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FOUR ARTICLES CONCERNING SOME FEATURES OF THE PHYSICAL GEOGRAPHY OF RUMANIA

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Pages 84-302

Stefan Stoenescu
Alexandru Savu
Nicolae Florea
Raul Calinescu

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FOUR ARTICLES CONCERNING SOME FEATURES OF THE PHYSICAL GEOGRAPHY OF RUMANIA

[Pages 84-139]

Stefan Stoenescu

CLIMATE

Genetic Factors

The physical properties of the air and weather are not uniformly distributed over the country, which fact results in continual changes in weather.

The radiative processes which are the most important, are based upon solar energy reaching the earth in the form of direct solar radiations and diffused light.

In the peripheral area of Rumania in the course of a year the energy of these direct and diffused radiations exceeds 125,000 cal in the southern part of the Danubian Plain and Dobrogea, falling below 105,000 cal in the north and below 100,000 cal on the high mountain peaks, where frequent clouds are formed (Figure 1).

In sunny weather, in the noon hours, during the summer solstice, direct solar rays have fallen with an intensity of over one cal/sq cm/min (maximum intensity = 1.43 cal/sq cm/min at Bucharest). The maximum absolute values increase in the high mountain area due to air transparency (160 cal/sq cm/min).

Diffused radiation generally has a greatly reduced intensity (hundredths of a calorie). This goes up (to a few tenths of a calorie) only in the noon hours when the rays pass through light and relatively transparent stratiform clouds.

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The energy of falling solar rays is absorbed and transformed into heat at a rate varying with the nature and albedo of the various parts of the territory (the albedo of the natural surfaces of the ground varies between 10 and 28% in spring and greatly increases in winter when the ground is covered with snow).

The surface of the Rumanian Plain absorbs about 100,000 cal/sq cm per year, and the northern part of the country under 900,000 cal. Part of this energy is given out continuously by the active surface.

The annual free heat resulting from the various energy exchanges in the form of radiation, or the radiative total, is about 60,000 cal/sq cm in the southern part of Rumania and about 55,000 in the north.

This energy is unequally distributed, going into the ground or the air, or being consumed in the process of evaporation of water, melting snow, etc.

In the positive phases of the radiative and caloric total the surface of the dry ground heats up intensively.

The maximum temperatures of the surface of earth not covered by vegetation reaches 60^{o} to 65^{o} to 70^{o} in summer on the Danubian Plain.

At night in the absence of solar radiation, the active surface cools and the temperature drops. Ground surface temperatures in summer on the plain for uncovered dry ground rise over 30^{o} in 24 hours.

In winter energy exchanges are less.

Water plays an important part because during changes of phase it absorbs and releases enormous quantities of heat and gives rise to a series of very important meteorological phenomena. Water

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vapors in the atmosphere absorb infrared radiations in the solar spectrum directly as well as those given out by the active surface. Clouds reflect and diffuse the solar rays during the day. They give out infrared radiations. From the clouds fall liquid and solid precipitations which also modify the temperature of the active surface. The presence of water and the intensity of the cycle and the transformation of water in the various parts of the country also influence meteorological processes.

On the surface of the plain over 500 lit/sq m of water fall annually. It evaporates, sinks in, or runs off. In mountain areas the amount of water entering into the cycle is over 1,000 lit/sq m. Over water basins continuous evaporation takes up annually 200-750 lit of water per sq m (in the various parts of Rumania).

Nonperiodic weather changes are caused by air movements. Regionally the frequency and intensity of intrusions of cold or warm, wet or dry air, the thermal circulation of breezes, convection currents, and shifting of fronts produce great changes in meteorological conditions.

The circulation of air over Rumania is determined by the uneven development and shifting of the main baric systems, including the dynamic subtropical anticyclone of the North Atlantic, the North Atlantic cyclones, the Eurasian thermal winter cyclone, the Scandinavia-Greenland anticyclone, and the winter cyclones of the Mediterranean Sea.

All these radiation, hydrometeorological, and dynamic phenomena and processes occur quite independently and in direct connection with the various physical and geographical conditions of the active surface. This surface forms the basis and the framework for the development of the most important processes.

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A continuous reciprocal exchange of energy and matter goes on between this surface and the air masses (absorbtion and emission of heat, kinetic exchange of energy, phase transformations of water, etc).

The relief formations, especially the Carpathian range, blocks and diverts the shifting of air masses. The mountains affect the system of clouds and precipitations. Their frequency and volume increase with altitude. Adiabatic shifts of air temperature with upward movement are very important for the climate of mountain areas. Thus the intrusions of warm air from the Eurasian winter anticyclone and the storms they cause are rarely felt in Transylvania or on the Tisa Plain. The relief greatly compartmentalizes climatic conditions.

The influence of the Black Sea basin on meteorological processes and phenomena is limited because during the warm half year there is a prevailing circulation of air masses over Rumania from the western sector. These air masses have brought on an intensive continentalization process and therefore our eastern littoral is the driest area in Rumania.

Vegetation through its vital functions activizes the continental water cycle, increases air turbulence, and modifies the radiative, caloric and hydrologic totals of the ground surface, also creating an additional, superimposed active surface.

Human activity is having more and more influence upon the whole complex of these processes and phenomena. Whether it acts inconsistently and passively or consistently and actively, human society is constantly transforming the active surface of the earth and bringing about the origin and conditions of many meteorological processes and phenomena.

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Distribution and System of Air Temperature

(The data are from recordings of thermometers and thermographs installed at a level of 2 feet above the ground in special aerated shelters.)

The distribution of air temperature can be evaluated on the basis of data recorded at meteorological stations (only after these data have been processed and correlated to make them comparable).

Because of the great variations in time of meteorological conditions, due particularly to the passing and stopping of various air masses and fronts over the surface of Rumania, continuous observations are necessary over as long a period as possible.

Mean Annual Air Temperature

The higher annual air temperatures are localized in the plains areas of the southern half and the western part of the RPR [Republica Populara Romina -- Rumanian People's Republic] as a result of the high values of the radiative and caloric total in the south and the intrusions of colder winter air masses.

Mean annual temperatures of over 11° have been recorded on the Timis Plain, along the Danube in a wider zone on the west (40-50 km) and in a narrower one on the east (15-25 km), and the southeast half of Dobrogea (the southern reaches of the Black Sea coast).

The annual isotherm of +10° C delimits the lower Siret Plain on the north and lies almost from east to west on the line of contact between the southern Subcarpathians and the Oltenian Hills, with the Wallachian Plain on one side and the Getic Plateau on the other.

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In the west, except the lower Somes Plain in the north, which is colder, on all the rest of the Tisa Plain the mean annual air temperatures are over 10° C with relatively uniform distribution.

In general the 10° C isotherm follows a path oriented from east to west along the latitude of 45° N on the base of the southern Subcarpathian slopes and from north to south in the zone of western hills forming the flat basin of the 2 great depressions (the Carpatho-Balkan and the Pannonian).

The highest mean annual air temperature values were recorded in the Danube valley at Orsova at 11.8° C and in southwest Dobrogea at Mangalia at 11.7° C.

The almost uniform distribution of air temperature over the flat terrain of the plain illustrates the relatively homogenous (in the horizontal sense) thermic structure of the air masses and the relatively uniform development over the area of the processes of transformation of the masses.

In the higher areas of the hills and plateaus of Rumania air temperature is less uniformly distributed because of the irregular relief.

In the depressions and great river plains the mean annual air temperature has greater values than in the higher areas.

The Moldavian plateau is distinguished from the mountain area by a mean annual air temperature of over 7° C. The Covurlui platform, the southern slopes of the Birlad Hills, and the plains of the lower courses of the Siret and the Prut are covered with colder air (mean annual temperature over 9° C), while the Moldavian Subcarpathians and the Suceava plateau are covered with warmer air (average under 8° C).

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In the Jijia basin the mean annual temperature is 8.5-9.5° C.

In the southern Subcarpathian depressions the air temperature is higher (8-10°) than in other areas but on the peaks it falls to 6-7°.

The air temperature is unevenly distributed on the Transylvanian plateau, being lower in the upper portion east of the Tirnava plateau (7° C) and higher in the sheltered valleys and depressions in the west (9.5° in the Alba Iulia depression and 10.1° at Deva).

At the bottom of the Maramures depression the mean annual air temperature exceeds 8° C.

The Carpathian chain is contured at its base by an annual isotherm of 7° C and on the various slopes the air temperature falls about 0.5-0.6° C for every 100 m of altitude. In the southern Carpathians, at a height of about 1,950 m, is the annual isotherm of 0° C, which in the north of Rumania extends generally down to the 1,800 m level.

According to certain observations of the Omul Peak Meteorological Station in the Bucegi massif (at 2,511 m altitude, temperature -29° C), it can be determined that on the highest peaks of the Meridional Carpathians (Retezat and Fagaras mountains) the air has a mean annual temperature of -3° C and on the 2 peaks of the Rodna massif about -2.5°.

It is established that above the 0° C isotherm forest, vegetation can grow only sporadically in areas sheltered from the wind.

The transition from deciduous to coniferous forests does not show a constant level and many massifs show overlappings and reversals. In January the air generally has the lowest mean temperatures of the

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entire year. The only exception is high mountain peaks over 2,000 m high, over which the mean annual temperature in February is equal to or a little lower than that in January.

The isotherms in January have their own characteristic distribution, the result of various complex processes peculiar to the cold season (Figure 2).

In the southeast corner of Rumania the mean air temperature remains positive (Mangalia $+0.2^{\circ}$ C), being higher than anywhere else in Rumanian territory because of the caloric balance peculiar to the waters of the Black Sea. This effect of heating of the air is felt the length of the coast and in the eastern half of Dobrogea.

Higher temperatures of -2° C are also recorded for the surface of the Tisa Plain, which is often covered in winter by air from the west and southwest heated over the waters of the Atlantic, Mediterranean, and Adriatic.

Over the surface of the Rumanian plain the average air temperature fluctuates from place to place around the value -3° C.

It is not by chance that localized values have been established in the central zone lower than in the Subcarpathians. This zone constitutes the bottom of a wide depression bordered by the peaks of the Carpathians and the Balkans, closed toward the west but wide open towards the east.

Due to the action of the horizontal baric gradient, air from the Eurasiatic winter anticyclone or those from the north is driven toward the periphery. Because of its density and greater specific gravity it is displaced and goes to the bottom of the depressions and spreads out in the form of thin, stratiform lenses. Often the low-pressure

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systems slide along over them without touching the ground. In the case of high anticyclones clear and cold weather prevails. In the long winter nights, due to the persistence of phases of predominance of negative radiative balance, the surface of the plain cools and intensely accentuates the stable sedimentation of cold air (thermic inversions).

Only along the plains and marshes of the Danube, where processes of condensation, sublimation of vapors, and release of heat when the waters are not frozen take place, does the air temperature rise to any extent.

In the valley of the middle Siret, through the broad saddle between the heights of the Suceava Plateau and those of the central Moldavian plateau, intrusions of cold air from the northwest are inevitable, although their progress en masse to the south is restricted by the general narrowness of the Siret valley. Consequently in the lower Roman-Bacau area very cold air strata are often isolated.

The surface of the Transylvanian plateau is covered on the west by warmer air than in the east.

The mountain slopes come in contact with colder air above. The level of the -10° C isotherm is located at about 2,000 m in the Southern Carpathians and at 1,800 m in the northern part of Rumania (Rodna Mountains, Calimani, etc).

On the highest peaks of the Fagaras Mountains, Mindra and Retezat, the air temperature in February can be fixed between -11° and -11.5° C.

The intra-Carpathian and peri-Carpathian depressions are often covered in winter by intensely cooled air, in contact with

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snow and the frozen ground, which slides down the slopes toward the valley. This very cold and dense air cannot easily be displaced by the warmer air of the advective intrusions which slide along above.

The long period of stagnation of the dense and cold air at the bottom of the depressions is characteristic of the winter system. In special cases the depressions are also filled with cold air by way of advection if the passages lie in the direction of the cold masses (such as the Ciuc depression).

Between the lower levels of the relief, covered with the very cold air of the thermic inversions and the peaks of the great cold heights there is on the slopes of the Carpathians and Subcarpathians a relatively warmer zone, fed by air from the free atmosphere or engulfed in clouds in the stratum of the condensation and sublimation processes, in which a considerable amount of latent heat is released. Usually cold masses have limited vertical development (some only a few hundred m) so that above them relatively warmer air masses circulate. Consequently the areas of precipitation often stay covered with somewhat warmer air. This peculiarity of the thermic system of the atmosphere accounts for the fact that the forest vegetation and foliage survives the winter.

To determine the winter system, a chart can be drawn up of the frequency of days of mean negative temperatures.

On the Rumanian Plain daily mean temperatures below 0° C are recorded for 60 to 65 winter days. On the Tisa Plain they fall below 35 in the south and exceed 70 in the north. In Central Drobrugea and in the northern part of the littoral the number of such days is 30-35 and they fall to zero in the southeast corner.

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On the Transylvanian plateau the frequency of such days is 70-80 as compared with 75-90 on the Moldavian plateau.

In the high mountain area, above the level of 2,000 m, the annual number of such days exceeds 200 (227 at Omul-Bucegi Peak).

In the internal depressions of the eastern Carpathians over 100 days occur per year with a mean temperature under 0^{o} C.

Acute frosts caused by intrusions of cold air are more frequent in the eastern half of Rumania than in the sector covered by vegetation. Their frequency is inconsistent from year to year in accordance with the development of the various baric systems.

Many winters are relatively moderate from the point of view of air temperature. Because of the displacements and interactions of air masses, differentiated as to origin and physical properties, in wintertime the air temperature system is highly variable. The intervals of acute frost alternate with freezing.

Covering of various sections and levels of relief by cold or warm air masses and by frontal systems do not take place simultaneously and do not last for the same period of time over the whole territory of Rumania.

Spring starts in the south and southwest.

Because of their great specific warmth the waters of the Black Sea basin heat up gradually so that in spring the air on the littoral is colder than in the south of the Tisa Plain (the mean air temperature in April is 9.2^{o} at Constanta and 9.4^{o} at Sulina as compared with 11.7^{o} at Orsova and 11.4^{o} at Jimbolia).

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The ground and the air warm up later in the north and in the mountainous regions of Rumania.

In July the mean air temperature exceeds 23° in the south, in a zone 10-25 km wide along the Danube meadows (Figure 3).

The entire surface of the Dobrogea, the Rumanian Plain, the southern part of the Getic Plateau, and the Timis Plain is covered with warm air of an average temperature of 22° C.

The plains of the Apuseni Mountains are contoured by an isotherm of 20° toward the west, including the southwest portion of the Transylvanian Plateau and the Alba Iulia and Hateg depressions and skirting the slopes of the Poiana Ruscai massif and the Banat mountains.

This isotherm passes through the area of the southern and eastern Subcarpathians and aligns itself to the north along the Siret Valley. On the peaks of the southern Carpathians over 2,500 m in height the air temperature averages 5-6° C and at the upper limit of coniferous forest the air temperature has a mean value of +10° C.

Although there are scant certain indications for the western and the eastern Carpathians, a mean drop of air temperature of 0.7° C per 100 m difference in altitude can be determined.

Throughout the year, but particularly in spring, the air temperature on the upper slopes and high peaks of the mountains exposed to the wind is on the whole lower than at the same level in a free atmosphere, since because of the sudden rise of the air it cools adiabatically. These processes frequently take place on steep slopes facing the north or northwest. Correspondingly in a sheltered mountain area falling air becomes warmed adiabatically. At the foot of high

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mountains the Foehn effect is noted toward the east and southeast while thawing, spring, and the gradual growth of vegetation are earlier.

Differences in air temperature in summer and winter are not identical over all Rumania.

The highest mean annual amplitudes (the differences between the average temperatures in the warmest and the coldest months) are localized in the central area of the plain (over 26°) and on the Moldavian Plateau. On the Black Sea littoral in the area of the meadows and fen lakes of the Danube, on the Tisa Plain and in the western part of the Transylvanian plateau the mean annual amplitude is about 23°. It is relatively more intense in the depressions and drops at high altitudes.

At the level of the southern Carpathian peaks this difference does not exceed 17° C.

In the coniferous zone the annual thermal amplitude values vary between 17° and 20°, being smaller on the northern forested slopes and larger on the southern and southwestern unforested ones.

On the Black Sea littoral the annual air temperature system is more moderate than on the plain, the annual amplitude being 2°-3° C less.

Therefore in the Rumanian Plain area the thermal system is continental, being characterized by occasional air intrusions which are very cold in winter and very warm during a long summer.

Toward the mountain heights the cold period of the year lasts progressively longer and the warm period is limited.

On the highest mountains the thermal contrast between summer and winter is limited, and the heating and cooling of the mass of the

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troposphere is later on the heights. At altitudes of 2,000 m and above the air is warmer in August but not in July, as on the plain, and in wintertime the lowest mean monthly temperature is in February (not January). This retardation becomes appreciable at 2,000 m and above and as a result spring is very cold in comparison with fall.

The waters of the Black Sea basin, because of their caloric system, especially on the plain, also considerably modify the temperature of the passing air masses. The maximum effect is produced in winter, when the caloric exchange is activated by the great difference between the high temperature of the waters as compared with the cold air masses.

On the Black Sea littoral in winter the air is 3-4° C warmer than in the central area of the Rumanian Plain.

In spring the waters and to a certain extent the air above them remain colder while they remain warmer in the fall. In Rumania's coastal area this distinction in the mean monthly value of the air temperature in the particular month exceeds 2° C as compared with the plain. The greatest distinctions are registered in the extreme southwest corner of the Dobrogea.

Mean Temperatures (°C)	April	October	January	July	Amplitudes
Mangalia	9.5	14.2	0.2	22.7	22.9
Alexandria	11.2	12.2	-3.3	22.7	26.0
Timisoara	11.1	11.6	-1.4	22.0	23.4

Extreme Air Temperatures

The lowest air temperatures are frequently registered on the highest peaks of the Carpathians.

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At 2,500 m, minimum sub-zero temperatures are obtained even in the summer months. The lowest value registered at Omul Peak was -38° (January 1929).

On the plains the minimum absolute temperatures are from -30° to -32°, on the coast -25° to -27°, and in the hills -26° to -29° C. In the depressions within the Carpathians the lowest values in all Rumania have been recorded, -38.5° C at Bod (24 January 1942).

