et Eig. sp.
34	Compositae sp. 1
58	Compositae sp. 2
87	Compositae sp. 3
91	Compositae sp. 4
89	Compositae sp. 5
73	Compositae sp. 6

CONCLUSIONS

From these data we may conclude:

1. There is more plant life on these rocky hills than is apparent from a distance.

2. The plant life is homogeneous in this area.

3. There is a close correlation between the amount of "soil" and the relative cover of the plants.

4. There is little correlation between steepness of slope and the relative cover of the plants.

5. The lower slopes are less steep than the upper slopes except for the extreme ends of the transects at the summits. Here there is a comparatively flat area.

6. Lichen-covered rocks may be able to store moisture.

7. Forty-six percent of the plants do not seem to be affected by altitude, while the remaining 54 percent seem to be so affected.

8. Most of the high elevation plants, except for 2 species, grow equally well at all elevations sampled.

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