The maximum absolute temperatures are 44.5° at Ion Sion on the Braila Plain (10 August 1951), 42° on the Rumanian Plain, 40° C on the Tisa Plain and the Moldavian Plateau, 39° on the Transylvanian Plateau, and 38.5° on the Black Sea coast. On the heights in the area of the Alpine meadows the greatest air temperature values reach $20-25^{\circ}$ C in clear weather, when there are summer tropical continental air intrusions.

Atmospheric Pressure and Air Movements

The pressure exerted upon the surface of Rumania's territory by the mass of the atmosphere is unequally distributed and constantly drifting. Under the action of gravity the lower strata support the pressure of the upper ones and therefore the greatest pressure is localized at sea level and in areas of low relief.

The mean annual air pressure values are 1,016 mb (one millibar = 100,000 dynes per sq cm = 4/3 mm Hg) in the Danube delta and on the beaches of the Black Sea coast they drop to 1,015-1,013 mb along the fen lakes and meadows of the Danube.

In regard to absolute height, up to the 300 m level the surface of the plains supports (per sq cm) an average pressure of 1,014-995 mb, the vertical baric gradient (G_2) being 13-15 mb/100 m difference of level.

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In hill and plateau areas up to a 600 m altitude the pressure drops to 950 mb.

The slopes of high relief bear less and less pressure and at the 2,500 m level the rarified air of the high altitudes exerts a pressure of only 745 mb/sq cm. More than one-fourth of the mass of the atmosphere is below this level.

In time, with the action of cosmic, dynamic, thermic, and terrestrial dynamic forces, the whole gas envelope of the planet is in constant agitation and oscillation.

In winter the Rumanian Plain and the littoral are often covered with the denser air of the continental anticyclones. In January the pressure mounts (in mean monthly values) to 1,015-1,020 mb. On the Tisa Plain at the same altitudes the pressure remains lower since the dense air from the east remains contained in the low southeast area, its advance being blocked by the Carpathian peaks.

In the warm half of the year, especially under the thermic convection action of the rising air, a general drop in pressure to 1,000-1,010 mb takes place in the plains so that in the course of the year the differences of the mean monthly values are 8-10 mb. In the highest mountain regions, depending on the baric structure, which varies with the season, and on the troposphere and the various baric systems of the air mass as well, the atmospheric pressure develops in the opposite way from the way it does on the plain, dropping in winter and rising in summer.

At 2,500 m the mean monthly pressure drops below 740 mb in January and February and exceeds 750 mb in July and August.

Fluctuations of the mass of the atmosphere are also caused by

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the attraction exerted simultaneously in different directions by the masses of the earth and the moon (atmospheric tides, which correspond to the phases of the moon).

Twelve-hour oscillations are produced by the rotation of the earth. Thus in the 24-hour period the pressure drops in the afternoon (between 1,500 and 1,900 hours) and rises in the morning (between 0700 and 1200 hours) and in the 12-hour interval 2 other corresponding oscillations are produced, but they are not as intensive (at 2200 and 0400).

These fluctuations do not exceed 1-1.5 mb/24 hours.

The greatest pressure changes are caused by the development and displacement of baric systems (local and advective pressure variations).

The main baric systems which influence Rumania's climate do not have fixed positions but constantly develop, shift, and disappear.

The North Atlantic dynamic subtropical anticyclone occupies more northerly positions in spring, driving humid and relatively cool air from its northern periphery in the form of a northwest wind. Ocean air masses pour huge precipitations on the slopes of the Alps and Carpathians and heat up intensively over the fields of Europe. In this process of transformation (they are continentalized), their temperatures rise while relative humidity drops. During the warm half of the year the horizontal baric gradient is directed from the west toward the east (the pressure in general drops toward the east).

In winter the entire northern surface of Eurasia takes on an infinitesimal quantity of solar energy. Under conditions of negative radiation balance, the active surface cools intensively, resulting in

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a cooling of the lower strata of the air which increases in density. The Eurasian winter thermic anticyclone develops unevenly in various years (with a pressure of 1,025-1,045 mb in the central area). On its southern periphery the cool and dense air covers the southern portion of Rumania, as the north wind is also from the east (Crivat).

In its phases of maximum development this system joins with the subtropical dynamic anticyclone, forming the great winter continental anticyclonic chain or ridge which covers all central Europe and the entire territory of Rumania.

But frequently the 2 anticyclones occupy diagonal positions (southwest and northwest) distributed over the north Atlantic depressions which develop over the warmer waters of the Mediterranean. These lows shift toward the east over Rumania. They bring about changes in weather, due to the passage of systems of warm and cold front clouds, and shift masses of air between their warm and cold sectors. Similarly occlusions of the cyclones and intensive precipitations are produced before the mountains.

In the western posterior sector of the cyclones, in the course of profound displacements, rapid dislocations and penetrations of cold and dense air from the Eurasian or northern anticyclone occur. In this phase the wind strengthens again, the temperature drops quickly, and frosts and storms wreak havoc. The cold air of the periphery of the winter continental anticyclones spreads toward the southwest, covering the concave features of the relief and the lowest areas. Similarly the pockets of cold air stay contained in winter at the bottom of the Carpatho-Balkan depressions. The warmer and more humid air from the west covers the Tisa plain, the Transylvanian plateau, and the peaks of the Carpathians, beyond which, passing toward the

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east, it loses contact with the land, sliding upward over the higher surface of cool and dense air strata. The Subcarpathians and the mountain peaks are covered during this phase by masses of humid air of a moderate temperature.

The eastern and southern section of Rumania is accordingly exposed in winter to intrusions of cold, dense, and dry air (continental). The direction of the northeast wind changes in accordance with the high relief formations. The wind blows stronger at high altitudes on the Moldavian plateau in the northeast. On the plains of the Prut and the Siret the general direction is from the north toward the south and even from the northwest (in the vicinity of the eastern Subcarpathian peaks). In the area of the Carpathian irregularities cold air from the east is dispersed over the surface of the plain and the direction of the northeast wind shifts between north, northeast, and then east-northeast.

When the air mass exceeds 1,000 m it can also penetrate the intra-Carpathian depressions through the eastern Carpathian passes (Nemira wind).

In the Oltenian Subcarpathians and the Mehedinti plateau the effects of the northeast wind are not noted. [Apparently some lines] ... the mountain peaks in winter remain above the stratiform clouds that cover the Rumanian plain and the Moldavian plateau.

In the cold half of the year there are at times intrusions of arctic air (from the north). If these masses have a relatively large vertical development they can at high altitudes pass beyond the Carpathian plain and occupy the great Pannonian depression and the Transylvanian plateau. The coldest and densest air remains contained in depressions (the air temperature falls to between -20° and -35°)

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and groups of stratiform clouds are formed which are phenomena peculiar to thermic inversions.

Intrusions of humid air from the west, northwest, and southwest (popularly called Auster) give rise to special phenomena in various parts of Rumania.

On the western slopes of the mountains of the Banat and the eastern and western Carpathians, the adiabatic cooling of the air and the condensation of water vapors form masses of relief clouds from which frequent rains and snows fall. On the high peaks of the Carpathians the west wind prevails almost all year long and its mean velocity exceeds 10 m/sec and even reaches 40 m/sec.

On the eastern mountain slopes the descending wind causes a compression and adiabatic heating of the air, a drop in its relative humidity, evaporation of the particles of water and ice in the clouds, and clear skies. The Foehn effects are localized in the eastern shelter of the great peaks of the eastern, western, and central Carpathians.

In spring and summer, when the trajectories of the cyclonic fronts occupy northerly positions facing Rumania, their southern sector consists of dry and very warm air masses of continental air advancing toward the southwest, south, or southeast. This dry and warm wind is popularly called "the poor thing" or "the black wind."

Besides the great displacements of the air masses resulting from the action of the main baric systems during the entire course of the year, a series of local air circulation systems develops under the physical and geographical conditions of the various regions of Rumania. The most frequent originate in the contrasts of heating

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and cooling of the active surface (breezes from the seashore, mountains, forests, etc).

During the warm half of the year, over those portions of the terrain that are heated by solar rays, vertically rising currents of warm air (thermal convection) are developed daily and cumulus clouds are formed.

With spring anticyclonic systems clear and dry weather prevails, with drought conditions.

Great instability of climate is characteristic of Rumania both in winter and summer. During the cold season intrusions of warmer and humid tropical air alternate with sharp frosts produced by the Eurasian anticyclone and the masses of arctic air. In spring, long intervals of drought are interrupted by brief, torrential rains with hail and electrical discharges. In spring, after a few days of rapid warming, the weather cools off, with late freezes and frost. This instability of weather peculiar to transitional areas results in great losses to the economy of Rumania and especially to Rumanian agriculture. The most extreme climatic conditions are localized in the plains area, precisely where they endanger the crops.

Humidity of the Air, Clouds, and Precipitation

Water vapors are dispersed in air masses as a result of evaporation of water (at the surface of bodies of water, rivers, and damp ground), sublimations (at the surface of layers of snow and ice), and transpiration of plants (physiological evaporation). Like other atmospheric gases water vapors exert a particular pressure which can be expressed in millibars. This is customarily called vapor tension. In many cases absolute humidity figures are used (gr H_2O/cu m of humid air).

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The most humid air is localized over the littoral, over the river meadows, the fen lakes, and the delta, and in the western parts of the Timis and Tur plains.

The mean annual values of the absolute humidity exceed 9 gr water/cu m air along the shore of the Black Sea and fall below 7 gr at altitudes of over 2,000 m in the southern Carpathians and on the peaks of Caliman and Rodna mountains.

In winter the cold air contains less vapors and the mean absolute humidity drops in January from 4 gr on the littoral to below 3 gr in hill and mountain areas and even below 2 gr on the highest peaks (Omul Peak 1.7 gr).

In summertime, besides the intensive evaporation of the waters of Rumania's territory, large quantities of vapors are also brought in by humid air masses of oceanic origin (especially in the western sector). In July (Figure 4) the mean absolute humidity is 12-13 gr at the base of the air masses which cover the greatest part of Rumania (the Danube Plain, the Tisa Plain, the Transylvanian and Moldavian Plateaus). Above the river meadows the humidity in the air increases over 14 gr along the river meadows and fen lakes of the Danube and 15 gr over the delta and the littoral (Figure 7).

In the high hills area and on the lower portion of the mountain slopes in the area of deciduous forests (beech) the humidity varies between 12 and 10 gr, dropping to 8 gr in the coniferous forest area and even below this value above in the alpine pasture area.

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MEAN ABSOLUTE HUMIDITY (GR H_2O/CU M OF AIR)

	January			July			
Times	8	1.4	2.0	8	1.4	2.0	Mean annual
1. Omul Peak	1.7	1.9	1.8	6.1	6.9	6.3	3.8
2. Predeal	2.6	3.0	2.8	9.7	10.1	10.4	6.0
3. Bucharest	3.1	3.6	3.4	12.6	11.8	12.3	7.4

Along the Black Sea littoral the air is the most humid all year and especially in summer when water evaporation is intensified. On clear days the sea air invades the coastal strip in the form of breezes.

MEAN ABSOLUTE HUMIDITY (GR)

	January	July	Annual
1. Sulina	3.8	15.7	9.3
2. Mangalia	4.1	15.7	9.4

In wintertime the northern part of the littoral is often covered by masses of cold and dry continental air, while in summer the air becomes intensely humidified over the delta, the fen lakes, and the expanses of water.

Relative Humidity. The real tension of water vapors and absolute humidity can be related to the maximum tension and the maximum absolute humidity (corresponding to the various air temperatures) and expressed in percentages in the form of relative humidity, the mean annual value of which is usually between 70% and 75% over the plain, the hills, and the Transylvanian and Moldavian plateaus. On the mountain slopes it increases in the higher altitudes, in the cooler air, reaching 85-90% at altitudes above 2,000 m.

In January the plain and the mountains are covered with the

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coldest air, with a very high humidity of 82-90%. Only the southern and eastern Subcarpathian regions, the Getic Piedmont, and the mountain peaks of northern Moldavia remain covered with warmer air of lower relative humidity (74-82%).

In July (Figure 5) the relative humidity is very high on the peaks of the highest mountains of Rumania, which are located above the condensation level and frequently covered with clouds. In the rest of Rumania it is lower, 70-75% over the Transylvanian plateau, 62-70% on the Tisa Plain, 55-65% in the southeast sector, and above 70% over the littoral.

While the plain is being covered by dry and warm continental air masses, if at the same time there is also a prevailing anticyclonic system with clear weather, the relative humidity of the air can drop below 30% in sunshine, withering plants and parching the soil. The same thing happens oftener in the southeast of Rumania and especially in the Baragan.

In July and August at 1400 the mean monthly relative humidity values generally drop even below 45% over the Danube Plain.

Cloud System and Distribution. Cloud masses cause diffusion of solar rays, the day affecting the system of radiative balance of the surface of Rumania's land.

The degree of cloud overcast (measured in tenths) in mean annual values is the greatest along the Carpathian range, on the slopes of which the ascending displaced air cools adiabatically and drops over the plain. On the peaks of the southern Carpathians the annual mean exceeds 7/10. In the south the annual value is between 5-6/10 and on the littoral and in the southern part of the Danube Plain it drops below 5/10 (Figure 6).

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DEGREE OF OVERCAST

Places	Omul Peak	Timisoara	Targul Mures	Iasi	Bucharest	Sulina
Winter	7.0	7.1	6.5	7.4	6.7	6.5
Spring	8.1	6.0	5.5	6.2	5.8	4.7
Summer	7.9	4.7	4.5	5.0	4.3	2.5
Autumn	7.1	5.5	5.0	5.8	5.3	4.4
Annual	7.5	5.8	5.4	6.1	5.5	4.5

In winter the whole lower area of the plain and the plateaus are covered with clouds for a longer period and the degree of clouding is 7/10. In the cold season stratiform clouds with slight vertical development prevail. The high peaks of the Carpathians often stay above them, being rather rarely covered by the cloud masses.

FREQUENCY OF OVERCAST DAYS (neb 7.6/10) IN %

Places	Omul Peak	Timisoara	Targul Mures	Iasi	Bucharest	Sulina
Winter	56.6	57.8	58.5	60.3	50.1	47.9
Summer	67.4	26.5	23.6	26.2	16.8	7.9

FREQUENCY OF CLEAR DAYS IN %

Places	Omul Peak	Timisoara	Targul Mures	Iasi	Bucharest	Sulina
Winter	19.1	19.5	16.9	14.8	22.0	25.9
Summer	8.7	43.9	46.3	36.2	42.8	70.6

In the first part of the warm half-year, in times of sunlight on the active surface, ascending thermic convection currents are developed and cumulus clouds are formed. Toward the end of summer and the beginning of fall the weather generally stays clear. The frontal systems cease to be active and because of the heating and drying of the ground and the lower stratum of the air the condensation level is raised to greater heights. Toward autumn thermic convection drops in

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intensity and carries up more dry air. Therefore the general and most frequent direction of displacement of air masses is from west to east. Those on the littoral are met by air which has gone through a more intense process of heating and drying (continentalization). From the northwest there are only intrusions of continental air. Therefore clear weather prevails on the littoral. As a result of the covering of the sky with various degrees of overcast in the various parts of the land, the duration of solar radiation is greater over the plain and in the southeast (clearer) sector and less in the mountainous area.

The System and Quantitative Distribution of Precipitation.

Various types of precipitation fall on Rumania at irregular intervals and give very variable amounts of water because the genetic, formative processes of clouds and precipitations are very complex and variegated. Thus, in the warm half of the year intensive and torrential rains from thermic convection clouds predominate. These are localized in restricted, isolated zones (local showers) and give large amounts of water in a short time; they start and stop abruptly and are accompanied by storms and often by electrical phenomena and hail.

In the course of the year intense and torrential rains give 70-80% of the total annual amount which falls on the Rumanian Plain and the Moldavian Plateau.

On the Tisa Plain these rains represent only 62-75% of the total.

In autumn and on until spring, cyclonic systems over Rumania are displaced from the west along the polar front. Overcasts of stratiform clouds and slow rains (drizzles) alternate with abundant

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rains and an abrupt change of weather upon the passing of a cold front. In the western part of the country and on the western mountain slopes, the frontal processes are more active. Before the Carpathian peaks occlusions are produced as are relief clouds with rain and general local snows (upon the passage of fronts and through adiabatic cooling of ascending humid air). In the southwest corner of the country, in the western Carpathians and even in the Maramures Mountains frontal precipitation is very common in autumn and spring. To these are also added the convective rains at the beginning of spring which are very abundant.

In winter Rumania is irregularly and not simultaneously covered by various advancing air masses. In the eastern sector the intrusions of cold continental air produce snows accompanied by storms and sharp frost. Part of the west is often covered by ocean (Atlantic) and maritime (Mediterranean and Adriatic) humid and not very cold air, so that winter precipitation falls more often in the form of drizzles or snows (Figure 8).

In the mountains at altitudes above 2,000 m, since the temperature is low, the precipitation falls in the form of snow for most of the year.

On the slopes of the high massifs of the Carpathians precipitation falls in great quantities, generally exceeding 1,200 mm per year. In depressions and valleys surrounded by great heights, smaller amounts of water fall because of adiabatic heating through compression of the air displaced in falling. This Foehn effect results in evaporation of the raindrops in the clouds and clearing up. The abrupt drop in volume of precipitation is evident in all intramountainous depressions of the eastern Carpathians (less than 700 mm of water a year), in the eastern

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shelter of the western Carpathians, and in the deep passes lying across the trajectories of the air masses (Bistrita valley, the transverse valleys of the southern Carpathians, the Cerna valleys, etc).

On the Tisa Plain, the annual amounts of water in precipitation are less in the west (550-600 mm) and greater toward the east, exceeding 700 mm in the piedmont zone. On the surface of the Poiona Rusca massif the annual distribution of water averages 1,100-1,200 mm, while in the western Carpathians and in the western corner of the central Carpathians these values are exceeded.

On the surface of the Transylvanian plateau, the annual volumes of water increase from west to east to the amount of over 800 mm a year in the rivers flowing between the Tirnavas plateau and the base of the Vulcan chain. In the upper regions of the Maramures Mountains, the Rodna and Caliman massif, frequent and abundant annual precipitation falls, which, upon the average, amounts to over 1,200-1,400 mm per year.

Comparable amounts also fall in the important massifs of the central Carpathians. Because of the relief and due to the prevalence of snows, the quantitative distribution of precipitation is extremely irregular and very difficult to measure. Under the action of the wind, the snow is driven from exposed peaks and slopes and drifts into sheltered areas. The steep walls stay uncovered in winter and deep layers of snow accumulate in the valleys.

The southwestern sector of Rumania receives annually a lesser amount of water from precipitation. Less than 500 mm in the south of the Rumanian plain and in the east of the Moldavian plateau, and less than 400 mm in southeast Barganul and in the area along the littoral and over the Danube delta.

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Since in these areas the major part of the water comes from local, convective precipitation, the distribution of the annual water totals has an insular aspect.

In this sector during the warm half-year, long intervals of dryness and heat (two-three months) predominate interrupted infrequently by teeming and torrential rains. Drops of less intense rains, which fall from altostratus clouds often do not reach the earth but evaporate in falling through the warm and dry air which covers the heated surface of the plain in springtime.

During the year precipitation falls on only 60-75 days on the littoral, on the average, 70-100 on the Rumanian Plain, 80-115 on the Moldavian Plateau, and 110-140 on the Tisa Plain and on the Transylvanian Plateau.

On the slopes of the Carpathians precipitation is much more frequent and occurs on 145-180 days per year in the coniferous forest area and on 180-200 days on the peaks of the highest massifs.

During the year, the smallest amounts of precipitation fall in the cold months of January and February, and the greatest at the end of spring and the beginning of summer (June). In the 3 summer months, on the plain, only half the amount of water from rains collects as in the summer season. On the surface of the plain, especially in the eastern part of the country, lack of precipitation in the winter months is aggravated by the action of storms which deposit snow on fields not equipped with snow fences.

The greatest volume of water falls in June, generally, but the mean volumes of precipitation in this month remain quite small in the Black Sea littoral area (40-45 mm) compared with the Danubian

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Plain (65-95 mm), the Moldavian Plateau (75-95 mm), and the Transylvanian Plateau, and the Tisa Plain (75-110 mm). The greatest volumes of water fall in this month on the high mountain peaks (185-200 mm) under the combined action of various frontal processes, dynamic and thermic convection, abundant evaporation of water, massive transpiration of forests, etc.

In the southwestern part of the country there is an intensification of precipitation in autumn, when lows encounter the Carpathian relief; the most frequent precipitation generally occurs in May, on an average of 6-7 days on the littoral, 10-12 in the eastern sector, 12-15 in the west and over the Transylvanian Plateau, and 17-21 days on the highest peaks of the Carpathians.

These mean values are exceeded in some years, but at other times during periods of dryness and drought they are reduced.

During the warm half-year, in the whole hilly area of the plateaus and the plain, intervals are possible of 30 days' duration in which no precipitation falls. On the average the duration of intervals of dryness is greater in the southeast, amounting to 18-20 days in the Baragan and Dobrogea. These phases are characteristic of the anticyclonic system. During the year there are 2 periods in which anticyclones predominate -- at the end of winter and between the end of the summer and the beginning of autumn. The summer dryness is more dangerous to vegetation because in these anticyclonic situations the sky stays clear, the ground heats up intensively by day, and the air becomes very warm and dry. Sometimes on the Rumanian Plain during the warm half year dry intervals can last for 2 or 3 months.

The continental nature of the meteorological processes which go

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on over Rumanian territory is more marked in the eastern sector, where not only dryness and reduced air temperature, but also the longer dry intervals contrasts with the particular intensity of the torrential precipitation in the cold half. In the eastern part of Rumania the precipitation system is extremely variable in time and the quantitative distribution over the area is very uneven.

The western sector and the high areas have more frequent and less torrential precipitation.

In wintertime, solid precipitation usually takes the form of snow.

In winter a snow blanket covers the surface of the plains irregularly (Figure 9).

In the littoral area it snows on the average only 10-15 days per year, and in southern Dobrogea snow never falls in many winters.

On the Danube Plain snowfalls are often accompanied by rapid intrusion of cold continental air from the winter anticyclone. The north wind blows snow over the fields, driving it up against obstacles and into valleys, so that rarely is an unbroken snow cover to be found on the terrain. Organization of the territory by planting forest rows to protect the fields is being conducted especially in the southeastern sector of the country, which is exposed to the north wind.

In this sector the accumulated snow in depressions melts later in the spring, forming ponds and fen lakes.

On the Tisa Plain wind action is less strong and the snow cover melts more slowly.

On the slopes of the Subcarpathians and the surface of the

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Transylvanian and Moldavian Plateau snows are more frequent (30-45 a year, exceeding 70 in the mountain areas). On the peaks of the southern Carpathians it snows on the average 100 days a year, and snow represents up to 75% of the total amount of water precipitated during the year. Heavy snows fall in some years even in July or August, and heavy hail falls sometimes lay on the ground for several days.

The snow cover does not last nearly as long on the littoral; it is entirely sporadic and intermittent on the Rumanian Plain and the Moldavian Plateau, progressively increasing toward the high mountain peaks, where it reaches about 200 days a year.

Climatic Zones and Sectors

Atmospheric processes develop in direct relation to the various physical and geographic peculiarities of the area. Among these the Carpathian relief is the most important climatic factor.

The ring of high mountains separates the central portion of the country from the peripheral zone which is particularly exposed to moving air masses and fronts, so that the western sector is often covered with humid air masses and frontal systems accompanied by precipitation of long duration. The eastern sector is exposed to cold air from winter continental anticyclones from the north and northeast.

In high areas on the mountain slopes the whole complex is modified in relation to the structure and vertical development of the various air masses, the altitude and dynamics of the fronts, the shifting of the condensation level, etc.

Mountain Climate

Distribution of soil and vegetation, the peculiar water system and the geomorphologic features are zoned according to altitude so as to bring out the distribution of the corresponding climatic conditions.

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Climate of Alpine Meadows. The highest peaks of the Carpathians above the 1,750 m level in the north and 1,900 m in the south are covered all year by the cold air of the high atmosphere.

Above these levels annual mean temperatures are negative and in the warmest month (July-August) the mean values do not exceed 10° C (5.6° on Omul Peak).

The mean volume of water vapor in the air is only 60-50% of what it is on the plain, and much less in winter in the continental air masses.

Because of the rarefication of the air solar radiation is much more intensive. (Maximum intensity of direct rays reaches approximately 1.6 cal/sq cm/min.

The number of dust particles in suspension is much less. Due to the rarefication and great transparency of the air, the effective radiation of the ground surface is greater.

On the various surfaces of the mountain relief the distribution of descending solar rays, heating, and the values of the radiation and caloric balance are very variable. Alongside sunlit surfaces there are shaded or sharply inclined areas which stay humid and cold.

Because of the nonuniform fall and persistence of snows, the snow cover of the various sectors may have very uneven values. As a result the peaks and mountain areas are characterized by a great variety of microclimatic conditions. Similarly, a great disparity between the temperature of the air and the temperature of the ground surface oriented toward the sun and sheltered from the wind in summertime is also characteristic, or the temperature of the intensely cooled snow surface on clear winter nights.

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The maximum absolute temperatures of the ground surface and rocks can exceed 40^{o}-50^{o} in the sun while the maximum air temperatures do not exceed 20^{o}-25^{o}.

As a result of the intense cooling of the ground in the negative phases of the radiation balance, the cooled air on the slopes condenses and slides down into the valleys, being retained only at the bottoms of declivities.

On clear summer days the sunlit southern slopes are heated intensely and the air above them rises toward the peaks in thermic convection currents (ascending breeze). As a result, the water vapors born by these currents condense, forming cumulus clouds of vertical development.

Around every peak and massif, thermic convection develops at the beginning of each day on the eastern slopes in the morning, then at noon on the southern ones, and later in the afternoon on the western ones.

Towards evening as the humid air begins to rise the water particles in the clouds fall and disappear through evaporation.

During periods of advective displacements of air masses, the wind velocity is very high on the high peaks and on slopes exposed to the wind (over 20-40 m/sec).

In sheltered areas there is prevailing calm or intrusions of irregularly whirling air.

On slopes facing into the wind the air is cooled adiabatically during intensive dynamic convection. These slopes are usually covered with clouds. In the sheltered area the air is heated more intensively

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in falling (according to the law of dry adiabatic processes), being felt at the bottom of the slopes as a warm wind (Foehn).

In this situation the sky is clouded and the air becomes very dry (relative humidity greatly reduced).

The greatly reduced density of the rarefied air up above (mean pressure under 800 mb) creates special conditions of exchange of atmospheric gases with the soil and plant tissue.

A violent wind often blows from the western sector, blowing snow over the peaks and forming cornices and great drifts on the sheltered slopes. In these areas there is greater danger of avalanches of frozen snow (without adhesion) in winter or during the spring thaw.

On the shaded slopes in the north and the sheltered ones in the east and southeast the snow cover lasts a long time (sometimes until the end of May).

Because of the intensive radiative cooling of the surface of the ground, through condensation or sublimation, the water vapors in the air produce dew, frost, and abundant rime.

The lower stratum of the air heats up in the immediate neighborhood of sunlit ground, but when clouds pass the temperature of the ground drops abruptly (sometimes 30^{o}-40^{o}).

Adiabatic cooling of rising air results in freezing of the ground, frost, and snow even in summertime.

These phenomena greatly reduce the brief season of plant growth in the higher altitudes.

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The snow cover lasts almost without interruption from October until May (18 to 200 days) and it sometimes snows even in summer (85 to 100 days of snow per year).

Clear weather prevails in winter, the high peaks being above thermic inversions and the stratiform clouds which cover the plain and the depressions. In these periods, the mountains are engulfed in air masses, especially those over the plain.

The sharpest frosts occur in February. The summer season is characterized by a general rise in the condensation level to about 2,500-3,500 m through development of thermic convection on the sunny slopes, the formation of cumulus clouds, and falling of heavy rains accompanied by electrical discharges and thermic storms (in the afternoon).

These cold rains, which are thus transformed into hail, hail and snow, or snow are frequent phenomena during the "warm" season.

In this cold and humid climate complex, true pockets of dry microclimate nevertheless appear on the sunny sheltered southern slopes, where xerophilous and heliophilous plant associations grow.

On shaded slopes, frost and rime last until noon on clear days in spring and autumn.

In mountain districts, the irregular terrain creates complexes of extremely diverse juxtaposed microclimatic conditions.

But on the high plateaus snow is more evenly distributed and the wind blows unobstructed. In calm weather or winter nights cold air covers the ground surface forming thermic inversions.

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Cold air collects in the valleys in winter, as well as mist and stratiform clouds. Frost, dew and freezing are frequent and abundant.

Climate of Medium High Areas. On mountain slopes between about 800 and 1,800 m grow coniferous, nondeciduous forests.

In winter these areas remain above the masses of cold air which cover the great depressions and plains of the country, and in summer they do not become exceedingly warm. The temperature of the air, relatively reduced, has a moderate range between summer and winter and between night and day. Minimum absolute air temperatures do not drop below -26° C. Mean annual temperatures are positive and the mean July temperature varies between 10° and 18° C. The annual vertical thermic gradient is 0.50°-0.60°/100 m, 0.40°/100 m in winter, and 0.70°/100 m in summer. The amounts of precipitation water exceeds 1,200 m ($1/m^2$) annually on the western slopes, being the result of adiabatic cooling of humid air in advective displacement (dynamic processes) or of summer thermic convection. When a cold front passes, occlusions of warm and humid air occur with heavy precipitations. On the eastern slopes sheltered from the wind, Foehn effects predominate and these values drop below 1,000 mm.

In spring and autumn and often even in winter these slopes are covered by cloud strata in which heat released by condensation of vapor raises the temperature of the air by several degrees.

In clear weather the mountain slopes are covered by alternating circulation of rising breezes of warm air by day and descending breezes of cold air by night.

The shading of the ground, the existence of thick forests with

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ground covered by a thick and damp layer of needles, the direct evaporation of water from the ground and on the needles moistened by precipitation, and the transpiration of forest vegetation create and maintain a constantly high humidity in the forest atmosphere.

In the upper part of this zone toward the high altitudes there is a modification where the vegetation begins to modify itself, anatomically and functionally, to the ecological conditions.

On the northern shaded slopes soil and air temperature have a much more moderate range. The soil humidity remains much greater, being excessive. Under the forest roof the lack of light results in a lack of chlorophyllous vegetation.

The upper limit of the forests is higher on the shaded northern slopes. On the southern slopes, Alpine pasturage occupies much lower ground (200-300 m) due to the intense insolation and dryness.

In the narrow, deep gorges dug by hydrographic forces there are prevailing shade, excessive humidity, accumulation of cold air, and phenomena resulting from condensation and sublimation of water vapor (mist, dew, frost, low-lying clouds, hoar frost).

Climate of Hills and Plateaus

This covers the greater part of the country (between 200 and 800 m), being encountered on the Transylvanian Plateau, in the Subcarpathians, the Moldavian Plateau, Horstul Dobrogean, the Getic Plateau, and the western hills.

The air temperature is moderate, the annual mean varying between 7°-8° in the north and in the high areas, and 10° in the west and toward the plain. In July the mean air temperature varies between 19° and 22° C.

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The daily ranges of air temperature are less than on the plain.

Precipitation falls in average amounts of 550-800 mm per year, more abundant in the north and west and less in the east and south.

Among the more prevalent climatic features of this sector are cooling, freezing, and late frosts in spring (which cause freezing and falling of flowers) and early in autumn, as well as deposits of hoar frost and glaze frost (especially in the valleys) in winter.

The valleys are covered in winter with more humid air and with mist. In some sectors the cold, dense air occupies only the lower portions of the relief.

The Climate of the Plain

The lowest level of the relief presents peculiar features in the development and distribution of atmospheric processes and phenomena.

In general the mean annual temperature and the summer temperature of the air and soil are higher than in the other climatic zones.

The winter phenomena have a short duration and are intermittent, although in some years heavy frosts, violent storms and successive snows alternate with the thawing, rains, and drizzling of humid and mild weather.

A dry spring with clear weather and a dry wind (anticyclonic system) often follow a winter with little snow.

The warm period of the year is very long, the transitional seasons are sometimes lacking, being replaced by an abrupt transition from winter to summer and the reverse, or by repeated alternation of cold and heat.

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The heat of summer and intrusions of dry air are associated with an uneven and unfavorable distribution of precipitation, which falls either in limited quantities (frontal precipitation) or is unevenly distributed in time and over the surface (torrential local rains at widely spaced intervals).

The most frequent precipitation falls at the end of spring and the beginning of summer.

The maximum extreme temperatures are recorded in summer, and in winter the plain is covered by the coldest and most dense air.

Important differences appear in the distribution of climatic features in accordance with the general orientation of the country's relief in relation to the displacement axes of the air masses, the baric systems, and the fronts in various seasons.

Climatic Sectors

The Carpathian peaks divide the country's territory into 3 great climatic sectors:

A. Central sector: the Tirnavas Plateau with the Transylvanian Plain and the Somesan Plateau.

B. Southeast continental sector: Moldavian Plateau, the Rumanian Plain, and the Dobrogea.

C. Western sector: the Tisa Plain.

Some climatic peculiarities appear in the north and the southwest of the country.

D. Northern sector

E. Southwest sector.

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A. Climate of the Tirnavas Plateau, the Transylvanian Plain and the Somes Plateau

Due to frequent intrusions of humid air masses from the west the whole section enclosed by the Carpathian peaks has a climate characterized by constantly higher air humidity than in the continental sector -- the southeast of the country.

Although the amounts of precipitation are not very large, nevertheless droughts are not felt.

Due to prevailing western circulation the distribution of humidity, air temperature, and clouds and precipitation is not uniform.

In the shelter of the Western Carpathian peaks (the transverse peak of Mount Bihor and the mass of Mount Gilau) the frequent Foehn effects produce a general air temperature rise in the area of the Alba Iulia-Turda depressions. The sky is much clearer than on the rest of the plateau and annual precipitation averages less than 600 mm.

On the eastern half of the Tirnavas plateau which is generally higher the humid air is cooled as it rises. The relative humidity is higher in this sector and clouds are more frequently formed in the north, yielding heavier and denser precipitation.

The annual mean air temperature becomes gradually lower toward the east (9.5° at Alba Iulia, 9.0° at Bratei; 8.4° at Cluj, and 8.7° at Targul Mures) to 7° at the foot of the eastern Carpathians.

The geomorphological disparities of the plateau's surface result in differences in the distribution of detailed climatic conditions.

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In wintertime during periods of anticyclonic weather colder air is generally compartmented in the main valleys (in January the mean air temperature being from -4^{o} to -5.5^{o}). Lower mean temperatures are registered in winter in the depressions near mountains and in valleys (-5.5^{o} at Iara and -5.5^{o} at Sighisoara).

Absolute minimum temperatures are characteristic of these depression areas (-34.2^{o} at Sibiu, -33.8^{o} at Fagaras, -32.6^{o} at Cimpie Turzii, -32.8^{o} at Iara).

And in the large valleys of the Tirnavas, the Mures, and the Somes rivers similar phenomena occur in winter in the case of intrusions of very cold masses of arctic or continental polar air from the north or northeast (-35^{o} at Medias, -32^{o} at Targul Mures, -32.5^{o} at Cluj, and -32^{o} at Jibau). In these periods, the peaks and rivers between stay above the strata of dense and cold air, being covered with somewhat warmer air (by a few degrees).

In summer the ground surface and the air in the valleys and depressions heat up more intensely. The mean air temperature in July exceeds 20^{o} in the Alba Iulia depression and at the confluence of the Great Somes with the Little Somes, dropping below 19.5^{o} in the east and the higher areas.

In the main valleys and large depressions the air temperature in summer can exceed 39^{o} C (absolute maximum temperatures recorded: 39.7^{o} at Alba Iulia; 39.2^{o} at Bratei; 39^{o} at Targul Mures; 39^{o} at Cimpia Turzii, 39.4^{o} at Fagaras).

The differences between the absolute extreme values of possible air temperatures may exceed 70^{o} in the valleys. On the high points of the plateau they are somewhat less.

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Compared with the southern part of the Rumanian Plain, on the Tirnavas Plateau and the Somes Plain and on the Somes Plateau in summertime there is no very extreme heating and the duration of the warm periods of the year is somewhat less.

The average date of the last spring freeze varies between 15 and 20 April in the southwest and the beginning of May in the east.

The date of the first autumn freeze is later in the west (10-15 October) and earlier in the east (25-30 September).

The tension of water vapor in the air is also higher in the southeastern, warmer sector and becomes lower toward the north and east.

Mean Values (mm Hg)	I	II	Annual
Alba Iulia	3.4	12.6	7.7
Sibiu	3.4	12.7	7.6
Bod	3.1	12.6	7.3
Cimpie Turzii	2.9	12.0	7.2
Cluj	3.1	11.6	7.0
Targul Mures	3.0	12.4	7.3

Near water and forests the air is more humid than on the hills and open country.

The relative humidity is generally higher than in the southern part of the country.

MEAN RELATIVE HUMIDITY IN %

	I	VII	Annual
Alba Iulia	87	70	78
Bratei	82	74	78

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MEAN RELATIVE HUMIDITY IN % (Continued)

	I	VII	Annual
Sibiu	90	74	80
Bod	82	71	76
Cluj	89	69	76
Targul Mures	83	72	76

Mist and dew are frequent phenomena in autumn and spring in the river valleys and in depression areas with stagnant water.

Frontal processes play an important role in cloud formation during the cold half-year and thermic convection in the warm half-year.

In the entire area the sky is more overcast in the cold season (more than 6/10) and clearer in summer (less than 5/10). Toward the end of summer and the beginning of autumn the most prolonged intervals occur of clear weather and the fewest instances of mist.

In the area where humid air masses come down from the west, clearing is more frequent than on the rest of the plateau.

The quantitative distribution of precipitated water is uniform in neither time nor space.

Mean annual totals of water over many years vary between 550-600 mm in the west and 700-800 mm in the east and in the vicinity of the mountains.

In the course of the year the greatest amounts of water fall in June and the most intensive precipitation occurs in the warm interval (May-August).

In 24 hours over 80-90 mm of water may fall especially in convection rains.

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Place	Number of days with mist	Degree of overcast (0-10/10)			Annual number of days		
		I	II	annual	clear	cloudy	overcast
Alba Iulia	48	7.3	4.3	5.7	107	116	142
Bratei	46	6.6	4.2	5.5	99	137	129
Sibiu	23	7.2	5.3	6.2	96	104	165
Bod	22	6.9	5.0	6.0	93	117	155
Cluj	31	7.0	5.1	6.0	85	120	160
Targul Mures	68	6.8	4.5	5.6	113	106	146

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In the course of the year precipitation falls on the average of 95-100 days in the western part of the plateau (Alba Iulia depression) and 130-140 days in the eastern part, while between them the annual number of days with snow is only 17-35.

Totalling the various successive strata of newly fallen snow, 55-85 cm of snow is obtained for the annual average.

As contrasted with the northeastern, continental sector of Rumania on the Transylvanian Plateau snow is not driven by the wind but slowly melts where it is deposited.

Most frequent air circulation occurs in the west, becoming more intense along the valleys and on the higher, unforested peaks.

The continental air from the winter Eurasian anticyclone is generally diverted in front of it, southwest of the Eastern Carpathian peaks.

Only in time of intrusions of great masses of arctic or maritime polar air can the entire area be covered with cold air. But in these periods the valleys and depressions are especially subject to frost.

Warm weather is common in the cold season and in the interval between the end of summer and the beginning of fall.

In spring, when the cyclonic systems are passing over Rumania the wind is more frequent and intense.

The thermic whirlwinds of summer are local phenomena covering quite restricted areas.

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B. The Southern and Eastern Continental Sector

This includes the Moldavian Plateau, the Rumanian Plain with the Subcarpathians and the Getic Plateau, and the Dobrogea.

It represents an extension of the continental climate from north of the Black Sea.

The area is covered rather frequently in winter by cold and dry air and summer by warm and dry continentalized air.

(a) The Moldavian Plateau. It is exposed in winter to intrusions of air from the Eurasian continental anticyclone and has an extremely continental climate.

Due to the advance of cold air especially in the valleys, along the Siret, the Prut, and the lower portions of the relief, it supports more acute conditions in winter than the high areas of the plateau and the Subcarpathian hills.

MEAN MONTHLY TEMPERATURES

Place	Jan	April	Aug	Oct	Annual
Iasi	-3.7	9.7	21.5	10.5	9.6
Birlad	-3.8	9.9	21.7	10.8	9.7
Roman	-5.2	8.3	19.8	9.2	8.2

The radiation and caloric balances in summer do not show as great values as in the southern part of the Rumanian plain, so that the ground and the air do not heat up extremely. But in winter sharp frosts are more accentuated than in the south of the country and the Moldavian Subcarpathians.

ABSOLUTE EXTREME TEMPERATURES

	Maximum	Minimum
Iasi	40.0	-30.0
Roman	37.5	-32.0

In summertime clear skies and dry air prevail. Sometimes in spring the east wind brings evaporation of water from the soil and transpiration of plants.

In the Jijia depression the long intervals of summer drought have forced the inhabitants to build primitive reservoirs.

The conditions of extreme dryness in summer are interrupted by rains which do not fall often or uniformly and generally on limited areas.

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In the winter the north wind blows violently.

The frontal rains of autumn (storms of long duration) make unpaved roads impassable, impeding transportation.

The first freezes generally set in toward the end of October, and the last ones of spring hang on until the middle of April.

There are characteristic intervals of thawing in winter, in which it is even possible to do some agricultural work.

During the cold season, due to thermic intrusions, the plateau and especially the valleys are often covered with mist and low-lying stratiform clouds.

The mean annual volumes of precipitation exceed 500 mm only in high areas, the dryest area being in the south (the lower Siret Plain).

The first snows begin in the middle of November and the last occur in the middle of March.

(b) The Climate of the Rumanian Plain. On the surface of the Rumanian Plain the physical properties of the air and the meteorological weather conditions have a relatively homogeneous distribution.

Along the valleys of the Danube in the broad (30-60 km) zone from Turnul Severin to the Braila Plain the highest air temperatures are generally registered and weather clearer than on the western plain prevails.

Although from one year to another the cloud cover varies considerably the mean annual duration of sunlight exceeds 2,100-2,300 hours (2,000-2,600 in various years). In clear weather, during

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the summer season and the high elevation of the sun over the horizon, the intensity of insolation is generally greather than one cal/sq cm/min (maximum value measured in Bucharest is 1.43 cal/sq cm/min). During the long summer days, the ground surface and the air are heated intensely due to the high values of the radiation balance.

In the form of direct and diffused solar rays, the surface of the plain annually receives an average of over 125,000 cal/sq cm in the south and under 117,000 cal/sq cm in the vicinity of the Subcarpathians.

The absorbtion and transformation of solar energy into caloric energy is not uniformly distributed over the surface or in time on the various portions of the plain. In general, their mean total annual value is 100,000 cal/sq cm (surface covered 10-28%).

Air temperature is higher in the south, exceeding on the average: 11° annually, 23° in July, and -3° in January. However in the north these values do not fall below 10° annually, below 22° in July, or below -3° in January. On the central portions of the plain between the Olt and Ialomita valley in winter there are stable localized thermic inversions (mean temperature below -3°). In this area the mean annual amplitude of air temporature exceeds 25° C.

The daily amplitude of air temperature fluctuations is less in winter ($6-8^{\circ}$) and greater in summer ($12-15^{\circ}$).

In the warm half-year the weather is more stable and the moving air masses heat up intensely. The variability of the air temperature is very great in winter when more frequent intrusions of maritime polar and tropical air masses alternate with masses of very cold air impelled by the Eurasian thermic anticyclone.

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The minimum temperatures of arctic and polar continental air penetrating between the Carpathians and the Balkans and continuing over the low surface of the plain are very low, below -20° C, in the December-February period and even -30° (for example at Bucharest-Bameasa -32° C).

The winter phenomena, although of short duration, are very intensive. Storms and frost in January and February 1954 were localized almost exclusively on the Rumanian Plain.

It is characteristic of the thermal system that periods of thawing and warming alternate with ones of heavy frost. Abrupt cooling also occurs in March and often after a warm interval there follow late cold air intrusions and advective freezes which are disastrous to cultivation of crops, vines, livestock, etc.

The long intervals of thawing in winter can be used to perform the agricultural tasks peculiar to this season. The late freezes of spring pose the problem of organizing measures to combat the damaging effects of this phenomenon.

During the summer, in the northeast sector of the Danubian Plain are registered the highest air temperatures (44.5° at [word omitted] on the Braila Plain).

Clear and warm weather prevails in autumn. The first freezes caused by advective displacements of cold air masses from the north occur on various dates, beginning in September and extending to the end of November. Determination of an average date on a statistical basis is not practically very useful because of the variability of the distribution in time of these freezes. The weather prediction service advises agriculture to take timely measures to avert the effects of the freeze.

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The precipitation system is characterized by great variability of the amounts of water and their completely uneven distribution in time and space. In the last 50 years, at some points in some years less than 200 mm of water have fallen (Cimpie Doicesti 132 mm, Vilcele 160 mm), whereas in rainy years the annual totals exceeded 1,000 mm (Lehliu 1,084 mm, Slobozia Galbena, 1,432 mm). In regard to mean quantities in recent decades dry years have had a frequency of over 50%. At greater time intervals in rainy years enormous quantities of water have fallen which raise the value of the general mean in the computation. For the greater part of the Rumanian Plain, the maximum probability is 375-450 mm of water annually and in the southeast part of the Baragan 325 mm.

If the mean total potential evaporation is valued at about 750 mm per year, the disequilibrium caused by great negative values of the hydrologic balance in this sector clearly appears.

In the course of the year in the months of January and particularly in February, the smallest amounts of precipitated water fall (average 20-35 mm per month).

The mean monthly quantities generally increase until June, when the total is 65-90 mm, and drop in the following months toward winter. On the Oltenian Plain there is at some points a supplementary increase of quantities of water during autumn caused by frontal processes taking place during the passage of baric lows over these districts.

Over the entire plain in the warm half-year thermic convection currents and cumulus clouds are formed from which fall intensive torrential rains. Volumes of water have been registered

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everywhere over a 24-hour period of over 100 mm (at Surdi, Greci 265.9, at Perieti 154 mm, etc). By their origin these are local rains which fall only on limited areas while the rest of the plain stays very low. Long intervals without any precipitation or quite insufficient precipitation are characteristic of the plain.

These intervals are most frequent in winter, during periods of prevailing anticyclones (especially the Eurasian thermic and the Atlantic dynamic subtropical cyclones) and toward the end of summer when in addition to anticyclonic conditions they take place during excessive heating of the air and a corresponding drop in relative humidity of the air masses occurring over the continent. Under these conditions, the cloud frontal systems are dispersed by the evaporation of the raindrops.

In the months of August and September, intervals of drought last on the average of over 20 days in the eastern part of the plain and over 17-18 days in the west. Sometimes the dry interval exceeds 2 or 3 months (in the Baragan: 143 days at Galbenul, 122 days at Slobozia). Since these intervals of clear weather, with strong insolation by day, predominantly high temperatures, and desiccation of the soil and air, coincide with the periods in which plants have an acute need for water, harvests can be endangered if steps are not taken to anticipate and combat these negative effects.

The most acute drought conditions are found in the extremes of the plain, in the Calafat area and on the Baragan and Braila plans. From the end of November to the middle of March snow falls on the plain with very limited frequency (12-20 days), and the

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height of all layers of newly fallen snow during the whole winter hardly averages 30-35 cm in the eastern sector (Baragan) and 35-55 cm on the western plain.

The mean annual duration of the snow cover is 40-55 days, but the snow cover is not unbroken. Snow on fields not equipped with snow fences and not planted with windrows is driven by the wind so that a good deal of the snow collected in pluviometers or measured at meteorological stations does not remain in situ and does not enter into the local hydrologic balance. The dearth of precipitation in winter, the variability of the dates of deposition, and the duration of the snow cover create difficult winter conditions for autumn sowers.

(c). The Climate of Dobrogea. In general central Dobrogea and the Black Sea littoral are the dryest part of Rumnia. The mean annual quantity of precipitated water is only 370-400 mm, and in some years it drops to 200-250 mm.

A long spring with clear sky is characterized by long periods of drought, and the thermal convection rains are of the torrential (continental) type.

In winter, intermittently, the north wind blows with great violence. During advection of great masses of very cold continental air, the sea freezes at the shore. Fog banks roll in over the whole littoral.

However, the meteorological conditions are extremely variable, especially in winter. In some years, when there are no intrusions from the north and northeast, the mean monthly air temperature remains positive (5 to 8° C) and when the north wind blows the mean monthly values drop to -7 or -8° C.

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Temperature extremes are more pronounced in the central area and in the east and more moderate on the seashore.

The absolute low temperatures have not dropped below -25° on the Black Sea littoral in the last few decades.

In the warm half-year, the entire seacoast area is covered by day with the humid air of the sea breeze. The breeze penetrates the area in a southeasterly direction covering a strip 15-25 km wide. Along this course the air is heated and drawn into a rising thermo-convective circulation.

In spring the air is colder than in autumn and fog is more frequent.

Throughout the Dobrogea area, in connection with the diversity of physical and geographical conditions, corresponding local climatic peculiarities appear, in the delta, the Danube fen bogs, the forested area in the Taita basin, Telita, Casimcea, the central Dobrogean steppes, southeast Dobrogea, and the southwest sector of Dobrogea with its high platforms alternating with the deep valleys of the estuaries, etc.

C. Western Sector

The Climate of the Tisa Plain. The plain is covered rather frequently throughout the year with masses of humid air in the west.

In January the mean air temperature is higher in the south (-1.2°) and is lower (below -2°) in the north on the plain [words missing] and of Somes-Vara, the air temperature is higher in the western part of the Timis plain (22° C). In this area, the mean temperature in the 3 summer months exceeds 21° C, and toward the north it drops below 20° (on the Somes plain).

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Because of the flat relief, the climatic conditions are distributed relatively uniformly in a horizontal direction.

MEAN TEMPERATURES

	Jan	Apr	Jul	Oct	Winter	Summer	Annual
Satu Mare	-2.9	9.6	20.0	20.4	-1.3	19.5	9.5
Orades	-1.9	10.8	21.5	11.2	-0.3	20.5	10.6
Timisoara	-1.4	11.1	22.0	11.6	-0.2	21.0	11.0

The maximum air temperature reaches 40° in the western half and below 37° in the extreme north.

In summer the area is often covered with warm air over the Hungarian desert.

Throughout the winter, because of thermal inversions, lower absolute minimum temperatures have been recorded in the low areas in the west and north of the plain than in the higher piedmont area in the east.

ABSOLUTE EXTREME TEMPERATURES

	Absolute Minimum	Absolute Maximum
Satu Mare	-29.6	37.2
Oradea	-26.2	39.5
Timisoara	-29.2	39.6

The last freezes of spring may occur between the end of March and the beginning of May (in most years the freezes are recorded up to 10-15 April).

In autumn, the first freezes normally begin in the last days of October. Intrusions of warm and cold air masses result in oscillation of the probable frost dates between the beginning of October and the end of November, and interruption of the cold season of the year by intervals of thawing of variable duration.

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In the western part of the Timis plain, mist and cloudy weather are more frequent than in the rest of the plain, especially in winter, since in the periods of stagnation of cold air at the bottom of the Pannonian depression, in the lowest areas, there is supersaturation and condensation of water vapors.

Places	Average Date 8 First Freeze	Average Date 8 Last Freeze	Average Duration of Interval Without Freeze	Average Duration of Interval With Freeze	No of Days With Freeze	No of Days of Thaw in Cold Period
Oradea	25.X	10.4	199 days	166 days	95	71
Timisoara	28.X	12.4	198 days	167 days	91	76

Places	Average Nebulosity (0-10/10) Winter	Summer	Annual	Frequency (%) of Days: Clear Winter	Clear Summer	Cloudy Winter	Cloudy Summer	Overcast Winter	Overcast Summer
Oradea	6.5	4.5	5.3	16.6	43.6	28.8	35.8	54.6	20.6
Timisoara	7.1	4.7	5.8	19.5	43.9	22.7	29.6	57.8	26.5

In winter, in the western area, more frequent and larger quantities of precipitated water fall from stratiform clouds than on the eastern part of the plain. Only in the north and on the slopes of the western part does the system of cloud formation and precipitation change toward intensification of these processes.

AVERAGE AMOUNTS OF PRECIPITATIONS

Places	Winter	Spring	Summer	Autumn	Annual
Timisoara	122.4	169.2	199.5	148.2	639.3
Oradea	108.4	167.4	202.4	157.1	635.3
Satu Mare	122.4	164.5	213.6	174.3	674.6

In summer over the western part of the plain, there is a stronger development of thermal convection and intensive torrential rains.

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		Timisoara	Oradea
1.	Maximumamount of rainfall recorded in 24 hrs (mm)	100.0	55.1
2.	Number of days with hail	2.3	1.2

Because of the longer duration of warm periods, in this area, precipitation falls more rarely in winter and the snow cover does not last as long.

Places	Average Number of Days with Snow	Average Annual Duration of Snow Cover
Timisoara	20.3	28.5
Oradea	23.0	35.0

The western corner of the Timis plain therefore has a more extreme climate with great periodic and non-periodic variations (daily and annual) of the air temperature with a longer annual interval of heat and dryness and a shorter and colder winter.

But the differences between the northern and southern parts of the Tisa plain are even greater.

The Timis and Caras plains are often covered with masses of tropical maritime air displaced toward the southwest, so that generally the air above these areas is colder and more humid.

From autumn and on into spring these regions are situated in the direction of the trajectories of the baric lows which shift toward the east. Upon encountering the western slopes of the mountains, the lows are occluded and the frontal processes intensified.

Fine rains of prolonged duration are frequent in autumn and winter when the warm fronts pass. In these seasons the cold air in the north and northwest can only rarely penetrate southward, because of the high Carpathian ridges. The winter is short and spring early. The humidity of the air, especially in summer, is higher than in the west of the Timis plain where there are frequent droughts.

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In the north the air is colder, the winter lasts longer (some 15 to 20 days), the first freezes come earlier in autumn, and the spring freezes later than in the south. Precipitation is more abundant, and winter precipitation more frequent, the sky is clearer in the south both in summer and in winter, and the solar energy system more active. The radiation and caloric balance of the surface of the ground also have greater values. A number of subtropical wild plants have survived in the southern part of the Tisa plain, indicating the more favorable ecological characteristics of the climate in this area. Great prospects of development are open to agricultural production through use of modern agrotechnical methods. Subtropical crops, tea, and valuable industrial plants will in the future cover increasingly greater surfaces of this area.

The prevailing wind directions in the western sector are northwest, west, and southwest. In winter, intrusions of cold air from the north are very rare. On the axis of the main valleys which pierce the mountains, rather intensive wind gusts are sometimes felt as far as the plain.

D. The Northern Sector

In northern Moldavia and in the Maramures depression winter is longer and snow falls more days per year, covering the ground for a longer time.

The air is generally more humid and the sky more often clouded. In summer the air is cool and humid.

The abundant rains fall at the beginning of summer and at the end of autumn. The annual amount of precipitation exceeds 700-900 mm. Drought is unknown in this area.

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E. Southwest Sector (Banat-Oltenian)

The Banat sector is exposed to air masses and frontal systems which form and move over the Mediterranean and the Adriatic.

In the Banat sector spring and fall frontal rains fall when lows pass from the west, and in winter there are prevailing masses of maritime tropical air in the form of west and southwest wind, humid, and warm, called the Austrul. In summer this wind is relatively cool and brings humidity.

The northeast Oltenian sector, sheltered by the Cernei mountains, is located in the descending area of the west wind which blows nearly all year.

In winter the north wind from the eastern sector of the country is not felt. The sheltering from the wind and the optic orientation toward the sun create conditions favorable for the introduction and cultivation of Mediterranean species of plants.

Modification of Climate in the Field of Transformation of Nature and the Effects of Measures to Transform Nature in the USSR on the Climate of the Rumanian People's Republic. Only within the framework of socialist orientation can human society conduct in an organized fashion a struggle against the damaging effects of climate and for the most rational possible use of natural power resources and climatic factors.

The application of the provisions of the overall plan for the transformation of nature creates new conditions for the development of physical and geographical processes and phenomena, essentially modifying the physical properties of the lower stratum of the atmosphere (temperature and humidity, wind structure, and intensity, etc).

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Through use of modern agrotechnology, deeply plowed soil can absorb and retain almost the entire amount of water from the intensive and torrential rains peculiar to our plains. Through treatment of the soil and maintenance of the porosity of its upper horizon the rapid and unproductive loss of the water (as a result of disorganization of ascending capillary circulation) is impeded and more water remains for use by plants.

Rotation with perennial grasses refashions the granular structure of the soil, which no longer heats up excessively under the action of solar rays. The new active surface of the soil transpires much water, humidifying the air above it.

Irrigation of the fields in periods of dryness brings about by day, through intensive evaporation of water, a drop of several degrees in the temperature of the lower stratum of the air and a 20-50% increase in its relative humidity as compared with the free air above it.

On clear days the moist surface of the irrigated soil stays 15-25° cooler than the heated surface of dry uncovered ground.

The networks of protective forest belts reduces the normal wind velocity on the open plain 20-75%.

In the belts and areas between them the snow spreads more evenly in winter and in greater quantity than on the plain, not being driven by the wind. In this way the duration and the depth of the freezing of the soil are reduced. Under the insulating snow blanket the earth thaws upwards, absorbing water in great quantities that infiltrates as snow melts slowly.

The plants thus have great water reserves in the soil.

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In the warmth of clear summer days, when the air heats up over the plains forming thermal convection currents, the humid and cool air in the forest curtains spreads laterally over the surface of the adjacent fields and invigorates the plants. During dry periods, at noon, the relative humidity of the air in the belts is 10-15% greater than over the open fields.

Large basins to accumulate water and ponds and reservoirs to catch and retain water are areas of intensive evaporation and humidification of the air. The effects of this are more markedly felt in dry years and periods of heat.

The application over a wide surface of a whole complex of measures in the plan for the transformation of nature assures improvement of climatic conditions over extensive areas.

The most acute necessity of integral organization of the land to combat winter storms which drive snow over the fields, resulting in acute and prolonged desiccation of the soil and prolonged dryness in summer, is felt in the southern and eastern continental sector of Rumania.

In other humid and cold sectors, like the depressions among the Carpathians, the excess of water creates conditions unfavorable to the growth of plants. Through systematic drainage of deforested areas and adequate agrotechnical measures, these areas are becoming productive and the soil is becoming warmer, retaining normal amounts of water.

In combatting spring and fall freezes by smudge burning, the effective radiation of the surface of the earth is reduced 20-60%. Stable thermal stratification of the cold air favors the spread of the smoke in horizontal layers over the ground. By these measures the air is heated 1-4° C which often assures survival of the plants.

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The greatest, most original and revolutionary example of systematic and planned influence on nature is the application of the great overall plan of systematic transformation of nature in the dry forest steppe, steppe, and semi-desert areas of the Soviet Union.

The reconstruction of the hydrographic network, the creation of large lakes to accumulate water, vast irrigation systems, and the immense network of forest belts for the protection of the fields, as well as other measures for the organization of the territory, represent the greatest offensive ever made against the negative natural phenomena.

The importance of all the results of these measures will lead to planned direction of the development of the main physical and geographic processes and phenomena connected with the characteristics of the active surface.

Stabilization of sands and soil, general reduction of the velocity of violent winter blizzards, humidification and cooling of the lower strata of the air in summer weather, and calming dry and hot winds will be realized progressively.

The continental eastern sector of Rumania, exposed in the past to devastating blizzards, prolonged droughts and dry and hot winds, will undergo large-scale improvements of climatic conditions as a result of the planting of forest belts and organizational measures, and the extreme continental characteristics will be modified markedly. The present great climatic distinctions between the humid western sector of the country and the dry eastern one will be diminished, the unreliability of harvests will be but an unhappy memory, and the entire surface of the land will be integrated and increasingly productive, assuring whole societies an unlimited abundance of harvests and raw materials.

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[Pages 139-229]

THE HYDROGRAPHY OF THE RUMANIAN PEOPLE'S REPUBLIC

Alexandru Savu

The variety of the natural conditions of Rumania can be easily discerned in the general aspect of its hydrography.

Subterranean Waters

Of the total of 635 mm of precipitation falling, on the average, in Rumania a good part infiltrates the soil and gives rise to water tables, conforming to the local petrographic and tectonic conformation of the various regions. Their depth is quite dependent upon the position of the supporting strata. In the crystalline areas of the Carpathians the water table is superficial; in the limestone areas, however, the depth is greater and the ground water, often forming real rivers or subterranean lakes, generally follows the lower level of the fissure. In the Jijia depression and the Transylvanian plain, with its prevalence of clays, a higher water table is found than on the Rumanian Plain, where infiltration is readily accomplished through loess and alluvial soil and the water table is sometimes 40-50 m deep. This depth depends not only upon the quantity and frequency of precipitation but also upon the thickness of the upper permeable stratum, evaporation, vegetation, hydrotechnical conditions, etc, and it shows considerable seasonal variations.

Thus the problem of drinking water becomes very difficult of solution in the Baragan, central and southern Dobrogea, etc, where more or less due to infiltration through loess, the water is hard and rich in sulphates. The Transylvanian plain, the Moldavian plain, and some parts of the Subcarpathians also suffer from salts dissolved by ground waters from the salty formations through which they flow.

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The water tables in areas of terraces of large rivers and in alluvial cones are very rich in water and well filtered, favoring great concentration of human settlements. Such a situation is encountered in piedmont areas, where the water tables are often stratified and come under pressure, giving rise to ascending or artesian drilled wells.

In accordance with their origin most of the waters of Rumania are vadose. The percentage of juvenile (magmatic) waters is small. On their way to the surface of the earth's crust, they meet and mix with vadose waters, raising their temperature and increasing their salt concentration.

Springs

In breaking through the surface of the earth, ground waters give rise to various types of springs: descending (the most common and widespread), ascending and artesian (at the point of contact between the Subcarpathian and the Rumanian plain, on the Tisa plain, in the Huedin depression, etc), occlusion (in the limestone regions in the Apuseni mountains, the Mehedinti plateau, etc), and geysers (Bujorel, Calugar, in the Apuseni mountains, etc).

Ordinary and mineral springs are classified according to their chemical properties, while cold springs, with temperatures up to 20° C, and hot springs, with higher temperatures, are classified by temperature. These in turn are divided into 3 groups.

(a) Hypothermal waters with temperature below 36° C: Mangalia (21.5° C), Tusnad (20.8° C), Toplita (23.6°-26.7° C), Lobogo (20° - 22.5° C), Lunca (22.5° C), Calan (27° - 29° C), Moneasa (20° - 32° C), Geoagiu (31.9° - 32.9° C), Bobilna, Calacea, Siriu, etc.

(b) Isothermal waters, with temperature equal to that of the human body (36° - 37° C): Vata (36° C).

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(c) Hyperthermal waters, with temperature over 37° C: Herculane (38° - 50° C), Baile Victoria (48° C), Baile 1 May (41° C).

The greater part of these waters are strongly mineralized so that their therapeutic value is greater and they are known abroad.

The cold mineral springs are more widespread and variegated and are found in volcania regions and areas of diapyrism, tectonic dislocations, etc.

Depending upon the predominant element in their composition, the mineral waters fall into a whole series of categories:

1. Oligometallic waters, weakly mineralized.

2. Carbogaseous waters, rich in free carbonic acid (Borsec, Buzias, Lipova, etc).

3. Alkaline waters, with predominant sodium bicarbonate in their chemical composition (Bodoc, Zizin, Casin-Iacobeni, Malnas, Covasna, Singeorz Bai, Anies, Bicsad, and Stoiceni).

4. Weak chlorine-sodium waters (under 15 g chlorine and sodium per liter) are very numerous, widely distributed in areas of diapyrism (Cojocna, Turda, Ocna Mures, Ocna Sibiu, Sovata, Ocnele Mari, Telega, Slanicul Prahovei, Costiui, Ocna Sugatag, etc).

Some saline waters contain iodine and bromium (Nastasachi, Baltatesti, Sarata Monteoru, Olanesti, Bazna, Ocna Sibiu, etc).

5. Sulphurous waters, containing hydrogen sulphate or sulphates (Calimanesti-Caciulata, Govora, Olanesti, Sacelu, Bughea, Strunga, Iacobeni, Breb, Leghia, etc).

6. Ferruginous waters, containing 3-10 cg of iron per liter (Buzias, Vatra Dornei, Dorna Cindreni, Valea Vinului, Vlahita, Lipova, etc). The waters at Valea Dornei also contain arsenic.

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7. Alkaline-thoric waters, weakly mineralized, with a diuretic effect (Caciulata, Govora, Clanesti, Covasna, Breb).

8. Sulphate waters, with large quantities (2-122 g/l) of sodium sulphate and magnesium (Baltatesti, Breazu, Cozla, Olanesti, Ivanda).

9. Radioactive waters, especially frequent in areas with massive eruptive sodiums (Maguri, the drinking water of Cluj, the sweet springs of Valea Jiului, etc). Radioactive waters are often warm also (Herculane, Geoagiu, Baile 1 May, Toplita) and mineral Olanesti, Caciulata, Buzias, Lipova, Singeorz Bai, etc).

Because of their therapeutic powers and the fact that they are situated in an especially picturesque area, with pure air, the mineral springs have favored the establishment and development of the numerous spas or health resorts of Rumania.

The springs generate a superficial hydrographic network to which rains and melting snows contribute through direct drainage. Lakes are also fed from the springs, rivers, and direct precipitation, which form part of the hydrographic network.

The Hydrographic Network

General Description

Except for a few insignificant streams in Dobrogea, all Rumania's rivers are direct or indirect tributaries of the Danube. If because of the relief Rumania is called "Carpathian," it can be regarded as "Danubian" in hydrography (Simionescu, Tara Noastra [Our Land]).

In turn the Danube, the collector of Rumanian rivers, flows into the Black Sea, so that our whole hydrographic network is drained by this continental maritime basin.

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A general feature is the fact that almost all fluvial arteries flow from sources in the Carpathians, which they traverse impressive gorges (Olt, Jiu, Dunare).

The nature and distribution of the hydrographic network in Rumania are determined by a whole series of factors.

The most important factors are relief and climate, which embody the essential traits; then come tectonics and geologic structure, soils, vegetation, and the human factor.

(a) Relief. By its formation, by its division into concentric natural zones (mountain, hill, and plain), and by its general incline, the relief determines the direction of water courses, groups them into basins, and determines in large part their speed and flow (V. Mihailescu, Rominia).

The central position of the Transylvanian basin, surrounded by the peaks of the Carpathian chain, has given the hydrographic network a radial form, since most of the important rivers flow from sources on the edges of the basin.

Various factors, taken separately, have contributed in their turn to the grouping of water courses in the basin. The Jijia depression is an example of this, in which the majority of the waters are concentrated in the Jijia basin, the central Moldavian plateau with the Birlad basin, the Hateg depression with the Strei basin, etc.

From the source to the mouth, as they pass through various morphological features, the rivers change their features as they go along.

In their upper courses, especially in mountainous areas, which covers most cases in Rumania, the waters flow in deep and narrow gorges,

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down steep slopes that increase the speed of flow. The longitudinal profiles of the rivers are characterized by numerous rapids and cascades, cyclic, or structural. The fall sometimes reach values up to 200-300 m/km.

The enormous hydraulic power potential of this region was little appreciated under the bourgeois landowner regime. The motive force of the rivers was exploited only locally, in small peasant industries (mills, fulling mills, sawmills, presses, etc). The electricity problem is of great importance at present, and its importance will increase enormously, constituting one of the prerequisites without which the building of socialism cannot be conceived of in Rumania. The electrification plan of the Rumanian People's Republic is on a scale to show us in part the importance of water in the future economy.

In middle course, traversing areas of plateaus or hills, the rivers have cut wide valleys accompanied by terraces and extensive river meadows on much less steep slopes and therefore at reduced rates of flow. The terraces are well suited to settlement, roads, crops, etc, and lend themselves to irrigation.

In their lower courses, in accordance with the topography of the plains, where the gradients are reduced to a minimum, the river waters are sluggish, continually muddy, splitting up into numerous branches, and forming meanders.

This is the situation of large rivers; the small ones can be classified, according to the relief features they traverse, into mountain, hill, plateau, and plains rivers. The following mountain rivers may be given as examples: the Cerna, Lotru, Bicaz, Gurghiu, Somes Cald, Somes Rece, etc. Among typical hill or plateau rivers: the Amaradia, Birlad, Taita and Talita, Hirtabaciu, Comlod (tributary

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of the Mures), etc, and among the plains rivers: the Teleormanean Calmatui, Cilniste, Mostiste, Bralean Calmatui, etc.

In connection with such varied relief must be considered the large number of basins with rivers and, as a result, the relatively limited surfaces to feed them. Relief closely connected with tectonics plays the most important part in the organization of river basins. Thus the concentration of a hydrographic network in areas of depressions or longitudinal orientation on the axis of the synclinal ravines of the Subcarpathians is very characteristic. The central Moldavian plateau, gently dipping to the southeast, as well as the Sarmatian formations of which it is composed, has favored the formation of some parallel watercourses which flow toward the central collector (the Birlad) like rivulets on a roof.

According to how the various relief elements are traversed by hydrographic arteries, the river valleys are either longitudinal (the Iza, Vise, Cerna, Lotru, Jiu Rominesc, Olt in the Ciucuri depression, Toance Bistrita at its confluence with the Bicaz, Tazlau, etc) or transverse: the Olt at Turnu Rosu-Cozia, Jiu at Surduc, middle Mures, upper Buzau, etc).

(b). Climate. This is the most important factor directly influencing the hydrographic network, conditioning it particularly by the precipitation and temperature systems and the annual, monthly, and daily variations of the level and the discharge; this illustrates the close relationship between the amounts of precipitation falling into the basin of a river and the amount of water flowing through its thalweg (the coefficient of flow) (V. Mihailescu, Rominia).

Precipitation has the decisive role, but temperature is what brings on freezing and thawing, low or high evaporation, etc, contributing considerably to the variations in level and discharge.

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This can even be said of the influence of winds which can sometimes contribute to acceleration of surface waters. The prevailing winds also condition, locally, the asymmetry of shorelines and thus permit displacement of watercourses or determine, in part, the extension and variability of inundation areas (the Ialomita and Calmatui on the Rumanian plain).

In connection with climatic elements, the density of the hydrographic net should also be considered, which differs over Rumania as we shall see further on.

The direct influences of the climate, however, will follow more fully from the analyses of the variations of level and discharge, where they will be treated more fully.

Besides relief and climate, which play the decisive role, other factors have only a partial influence upon some of the features of the hydrographic network.

(c). The Geologic Structure. The geologic structure, which is so varied in Rumania and with which the formation of the relief is directly connected, impresses certain features upon the water courses. Crystalline schists, for example, due to their conditions of disaggregation, infiltration, etc, favor a richly ramified net, as found on the Rodna, Fagaras, and Gilau mountains, etc, as distinguished from a limestone area, in which the subterranean network is more readily organized, at the expense of the surface one. The most typical example is found in the Bucegi mountains. Though their massiveness and climatic conditions are almost identical with those at Gagaras, the superficial hydrographic network is more disorganized and less dense. Similar cases can be cited in all limestone areas of the country. We can say the same thing of a different network of rivers in areas with predominant impermeable clay formations (the

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Jijia depression, the Rumanian Plain) as opposed to those with sand and loess, where heavy infiltration reduces not only the discharge of the great rivers, but is entirely unsuited to the formation of permanent arteries. Certain subdivisions of the Rumanian Plain (Bailesti plain, Caracul plain, the Baragan, etc) are typical in this respect.

The geologic structure also leaves its mark, to a certain extent, upon the level and discharge variations, which show certain fluctuations depending upon the permeability of the rocks. But its influence is even more pronounced on the appearance of valleys in longitudinal and transverse profile. The alternation of resistant with readily friable formations causes the majority of slope fissures in the longitudinal profile, so frequent in mountainous regions and contact zones between different units, fissures which explain the cascades and rapids in the waters. The only exceptions are the cyclicones, which result from the evolution of the relief. The very names of some Carpathian rivers indicate these features: Bistrita, Bistricioara, Bistra, etc, meaning "rapids" in Slavonic.

The variations displayed in transverse profile from this point of view are very typical.

The crystalline schists of the Rodna, Fagaras, Paring, Retezat, Gilau mountains, etc, force the rivers to cur deep and narrow valleys almost devoid of a major bed, shaded, and unsuited to settlement.

Their narrowness also makes their rise above the low level mark more pronounced than in areas with less resistant rock. The same is true in eruptive areas (Tibles, Caliman, Harghita) or in thickly cemented sandstone (Taracau, Oituz mountains, etc).

Rumanian waters have actively eroded vertically in limestone,

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resulting in imposing gorges and defiles of unusual beauty: the Bicaz gorges in the eastern Carpathians, the gorges of Tatar, Zanoaga, and Orza on the upper Ialomita in Bucegi, the Oltet gorges of Pelovraci, the gorges cut by the Motru and most of the tributaries on its right on the Mehedinti plateau, the gorges of Aiud and the Turzia in the Apuseni mountains, etc. The rivers of Dobrogea have all cut narrow valleys in the loess deposits.

The friable formations (clays, marls, sands, etc) favor the formation of valleys with large open profiles as in the majority of the rivers of the hills, plateaus, and plains.

The alternation of rocks differing as to resistance also explains the epigene valley types: the epigenesis of the Hasdate in the Turzia gorges (De Martonne) cut in Portland limestone; the epigenesis of the Mures at Seimus-Lipova, cut in eruptive; the epigenesis of the Lapus through the crystalline massiv of the Prelucai, etc.

(d). Tectonics. They also explain, along with the other factors noted, some of the peculiarities of the hydrographic chain of the country.

The rivers are closely connected with the 2 deep tectonic depressions, one in the east (the Rumainian Plain) and the other in the west (the Pannonian plain). These 2 were not formed at the same time and do not have the same evolution at all.

The play of vertical movements resulted in a change of base level, and this revived the forces of erosion not only in depth, giving rise to terraces, but also lengthwise, making young valleys advance more and more toward the heart of the mountains (Simionescu, Tara Noastra). Thus were produced numerous frontal or lateral caps on a scale to explain some of the impressive incisions cut by the rivers in the massive chain of the Carpathians (the Olt, Jiu, Danube, etc).

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It is very interesting to follow, from the point of view of the evolution of the hydrographic network, the line of weak resistance Focsani-Namoloasa-Galati and especially the area of gradual stoppage in the northeast of the Rumanian Plain, which has conditioned the formation of a collection point for waters in the region of the lower Siret.

The majority of the great rivers of Wallachia are channeled through this area.

This explains the deviation toward the southeast of the Arges after leaving in turn Teleorman, Dimbovnic, and Glavacioc; the eastward deviation of the Ialomita after leaving its former path (the Mostistea of today); the deviation toward the northeast of Buzau, after a similar abandonment of its former bed (the Calmatui). The Rimnic is very characteristic, a former tributary of the Buzau, which has successively displaced confluence points in the area of Lakes Jirlau, Amara, and Balta Alba to be then attracted directly by the area of maximum inundation at the Siret.

The Putna River also carries water here, as also the Birlad, whose curious turn to the southwest cannot be explained except in the light of the above mentioned phenomenon. A similar region, but much less extensive, has been identified on the middle Prut, in the vicinity of Iasi, through which the Jijia and the Bahlui channel their sluggish waters causing catastrophic inundations at times.

Water collection points connected with tectonics have also been identified in other parts of the country. On the Danube, for example, the first area of local stoppage is in the area of Cetate-Calafat; there is a second at Zimnicea and a third at the mouths of the Ialomita and the Calamatui; on the Jiu at Filiasi and on the Olt

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northeast of Caracal; on the middle Arges at Pitesti, and on the lower Arges in area of Comana-Budesti; and on the Ialomita west of Urziceni (Gheorghita Region), etc.

Even more typical is the grouping of the Cris rivers as well as the inundation area of Bodrog, toward which the Tisa abruptly bends and the majority of the tributaries in its upper basin flow. (Both areas are located on Rumanian territory).

The concentration of most of the tributaries in clusters in these very areas of stoppage also influences the variations of level for the downward course of rivers in which they normally flow in a single bed to their mouths (Jiu, Olt, Jalomita).

Thus great increases over the low level mark, accompanied by inundations, are characteristic when the snows melt or there are torrential rains up in the mountains, when the lower course can no longer accommodate the flow under good conditions of so great a quantity of water received all at once in practically the same place.

This also explains the marshy areas which correspond to the areas mentioned above. In a reverse direction, the positive tectonic movements, manifested by the wholesale elevation of certain areas, or by their building, have determined the phenomena of the dispersion of the waters.

Such an instance has been pointed out at the watershed between Gilort and Oltet, at the Amaradia springs; more typical is the area of bulging on the Cotmean platform, in the area of the source of the Vedea River, an area from which watercourses run in radial formation. Similar cases are also encountered on the Cindesti platform, between Argesel and Dimbovita, in Dealul Mare, between Siretel and the source of the Bahlui, etc.

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Positive epirogenetic movements create antecedent valleys.

In previous geographic literature rivers in southeast Dobrogea, are still included in these categories: "The Danube in Defile" (J. Cvijic), "The Olt in the Southern Carpathians" (N. Orghidan), "The Somes Mic Near its Springs," "The Bistrita at Toance," etc.

In many cases the tectonics follow the direction of watercourses; typical examples of this being the 2 tectonic corridors in the western part of the southern Carpathians, along which flow in the opposite direction the 2 rivers Timis Cerna and Bistra-Farcadin (a tributary of the Strei).

This relief and geologic and tectonic structure has conditioned the formation of a whole series of hydrographic network types: (P. Cotet, Man. Ing. de Mine [Manual of Mining Engineering], chapter on morphology).

The dendritic network, in the form of a tree, is typical of regions with a flat structure: (example: Vedea-Teleorman with all their tributaries).

The rectangular network (tributaries converge with main rivers at right angles, common in crystalline areas). Example: the tributaries of the Bistrita between Barnarel and Tarcau, the Hideg, Riu Mare, Bistra, etc.

The radial network, divergent, typical of areas of volcanic cones (Pietrosul Calimanului, Batrina, Fincelul, Harghita, etc, or in areas of bulging).

The convergent network, in areas of local subsidence (Filiasi, Pitesti, etc) which also characterize, however, volcanic craters

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(Izvoarele Negrei, Sarului, in Pietrosul Calimanului, [one or two words illegible] Sechei in Saca crater, etc).

The circular network, disposed around dome-shaped areas (the streams Simnic, Slatina, and Zapozi, around the hill at Enciu south of Tigveni-Arges).

The opposing network, in parallel but opposite systems, very typical of the northern slope of the Fagaras mountains.

The spiral network, of the type of the Buzac, the Somes between Dej and Seini, the Tusnad Olt at R. Vilcea [Rimnicu Vilcea], etc, conditioned by erosion in areas which differ from the tectonic point of view.

The effect of other factors upon the condition of the hydrographic net is much less and manifests itself in general indirectly.

(e). The Soils. The soils depending upon their structure, are more or less permeable, influencing to that extent the possibilities of organization of the superficial network, since the flow is in inverse proportion to the infiltration potential.

(f). The Vegetation Cover. The vegetation cover makes a more active contribution, through its more varied influences.

Also large quantities of water (sometimes over 50%) are returned to the atmosphere through transpiration. On the other hand, water on the ground and especially snow are retained longer and feed the river system,

The role of the forests, however, is that of attracting precipitation, and the rivers will be better organized for it and will have a more constant discharge. This is confirmed in mountainous

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areas, in the forested areas of the Lapus, the hills of the Tirnava rivers, etc, where the forest cover has been better preserved.

In all pasture and cultivated land in the country the vegetation contributes, in addition to the other factors, to the determination of a more weakly organized network.

(g). The Human Factor. Man is the most important transformer of nature and indirectly affects the hydrographic net, through plowing, tillage, etc, which modifies the local microclimate and consequantly the hydrographic net, but also directly through canals, irrigation, drainage of swamps, levees, etc.

Examples are the Bega Navigation Canal, the levees of the Timis, the Cris rivers, the Somes, and the lower Prut; drainage of swamps in the region of the Eced, the irrigation canal on the Birzava, Ialomita, Arges, etc, regularization of the discharge and the level of artificial lakes, etc.

The more or less active contribution of some or all the analyzed factors shows not only the general nature of the hydrographic network in Rumania, but also indicates the possibilities of exploiting them in many projects of community interest (hydroelectric power, irrigations, drainage, supply of communities and industrial enterprises, etc).

1. Density of the Hydrographic Network

This is the relationship between the length in km of rivers and the surface in sq km of the various basins and is bound up with a whole series of factors: massiveness of relief, geologic structure, distribution of precipitation, distribution of temperatures, evaporation, indexes of aridity, soils, vegetation, size and shape of basins, and the human factor. The density of the hydrographic network in

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Rumania in type I, II, III, and IV basins is very varied, consisting of between 0.10 and 0.90 km of river per sq km of surface.

But there are some basins with lower densities (0.01-0.09) in the steppe areas of Dobrogea, Baragan, and the Tisa plain, just as there are basins with densities of over 0.90 per km, as in the case on the northern slope of the Fagaras mountains and the western slope of the Apuseni mountains.

In general high densities (0.70-0.90) correspond to areas of massive relief with compact structure and heavy precipitation (the Somes Cald, the Cris Repede in the mountains, the Viseu, Lapus, Bistrita Ardeleana, Olt, Mures at its source, the Olt in the Fagaras depression, the upper Jiu, etc).

Medium densities (0.40-0.70) are peculiar to hill and plateau areas and low ones (0.10-0.40) to plains, where almost all the above mentioned factors have a negative effect upon the density of the waters. Exceptional areas must be viewed in connection with the predominance of some of these factors. Examples can be cited for lower densities in Bucegi (0.50-0.60), the Mehedinti Carse (0.40), etc, due to the possibilities of infiltration in limestone which is unfavorable to organization of the surface network in good conditions. Higher densities are also encountered in relation to neighboring areas, in the region of the Lapus mountains (0.70), the Birlad hills (0.55), richly forested and favorable to precipitation, or in the lower basins of the Mures and Somes (0.40) influenced by the network of canals made by man for irrigation.

It is important to remember the fact that the areas with maximum density constitute actual reservoirs of water which can and should be used for practical purposes.

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2. System of Flow

This is closely connected with conditions of relief and climate, being influenced to a lesser extent by other factors such as geologic structure, soils, vegetation, etc.

The problem of flow should be viewed from the following points of view:

A. The Way Rivers Are Fed

B. Variations of Level

C. Variations of Discharge

D. Temporary and Permanent Rivers

A. The Way Rivers are Fed. Rivers are fed not only by water flowing on the surface of the basin during rains or melting of snow, but also from water tables when they come to the surface in the form of springs.

The climatic factors, geomorphologic and hydrologic, determine the intensity of each of the 2 sources.

The climatic factors are nevertheless definitive, as the Russian expert A. I. Voyeykov said, who considers rivers, "precisely a product of climate,"

Considering local conditions, Rumanian rivers come under Type 6, Group III-a of the Voyeykov's classification, having mixed sources, rain and snow (pluvio-nival), with a predominance of rain. The maximum level is registered in spring with the melting of the snows and the increases brought on by the floods in spring and fall.

Depending on the periodicity of the increases directly connected with climate, however, some distinctions can be made in Rumania, giving the following types of source:

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(a) Pluvio-nival type with weak oceanic influences, characterized by early increases, however, at the beginning of March and reaching a maximum in April prevailing in the western part of the country (the lower Somes, Barcau, the Cris rivers).

(b) The type with Mediterranean influence, with a period of gentle increase in wintertime reaching a maximum in May, prevailing in the Banat (the Timis, Birzava, Caras, Nera).

(c) The type of source with steppe influences, with late maximum increases (May, June) and pronounced falling off in August and September prevailing in the east and south of the country.

(d) The intermediate type characteristic of the internal basin of Transylvania. The Danube, viewed as whole, has a complex source system (Type 8 in Voyeykov's system) but in Rumania it is entirely pluvio-nival.

B. Variations of Level. Variations water levels are a direct result of the climatic system. Other factors also contribute locally such as the transverse profile of the valleys, flow, gradient, etc.

The continental temperate climate in Rumania impresses particular characteristics on the water system, a fact to be seen in the annual average of the increases, in the monthly and even daily variation of levels, and in the contrast and irregularity of the maximums and minimums (Mihailescu, Rominia).

From calculations already made it has been determined that the levels of water undergo mean increases over the low-level mark of 25-100 cm.

In considering rivers fed by mountain areas and those with

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sources in the hill, plateau, or plains areas some surprising contrasts appear:

A good many rivers in the first category thus present annual averages in the lower basin below the low-water mark:

	Average	for Period
Cris Repede at Oradea	-66	1917 - 1942
Cris Negru	-41	1927 - 1940
Cris Alb	-48	1917 - 1939
Timis	-28	1923 - 1943
Birzava	-161	1936 - 1945
Ialomita	-91	1929 - 1938

The others show averages either less or similar to those of the steppe waters, and that not only in their lower course but also in their mountain regions. We cite a few more typical examples for comparison:

Rivers with Mountain Springs	Average	for Period
Somes At Mira Somesului Rece (mountain)	31	1927 - 1945
Somes At Satu Mare (plain)	7	1922 - 1939
Cris Negru At Vascau (mountain)	57	1932 - 1945
Mures At Alba Iulia (plateau)	8	1932 - 1945
Mures At Arad (plain)	28	1927 - 1945
Siret At Cosmesti (plain)	59	1931 - 1943
Steppe Rivers		
Vedea At Cervenia	60	1922 - 1945
Birlad At Tecuci	58	1923 - 1945
Jijia At Cirpiti	31	1932 - 1940
Bahlui At Iasi	14	1922 - 1945

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This state of arrairs, apparently abnormal, is explained by 2 causes:

(a) The large rivers have very wide valleys in their lower basins, in which the level over the low-water mark cannot stay very high all year long.

(b). The low-water marks of the steppe waters are confused with or are very close to the bottom of the valleys, while in the case of those with mountain springs, the bottom is sometimes several meters below the low-water mark (V. Mihailescu, Rominia).

Yet the fact that the mean annual level of the steppe waters rises more sharply than that of many of the rivers with mountain sources confirms the extreme nature of Rumania's climate. Although these relatively deep valleys sometimes run almost completely dry in summer and fall, when there are cloudbursts they show such great increases as to affect the mean annual level.

To describe the water system ingreater detail we must consider, however, the monthly and even daily variations in which their dependence upon climate clearly emerges. In general our rivers show 2 periods of increase and 2 of decrease according to the season.

Thawing of rivers accompanied by thawing of snows begins in March and sets off the great spring rises. These come earlier in the west where weak oceanic climatic influences are felt and later in the east and north, where the continental climate prevails.

The increases last until May, June, and even into the first half of July due to the spring rains. The second half of June and July marks the beginning of the decreases which gradually gain until August and September. There follows a slight increase in November, brought on by autumn rains and reduction of evaporation and then

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decreases in winter, with minimum values in December and January, due to the freeze and solid precipitation. In the Banat there is sometimes also a third maximum in winter, conditioned by Adriatic climatic influences.

The rises of Rumanian streams are sometimes striking. On the average they fluctuate between 1 and 2 m; in exceptional years, however, the maximum levels over the low-water mark have been much more pronounced:

		Year
Somes at Satu Mare	+840 cm	1940
Cris Negru at Zerind Mare	+776 cm	1932
Cris Alb at Chisinau Cris	+778 cm	1939
Mures at Arad	604 cm	1932
Mures at Parcul Rudna	879 cm	1926
Jiu at Pedari	480 cm	1940
Olt at Rimnicu Vilcea	492 cm	1924
Vedea at Cervenia	470 cm	1941
Ialomita at Cosereni	510 cm	1915
Siret at Lungoci	577 cm	1929
Jijia at Cirpiti	809 cm	1932
Bahlui at Iasi	580 cm	1932

Ordinarily these maximums are followed by rapid drops, the high water level often lasting only a few days, to below the low-water mark, which shows the continental nature of the climate. This feature is even more evident if the contrasts between the extremes are considered the values of which are very high.

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River and place of measurement	Absolute maximum in cm	Absolute minimum in cm	Difference in cm
Somes at Satue Mare	640 (1940	-134 (1946)	774
Cris Negru at Zerind Mare	776 (1932)	- 67 (1904)	843
Cris Alb at Chisinau Cris	778 (1939)	- 76 (1932)	864
Mures at Branisca	610 (1932)	- 137 (1837)	747
Timis at Ciausa	794 (1925)	- 79 (1882)	873
Jiu at Filiasi	480 (1923)	- 40 (1925)	520
Siret at Racatau	460 (1929)	- 56 (1945)	516
Jijia at Cirpiti	809 (1932)	- 1 (1930)	810
Bahlui at Iasi	580 (1932)	- 32 (1947)	612

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The greatest contrasts (Cris Negru 843 cm; Cris Alb 864 cm; Timis 873 cm; Jijia 810 cm) were recorded in the steppe areas, where the climatic contrasts are great, and at the same time for relatively small rivers with rather narrow beds. For large rivers with very wide valleys, the contrasts are less (Jiu 520 cm; Siret 516 cm; Olt 492 cm), although the basins that feed them and their discharge volumes are much greater to those in the first category. A distinction can be seen between the rivers of the west and those in the southeast because of the uneven distribution of precipitation.

In the observations of variations of the level of the Rumanian streams some typical cases have also been established which depend in great part on the transverse profile of the valleys.

The stations in defile regions are very typical, from this point of view, where because of the relatively narrow profile of the respective valleys, the increases are more pronounced.

Somes 1933 - Dej 38

(humid year)

Somes 1934 - Dej -7

(dry year)

Mures 1933 - Alba Iulia -22

Mures 1935 - Alba Iulia 22

(dry year)

Ulmeni (defile) 80

Ulmeni 38

Branisca (defile) 130

Branisca (defile) 68

Satu Mare 30

Satu Mare -28

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The flow gradient also plays a quite important part in the variations of level of the rivers. In mountain areas, where the precipitation is relatively heavy and evaporation relatively limited, the water level should be constant and generally high, all the more so because the valleys are narrow. However, due to the steep gradients, however large the increase would be, the flow is easy and the level returns quickly to normal.

The duration and frequency of snow also depends upon the area of the source basins and on the gradient changes. The Jiu and Olt, with large basins, at the exit of the defiles where the gradients are low and the valleys still not large, show levels which only very rarely reach 50 cm above the low-water mark.

The Mures, on the other hand, with smaller tributaries and a very wide valley, remains all year at +50 cm, while the Somes and the Cris rivers on the plain drop to below the low-water mark for a period of 6 or 5 months or the whole year.

The Cris Repede at Oradea, in the period from 1917 to 1942, had the highest average in March and did not exceed -19 even in that month.

Usually, in water level most of the Rumanian rivers show sharp contrasts between the mountain and plains areas because of the difference in their physical and geographic conditions. The same cannot be said if we consider these phenomena only in the mountain area, where compared with the rest of the country a certain uniformity is established in the distribution of precipitation and temperature.

Here also the contrast between the maximum and minimum levels is less.

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The Cris Repede, at Ciucea (in the mountains), for the period between 1924 and 1923 [sic] showed an average contrast of 146 cm compared with 202 at Oradea (on the plain) and the Somes at Nepos (mountain), for the same period, showed a contrast of 160 cm compared with 399 at Satu Mare (plain).

The above rivers also demonstrate the fact that from source to mouth the rivers lose considerable amounts of water and that these losses are much less in the mountains than in the hill and plain regions.

On the map of the mean specific flow of our rivers, drawn up by the DGH [Directie Generala de Hidrographiei -- Main Administration of Hydrography] (by the team of Ciaconu, Ujvari, and Lazarescu) it can be seen that the maximum values (50-40 l/sec per sq m) correspond to the mountain massifs with heavy precipitation (Retezat, Paring, Fagaras, Apuseni); high values (30-20 l sec per sq km) to the areas which are high but poor in precipitation (Eastern Carpathians); the medium values (10-7 l/sec per sq km) are peculiar generally to the Subcarpathian areas. Isolines with low values (2 l/sec per sq km) cover in great part the Moldavian plateau, the Getic piedmont, and the western piedmont, but those with minimum values (1-0.5 l/sec per sq km) the Banat plain, the Mures Corridor, the Danubian plain, southern Moldavia, and Dobrogea.

The variations in water level may also be influenced by such other factors of a secondary nature as:

Natural disturbances caused by a tributary which comes in below.

Artificial disturbance caused by a dam or high hydrotechnical structures on the river (as the Bega canal).

Silting of the river bed.

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Blockage of the course by blocks of ice with abrupt arrival of spring. Thus the Danube in 1900 registered 754 cm above the low-water mark at Turnu Magurele and 802 cm at Zimnicea, but in 1941 it was +823 cm at Oltenita, due to chunks of ice in the slow current.

High rises over the low-water mark transform many of the streams into really great rivers, in appearance, and cause extensive inundations, especially in the middle and lower basin. Turbid waters carry huge quantities of fine alluvium in suspension and even gravel up to the confluence area, to say nothing of the neighboring mountain regions where boulders of considerable size roll down.

For large rivers, arising from mountain springs, inundations generally occur with the sudden advents of spring after winters in which large amounts of snow have fallen. More rarely those with large source basins (the Olt, Siret, Mures, etc) also overflow after ordinary cloudbursts.

In Transylvania and the Banat the permanently threatened areas reach into the Tisa plain, floods being caused by the Somes, Crasna, Barcau, Cris rivers, Mures, Timis and Birzava. The Olt sometimes causes damage in the depressions which it traverses (the Ciucuri depression, Tara Birsei, Tara Oltului).

Flooding of steppe rivers are frequent and capricious in summer when there are torrential rains in their source basins.

The Baseu, Jijia, Bahlui, Birlad, Elan, etc are characteristic and their inundations sometimes last quite long due to the very slight flow gradients.

Similar situations but of less intensity and frequency because of the less extreme climate are seen on the smaller rivers which drain the

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Transylvanian plain (the Chintaului, Borsei, Lunei, Fizesului, etc).

The waters of Dobrogea, like the typical steppe rivers of Wallachia and Oltenia, also often destroy crops and even human settlements in adjacent areas during torrential rains. For prevention and remedy of all the disasters caused by floods there are in course of construction or planning a series of measures consisting of forestation, clearing channels, transverse dams, drainage of swamps, etc. Recent important projects have been carried out along the Prut at Balta Brailei, along the Danube at the Valea Birladui, on the Tisa plain, etc.

All these remedial projects have intensively rehabilitated the land for the economy of Rumania, but the problem of inundations is still far from being definitely resolved.

As distinguished from periods of increase, in times of low water the rivers have an entirely different appearance.

The largest ones arising in the mountains (the Olt, Jiu, Siret) disperse their low waters among a series of branches, leaving numerous bars and islands among them.

The medium ones of the size of the Buzau, Ialomit, Arges, Timis, Cris, Somes, etc, with mountain sources, fall to such an extent that they can be forded on foot almost anywhere.

Among the steppe rivers a few (the Birlad, Jijia, Bahlui, Vedea, Teleorman, etc) persist with great difficulty and bring to their mouths insignificant trickles of water.

A good many of the steppe rivers are transformed into veritable strings of lakes, i.e. the Mostistea in Wallachia, those located in the

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Jijia depression (the Baseu-Sitna, Zeletin, etc), on the Danubian plain (the Mostistea) and the Transylvanian plain (the Fizesului, Comlod, Ludusului).

Finally, in dry years many of the small rivers dry up, their minor beds remaining covered with sand and fine gravel or hydrophilous vegetation or with swamps (the waters of the southern Dobrogea and the small streams of the Danube plain and the Tisa plain).

To remedy the lack of water in these unstable basins, man intervened even in very ancient times by building innumerable reservoirs of the kind found in the Jijia depression and the Tranyslvanian plain.

Man's work was often easy, consisting merely of strengthening natural dams caused by landslides on the slopes or the deposits of tributary torrents. The number of these reservoirs has diminished considerably today either through natural action or the intervention of man who drained them to obtain pasturage or arable land. Their restoration is one of the main projects of the economy because of their particular importance to fishing, irrigation, small power plants, hydroelectric stations, etc.

C. Variations of Discharge. Discharge depends greatly on climatic factors, of which precipitation, temperature, and evaporation are decisive, while humidity of the air, lack of humidity, winds, and atmospheric pressure influence it indirectly raising or lowering the degree of evaporation.

Discharge variations, however, are also influenced geologic structure with its more or less permeable formations, vegetation cover, density of the hydrographic net work, the effect of the number of lakes and swamps, the relief, the size and shape of the basin, human activity, etc.

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Due to these factors the discharge of the Rumanian is very variable.

The unstable climate is directly felt in fluctuations in discharge which show maximum values for the majority of our rivers in March and on into May, when precipitation is added to melting snows, and sharp drops in summer and the winter months. Examples:

Somes at Dej	113,870	cu m/sec	on 21 April 1950
	9,614	same	on 25 July 1950
Mures at Reghin	29,760	same	on 22 April 1950
	4,740	same	on 28 September 1950
Timis at Valisoara	15,050	same	on 16 April 1950
	1,810	same	on 26 July 1950
Jiu at Podari	161,000	same	on 7 March 1950
	6,882	same	on 15 September 1950
Olt at Bujoren	229,600	same	on 6 April 1950
(Rimnicu Vilcea)	35,250	same	on 13 April 1950
	32,000	same	on 2 February 1950
Siret at Racatau	125,760	same	on 16 April 1950
	50,400	same	on 14 September 1950
	25,400	same	on 4 February 1950

Along their courses the rivers lose large quantities of water through evaporation, infiltration, etc to such an extent that the discharge is often lower in the lower basin than in the middle one; this situation is characteristic of rivers which pass through areas with sharply contrasting climate.

In 1928 the following discharges were measured in the same period:

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Ialomita	at Tirgoviste	= 8.67 cu m/sec
	at Slobozia	= 7.59 same
Mures	at Branisca	= 42.75 same
	at Arad	= 15.70 same
Timis	at Lugoj	= 12.29 same
	at Timiseni (on the plain)	= 0.82 same

Thus the striking contrast between Timiseni and Lugoj must also be considered in the light of the fact that part of the water of the river has passed through a connecting system, located above Timisoara in the Bega Canal, to assure navigation.

D. Permanent and Temporary Rivers. The instability of the Rumanian climate is reflected to a considerable degree in the state of the hydrographic network. Since most of the rivers have permanent courses, being fed by the water table, there are many water courses of an intermittent torrential nature, closely connected with the distribution of precipitation.

The three great relief units of Rumania present different features from this point of view.

In the mountain area, due to heavy precipitation, steep gradients, limited infiltration, etc even small water courses have a permanent character, fed by many springs dependent upon the superficial water table and with a large discharge.

In these relief units the permanent network has a higher percentage than the intermittent one.

In hill and plateau areas a good part of the water courses, and especially the small ones have an intermittent torrential character, fed not only by rains but also by melting snows. While they flow, their

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erosion potential is great and has eroded extensive tracts of land especially where forests have been destroyed by irrational exploitation in the past. Alluvia carried by torrents have contributed to the damming of valleys in the Transylvanian plain and the Jijia depression giving rise to the numerous lakes adapted in the past by man.

However all these alluvia have contributed to filling to the point of disappearance of most of the lakes which at one time constituted one of the main local resources. Control of the torrents is a primary necessity in some areas (the Moldavian plateau, the Transylvanian plain, the Vranca depression, the Wallachian Subcarpathians, etc), and from the point of view of the restoration of economy it forms and important part of the electrification plan.

Even more characteristic is the distribution of intermittent water-courses in plains areas with steppe climate, where their percentage is higher than the permanent ones. The lack of precipitation, very active evaporation, infiltration, aridity, and other factors ordinarily transform even the larger rivers into veritable swamps (the Desnatui, Calmatui, Teleormanean, Mostistea, Calmatui Bralean, etc).

Water-Power Resources and Usefulness of Rivers in the RPR

The discharge and the rate of flow are the main factors which give priceless value to the Rumanian stream because of their water power potential. It is estimated that the Rumanian streams have a total exploitable potential of 565,000 kw, totaling 7,200,000,000 kwh of power in normal years. Assuming complete and ideal exploitation, this output could be raised to 36,300,000,000 kwh per year. The Bistrita alone, dammed at Steja, will furnish 210,000 kw, representing a third of the existing total of the thermoelectric and hydroelectric power plants at the beginning of the electrification plan.

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The Danube at the Portile de Fier has a potential of 1,500,000 kw, capable of supplying over 8,000,000,000 kwh per year.

The Jiu, together with its tributaries, also could provide a total of 83,637 hp. Not only the large rivers have such important reserves, but also the small ones in mountain areas, which through hydrotechnical exploitation could contribute to the achievement of socialism in Rumania.

However, the usefulness of Rumanian rivers is much more varied. The Danube and the Bega Canal are navigable. The Mures, Jiu, Olt, Arges, Ialomita, Buzau, Siret, and Prut could be adapted to this purpose for considerable distances. The Bistrita, Siret, Olt, and Mures are arteries intensively used for flotation. In mountain areas most of the water courses furnish motive power for small industries of the peasant type: mills, sawmills, fulling mills, etc. The hydrographic network supplies population centers and various enterprises with drinking and industrial water. The irrigated area is being extended more and more in regions lacking in water, especially for certain kinds of crops (cotton, rice, vegetable, etc). Multilateral use of the hydrographic network in Rumania is one of the most important objectives of the electrification plan and the five-year plan.

Hydrographic Associations in the RPR

Adjusted to relief, geologic structure, and tectonics, and directly influenced by climate, the hydrographic network can be grouped into a series of associations with traits in common which are concentrated in the Danube, the one river which crosses the RPR.

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The Danube

The Danube is the main hydrographic artery of the nation, collecting, with the exception of a few insignificant streams in Dobrogea, all the rivers of Rumania.

From its source in the hills of the Black Forest in Germany to its mouth the Danube follows a course of 2,855 km, being the second longest river in Europe after the Volga (3,688 km).

It rises in a basin covering 817,000 sq km, amounting to nearly one twelfth of Europe and about three and one half times the area of the RPR. It receives 120 important tributaries, of which 34 are navigable. In its navigable part, between Ulm and its mouth, widths vary from 100 to 2800 m and depths from 1 to 75 m.

More than one third its length flows over Rumania, and about one half of its navigable part and 36% of the area of its basin are on Rumanian territory.

The Danube basin covers approximately 8° of latitude (50° at the source of the Czech Morava, 42° at the source of the Serbian Morava).

It is supported on all sides by the mountains of the Alpine-Carpathian-Balkan system and it drains, directly or through its tributaries, a series of depressed regions: the Vienna basin, the Croatian basin, the Hungarian plain, the Transylvanian depression, and the Rumanian Plain.

It waters eight countries (Germany, Austria, Czechoslovakia, Hungary, Yugoslavia, Bulgaria, Rumania, and the USSR) and three capitals: Vienna, Budapest, and Belgrade. It cuts through mountain systems which it must cross via eight passes:

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1. Tutlingen-Sigmaringen, through Jura Suaba.

2. Passau-Linz, between the Alps and the Bohemian forest.

3. Grein-Krema, between the same massifs.

4. Klosterneuburg-Bissamberg (Vienna Pass), between Wienerwald and the Hercynian massif.

5. Heimberg-Theben (Bratislava Pass) between Leitha and the Little Carpathians.

6. Gran-Vac, (the Budapest Pass) in the volcanic chain in the RPU [Republica Populara Ungara -- Hungarian People's Republic].

7. Buzia-Turnu Severin, between the Carpathians and the Balkans.

8. Hirsova-Macin, around Horstul Dobrogean.

The marked differences between the massiveness of the Alps, attaining 4,810 m at Mt. Blanc and that of the Mercinice range in the north, which rarely exceeds 1,400 m are reflected in the uneven distribution of the tributaries, which involves the asymmetry of the upper basin of the Danube. The river receives not only most of its tributaries from the Alps but also the greatest ones. Asymmetry is also characteristic of the middle and lower basin. Here, the Danube receives numerous and rich tributaries from the Carpathian area and much fewer and less important ones from the Dinaric Alps and the Balkans. The reasons are to be found not only in the difference in massivity which otherwise would not be reflected at all, but even more in the regional characteristics of the climate, which present a considerable variety dependent upon the general circulation of air currents and the climate barrier role played particularly by the Dinaric Alps and the Balkans.

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The Evolution of the Course of the Danube. According to geologic studies on its basin, the Danube was conditioned by a great depression, compartmented by mountain rings and covered in the Oligocene and later in the Miocene period by a branch of the Mediterranean. It started from the present Rhine valley and penetrated, successively, through a series of gorges in the area north of the Alps, in the Vienna basin, then in the Pannonian basin, and from there, through a small pass it passed into the Pontic basin and extended into the Caucasus.

The movements at the end of the Miocene brought on a withdrawal of the sea, along with a rise of the continent. The eastern part of the marine branch, broken at the Mediterranean, was transformed into a basin of brackish water, constituting the old Sarmatian Sea, between Vienna, The Dardanelles, and Turkestan.

Going down even further it produced the Black Sea, the Caspian Sea, and Lake Aral, and on the site of the old marine branch was then formed the course of the Danube. Its present bed is the result of a long evolution, an intensive process of erosion, transport, and deposit.

Physical and Geographic Description of the Danube. Taking account of the fact that along its 2,855 km the Danube traverses the most uneven areas of Europe, with different physical and geographic conditions, reflected directly in its general condition and especially in its hydrologic characteristics, we can divide its course into three sectors:

(1) Upper Course (Alpine sector) from source to Bratislava;

(2) Middle Course (Pannonian sector) from Bratislava to Bazias;

(3) Lower Course (Carphatho-Balkan sector) from Bazias to the mouth.

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1. The Upper Course (Alpine Sector). The Danube rises at the foot of Kandel peak (1,241 m), on the eastern slope of the Black Forest massif, at an altitude of 678 m, from two branches: the Brigech and the Breg, which join at Donauschingen after a trun of 48.5 km. The river flows 900 km to Vienna.

In this sector, the great Alpine system meets the Hercynian system, represented by the Black Forest, Jura Suaba, Jura Francena, and the Bohemian Forest.

It receives tributaries almost exclusively from the Alps, and consequently from the right, so that its character is typically Alpine. Up to Ulm the only tributary worthy of notice is the Riss.

At Ulm there is a confluence with the Iller, and from there to Passau it meets the Guenz, Mindel, Lech, Isar and Wurm, etc. The Inn, the greatest of the Alpine tributaries, flows into the Danube at Passau. Between Passau and Bratislava, among the multitude of rivers flowing down the northern Alpine slopes, the Enns is the most powerful. The first great tributary on the left is the Altmuehl, which connects the Danube with the Rhine through the Ludwig Canal and the Regnitz, an indirect tributary of the Rhine. Along the massif of the Bohemian Forest, the Danube digs a wide and fertile valley, with the sole exception of defiles.

The average gradient on the upper course reaches 93 cm/km in the west and 60 in the east, the average rate of flow, closely related to the gradient, varies between 3.5 and 2.5 m/sec. The Danube first becomes navigable at Ulm, where a depth 1.2 m in the center can be counted on. The Czech Morava contributes its waters from the Bohemian quadrilateral even before the Danube penetrates the Bratislava defile.

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2. The Middle Course (Pannonian Sector). This section extends between Bratislava and Bazias over a stretch of 815 km and has characteristics quite distinct from the upper course.

Once the Danube has left the Bratislava pass, it enters the Raab depression, which has been very appropriately compared to an antechamber of the Pannonian plain. The river bed widens abruptly. The waters deploy and embrace two large islands, Great Schuett and Little Schuett. A new grouping of the waters is brought about by the mountains of Central Hungary, which they traverse through the defile cut in basalt between Gran and Vac. From Budapest the river passes into the Pannonian depression properly speaking, which it does not leave until Bazias. In the middle course the Danube receives important tributaries arising in the Alps, the Carpathians, and the Dinaric Alps, associated in two groups representing five eighths of its basin:

(a) Northern group, consisting of the smaller rivers, the Raab (Alpine), and the Vah, Hron, and Ipel (Carpathian).

(b) The Southern group, more complex and with greater rivers: the Sava (Alpine), Drava (Alpine-Dinaric), the Serbian Morava (Dinaric), and Tisa (Carpathian).

The two groups of rivers are situated at the ends of the Pannonian sector, where there are also considerable modifications in the river's variations in level and discharge. For the rest of this section the Danube is almost completely without tributaries and feels the continental climatic influences, with dry summers, of the Pannonian depression.

The average gradient is very low (5 cm/km) which produces a sluggish evacuation of the waters. Since the banks are low (especially the

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left bank) there is a permanent flood danger which has required a whole series of remedial measures. The rate of flow reaches a mean value of only 0.9 m/sec and a depth of 1.60 m.

3. The Lower Course (Carpatho-Balkan Sector). This is the most important section from the economic point of view, especially for Rumania, covering the area which the Danube enters at Bazias and then crosses for about 1,075 km to its mouth.

Draining the area between the Carpathians and the Balkans, the Danube is characterized by the complexity of its course, resulting from the contrast between the defile region and the ever widening meadow ending in a delta.

Professor Antipa brings out the regulating role which the meadow plays in stabilizing the hydrologic equilibrium of the river. The many Alpine, Carpathian, and Dinaric tributaries which make their contribution above Bazias cause massive accumulations of water here during the rise period, since it is impeded by the very narrow transverse profile of the valleys. History mentions the famous "White Sea" in the area of confluence of the Danube with the Tisa and Sava, and the geographic literature cites innumerable cases of catastrophic floods which often extended far into the Tisa basin before the latter was canalized. Since there was no meadow which Antipa aptly calls a "safety valve" of the Danube and which permits a gentle flow to the sea of surplus water, the spring floods spread extensively over present day Rumania. The storage capacity of the meadow, estimated by Engineer I. Vidrascu at the time of the high water of 1897 at over 24 billion cu m, protects huge areas on the Danubian plain from inundation (Figure 5). In regard to its general characteristics, the Danube can be divided as far as Rumanian territory is concerned into four different sections:

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(a) The Bazias-Turnu Severin section

(b) The Turnu-Severin-Calarasi section

(c) The Calarasi-Braila section

(d) The Braila-mouth section

(a) The Bazias-Turnu Severin Section. This corresponds to the great defile which the river has cut for itself transversally separating the Carpathian from the Balkan ring along a course of 144 km. The struggle of the river with the mountain begins at Bazias and ends definitively at Turnu-Severin, after which, below Vircioreva it crosses the last extensions of the Mehedinti plateau.

Between Bazias and Moldava Veche the valley as yet presents no unusual features, the major bed reaching a width of 5 km and gradient 0.04 m/km. Moreover the river separates into two branches and embraces the beautiful island of Moldava. Its appearance begins to change at Moldava Veche. Important features appear which are accentuated below Drencova and which have required special measures at Greben in the vicinity of Svinita and Iuti to regulate navigation. The gradient increases, having an average value of 0.23 m/km. At Plavisevita the Cazane section properly speaking begins. Over a length of four km the river bed narrows sharply to only 152 m in width. However the calm waters leave great depths, as much as 52 m the bottom sometimes being below sea level. It is the most picturesque area of the defile with almost vertical rock walls and whole groves of lilacs which grow wild here, showing influences of Mediterranean climate.

Three km from Orsova, after the confluence with the Cerna, there is the island of Ada-Kaleh, once an important fortress defending the Danube defile. Genetically it is actually an island, as the Rumanians called it in the past, formed of gravel and sand, later covered with vegetation and then peopled by Turks.

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It is 1,750 m long normally and attains 2,250 m at low water, when the alluvial deposits below the surface at its extremities emerge. It has an area of about 2 hectares, with an absolute height of 50 m and a relative height of 2 to 3 m, and it is level with the lower terrace of 4 to 8 meters of the river. Its formation was favored in part by the sharp bend in the Danube, which generated a somewhat calmer zone of water, and in part by the large quantities of rocks carried by the Cerna in time of floods only 2-3 km above.

For the next 5 km as far as Virciorova, the Danube flows through the Portile de fier, the wildest sector and the one most dangerous to navigation. The gradient reaches 2.2 m/km, which greatly increases the rate of flow (5 m/sec), necessitating supplementary traction to propel boats against the current.

Rocks which at low water reach up to the surface, constituting a constant danger to ships, have necessitated cutting a long channel about 2.5 km long, 80 m wide, and 2 m deep, which however is insufficient for the present needs of Danubian navigation. At Virciorova the river passes through the defile properly speaking, remaining without a meadow, however with a narrow valley, as far as Turnu Severin.

(b) The Turnu-Severin-Calarasi Section. At Turnu-Severin, the Danube enters into its true lower basin, known in geographic literature as "The Lower Danube." Asymmetrical banks are very characteristic of this sector. The right bank, cut into the sediments of the Pre-Balkan platform, is steep and higher than the left bank by about 50-200 m, very low, and favorable to the extension of the meadow and the formation of the Danubian fen lakes.

The meadow properly speaking seems better distinguished at Cetate and begins to spread widely at Calafat.

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In time of floods the river is fed with water from the innumerable fen lakes which accompany the river up to Calaras: at Ochiu, Fintina Banului, Lala, Tinoasa, Rastu Coldova, Bistretu, Nasta, Cirna, Nedeia, Potelu (west of the Olt), Berceu, Suhaia, Calota, Rotunda, Plaminaru, Maharu, Balta Pietrilor, Balta Lata, Topilele, Greaca, Boian, Sfrederile, and Calarasi (east of the Olt).

On the right bank the only meadow areas are between the mouths of the Ischer and Osma and further downstream from Nicopol to Sistov.

The mean gradient varies from 0.03 to 0.08 m/km, which causes a decrease in the rate of flow and favors the formation of islands.

The latter extend in a chain over the whole section between Turnu-Severin and Calarasi, making navigation very difficult. Some of them are very old, as shown by prehistoric life (simian) or permanent settlements (Ostrovul Corbului and Ostrovul Mare); others are less suitable for habitation (Ostrov Calnovat, Insula Ciobanu, Ostrov Mocanu, Tabanu, Longu, Becheru Mare, etc), covered with willow thickets.

Recent investigations made by sounding have eliminated the hypothesis of a fissure on the line of the Danube, admitting of only a slight inclination of the foundation of the Rumanian Plain toward the Carpathians.

The asymmetry of the valleys is partly explained by the large number of Carpathian tributaries (75%) as compared with Balkan ones (25%), causing continual erosion of the right bank. This has also resulted in the extension of the Danube terraces, well preserved on the Rumanian side and almost completely cut away by erosion on the Bulgarian side. The right bank was settled earlier, being higher and safe from floods. As late as the time of the Roman occupation, a whole series of camps were built here around which towns were later established and used

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by the Turks to guard the Danube. Along with the development of the grain traffic in Rumania, connecting towns were also developed on the left bank, paired with the old towns on the opposite bank: Turnu-Severin, Cladova, Giurgiu-Ruse (Rusciuc), Oltenita-Turtucaia (Tutrakan), Calarasi-Silistra, etc.

The problem is posed at present of maximum use of flood areas for cultivation of rice and cotton, as well as adaption of the fen lakes for fishing.

(c) Calarasi-Braila Section. The Danube meadow is so wide that the river cannot hold its waters on a single path and splits up into many branches. Between Calarasi and Hirsova the river thus flows in two main branches: the Dunarea Veche and the Borcea, which embrace between them a whole region of lakes, secondary branches, brooks, small waterfalls, and ponds known as the Balta Ialomitei. East of Calarasi the Danube sends out a great branch, the Rau, toward the Borcea. The Rau is used for navigation in times of low water. The area between them is 90 km long and 16 km wide at the maximum, so that the Balta Ialomitei offers great possibilities of rational exploitation through irrigation farming, pasturage, fishing, etc.

At Vadul Oii the river again gathers its waters into a single bed, partly because of the Dobrogean spur of Hirsova, with a resistant formation, and partly because of the heavy alluvia deposited at the mouth of the Ialomita.

The river then parts again into two branches: the Dunavea Noua composed of the Cremenea and Vilciu, and the Dunarea Veche, which bears its waters to the fields of Horstul Dobrogean.

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Between them lies the Balta Brailei (the island of Braila) 60 km long and 20 km wide. Like the Balta Ialomitei, the Balta Brailei is characterized by its numerous lakes, pools, small lakes, small waterfalls, ponds, islands, popine, bars, etc. From this point of view it can be regarded as an internal Danube delta, presenting features almost identical with a true river delta. At Braila the two branches join again in a single course which measures, when the waters are at normal level, 852 m in width and 24 m maximum depth. The Danube valley, however, maintains its asymmetrical character brought on by abrupt contact between the Horstul Dobrogean and the Rumanian plain. The very low gradient (3-5 cm/km) results in a very low rate of flow and sluggish evacuation of waters in the time of the spring rises.

(d) The Braila-to-Mouth Sector (Maritime Danube). The river leads its waters along a single bed which encircles the Hercynian spur at Macin and then turns eastward to the fork, or Ceatalul Ismailului, where the Delta begins. The Danube cuts its final defile on this course separating Horstul Dobrogean from the southern extensions of the Moldavian plateau. And in this sector, in the very wide meadow, a series of fen lakes and lakes extend: Ratoaiele (at the confluence with the Siret), Brates, (at the confluence with the Prut), Jijila, Plosca, Popina, Crapina, etc on the Dobrogean bank. The gradient is even lower, being only 0.5 cm/km in places. The Delta will be described in a separate chapter.

Hydrological Characteristics of the Danube Basin. The varied conditions of relief, climate, geologic structure, vegetation, etc, which characterize the immense area drained by the Danube, are reflected directly in its hydrologic features, impressing specific traits upon it.

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Source system: The Danube has a complex source system, in keeping with the areas traversed.

It springs from a source comparable to the oceanic determined by that type of climate and characterized by a steady and heavy discharge.

The source is mostly from rains and a slight amount of snow at the beginning of spring. The amount and consistency of the discharge are on a scale to explain the penetration by the river of the Jura-Suaba mountain chain at a distance of only a few dozen kilometers from the source.

As it enters the Bavarian plateau, the Danube becomes an Alpine river fed by a preponderance of ice, with a heavy discharge, registering maximum values in the spring months with the melting of the ice. The snows and rains play a secondary part in feeding the river.

The Alpine characteristics are more pronounced between the Ulm and Passau and are determined by the great tributaries on the right (the Iller, Lech, Isar and Inn), with sources 3,500-4,000 m high in the Swiss and Austrian Alps, rich in ice. The Alpine climate extends, in increasingly attenuated form to Budapest.

In the Pannonian depression the Danube system changes again, becoming continental, with pluvio-nival sources. The infiltration and evaporation produce great drops in level and discharge in summer. In spring, however, the Tisa and Dinaric, and the Carpathian tributaries (the Sava and the Serbian Morava) bring in great quantities of water produced by the melting snows and rains characteristic of the local climate.

After leaving the Portila de Fier defile, the continental character of the system is accentuated even more -- comparable to the waters of the Russian steppes.

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Variations of Level: The source system conditions variations in level to the greatest extent. But the contributions of the tributaries and to a lesser degree the transverse profile of the valleys play a particularly important role.

In the source area, where a strongly oceanic system prevails, the level variations are generally constant all year around. The most pronounced increases are in winter and spring, from December into April, and the decreases in September and October.

In the Alpine sector, even at Passau, the great number of important tributaries on the right of nival-glacial origin determine the maximum increases in spring (June-August), while the melting [sic] of the snows and ice determine the decreases in winter (December-February), when solid precipitations no longer has a direct effect. The Alpine characteristics continue to Budapest but are increasingly attenuated. Since snow is more important than ice in feeding the river, the increases come earlier registering maximum values in May-July.

On the Hungarian Plain infiltration and evaporation are very pronounced and cause a drop in level in spring; the Carpathian and Dinaric tributaries, however, bring large amounts of water causing this rise because of increases caused by the melting snows and rains of the local climatic system. Thus at Orsova the maximum increases are in March-May, while the decreases are in August-October.

As distinguished from the Alpine sector, the minimums occur not in winter but in autumn and the maximums come in spring instead of winter.

These characteristics are more accentuated once the Danube enters the Pontic basin, where a typical steppe climate prevails which not only

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lowers the value of the minimums even more, but also accelerates them. Except for periods of rising water, the evacuation is much delayed by the low gradients. This explains why at Tulcea the maximum level is reached only in late June.

The lower Danube increasingly resembles the water courses of the Russian steppes more and more as it goes on.

The extreme rises grow less toward the east, which also contributes to the progressive width of the valley. In 1897 the Danube registered 8.65 m over the low-water mark at Turnu Severin, 7.63 m at Giurgiu, 6.64 m at Galati, and 5.10 m at Tulcea.

The resemblance to Russian rivers is also true of the freezing system.

The periods of freezing vary with the severity of the winters. On the average they last 7-8 weeks. The maximum duration was recorded in 1879 at 96 days.

In 40 years of observation the Danube was free of ice in only 15 years.

Due to climatic influences thawing proceeds from west to east; on the lower course the blocks of ice are impeded by snow, a very dangerous situation because of the floods it causes.

The blocks of ice usually begin to move out in February and less often in March.

Blocks of ice 7 km long and 1 km wide have been measured which destroy not only meadows, docks, and piers, but sometimes even the islands in their path.

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The discharge increases successively from the source to the mouth. Its average value is 800 cu m/sec at Passau, 1,600 at Vienna, 2,300 at Budapest, 5,800 at Portile de Fier, and over 7,200 cu m/sec at Tulcea.

In the lower basin the discharge varies according to the season between 2,200 cu m and 20,000 cu m/sec.

Maximum amounts of water are accumulated in spring and the beginning of summer, due both to the contribution made by the tributaries received in the Pannonian depression (the Drava, Sava, Morava, and Tisa) and to the rivers outside the Carpathian and Balkan rings.

The discharge variations follow in general the same curve as the tributaries on the lower course of the Danube. In spring, however, they affect more tributaries above Buzias while in summer and autumn it is those below.

On Rumanian territory during its great floods, the Danube inundates over 800,000 ha including the Balta Ialomitei and the Balta Brailei and the Delta. The width of the flood area extends on the left side of the river for 5 or 6 km and reaches 12 km at points. The flood area of Dobrogea alone amounts to about 430,000 ha.

The river rises at three times:

(a) In autumn, when the water does not overflow the banks.

(b) When the ice breaks up and currents are formed and local flooding takes place.

(c) In spring and at the beginning of summer from March to June, along with the melting of the snows and the May-June rains, when there are commonly frequent and heavy inundations.

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The river water bears large amounts of alluvia in suspension, varying between [figure illegible] tons ([date illegible]) and 154,000,000 tons (1871).

On the average these alluvia exceed 80,000,000 t per year, being deposited unceasingly, especially in the Delta, which brings on the permanent necessity of dredging the Sulina branch and other parts of the lower course.

Despite all the deficiencies caused by the fluctuations of its system, the great quantities of alluvia, the periods of freezing, the rocks and the rises at Cazane and Portile de Fier, and the fact that it terminates in a delta on an almost enclosed sea, the Danube is nevertheless a highly important artery of communication in continental Europe, forming a veritable diagonal across Europe between the North Sea and the Black Sea -- especially since its connection with the Rhine via the Ludwig Canal.

The importance of the Danube in the economic life of the continent and especially the riparian countries is very great. It is an important economic axis for the country, especially since it collects a whole network of rivers which provide convenient highways for all its areas.

Tributaries of the Danube

Depending upon relief and climatic characteristics, Rumania's hydrographic net falls into several distinct parts.

1. The Western Group. This includes all rivers of the interior of the Carpathian area, which flows into the Danube through the Tisa as intermediary.

It is in turn divided into the following basins:

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The Maramures Basin (3,283.76 sq km) This groups the Tisa tributaries, on the stretch between Valea Viseului and Teceu Mic on which the river forms the Soviet frontier. The Viscu, joined with the Ruscova, has a source under Priskop, and the Iza, joined with the Mara, has a source under Pietrosul Rodnei. The precipitation system assures a quite rich permanent discharge and mean annual increases over the low-water mark of 50-100 cm. The mean summer increases stay between 150-200 cm. No drops below the low-water mark are recorded (Mihailescu, Rominia). The high density (0.70-0.80 k/ sq km) reveals a permanently well-organized network with numerous tributaries, a natural result of a climatic system rich in precipitation. Though insignificant in appearance, because of heavy precipitation and irrational cutting of vegetation on the slopes and also because of abrupt changes in the gradient, the tributaries of the Tisa sometimes flood the low lying center of the Maramures depression, to say nothing of the fact that torrential erosion, very active, has changed the deforested areas into unproductive land. In order to correct this situation the Maramures is one of the areas slated for immediate hydrotechnical adjustments.

The Tur Basin. Outside the Maramures basin the Tisa receives the Tur, joined with the Tilma (1,294.51 sq km) which traverse the Oas region.

It presents a great contrast in that the density reaches 84 km/sq km in the area of the source in the Ouas Mountains, where precipitation exceeds 1,000-1,100 mm, and drops to only 0.20 in the plains area, dominated by the much dryer system of the Pannonian depression. The abrupt transition from the mountains to plains results in an equally abrupt change in the flow gradient and creates conditions likely to result in flooding.

The Basin of the Somes River. Exetnding over 15,826.16 sq/km (without the Crasna), the Somes drains various physical and geographic

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units presenting complex characteristics. It consists of two branches with sources in opposite directions which converge at Dej; it then crosses, through epigenesis, the defile at Surduc and enters the depression of Baia Mare gulf [i.e., prehistoric] to flow into the Tisa after meandering through the extensive swamp area of Ecod.

The Somes Mic springs from the waters of Mount Bihor, through the Somes Cald and the Gilau massif through the Somes Rece. At Gilau it receives the Capus, at Cluj the Nadas, and in the interior of the Transylvanian basin, minor tributaries with unstable systems (Valea Borsei, Piriul Luna, Valea Fizesului).

The Somes Mare, with sources under Inau, collects on its way the Valea Ilvei, Salauta, along which the Salva-Viseu railroad was built, the Sieu joined with the Bistrita and a series of smaller tributaries.

After leaving the Surduc defile, it also receives the Agris and Almas from the mountains, with huge deposits of coal in their basins, and the Lapus from the Tibles Mountains joined with the Capnic and Sasar, the latter watering the industrial center of Baia Mare.

The density bears the imprint of the physical and geographic conditions of the areas which the Somes, in its two branches, successively traverses. It is high (0.70-0.80) in mountainous areas (Gilau, Rodna, Caliman Mountains), medium (0.60-0.70) in the high hill area of Cluj or Bistrita, and even registers lower values (0.40-0.50) in certain secondary basins on the Transylvanian plain where the climatic system approaches that of the steppes in its characteristics.

On the Somes platform the values increase again (0.60-0.70), so that a new, even more pronounced decrease is recorded once the Somes enters the Tisa plain.

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In the measurements taken in mountain areas (the Somes Cald, Somes Rece, the Somes Mic; Rodna Veche, Nepos, the Somes Mare; the Razoare at the Lapus) drops below low-water mark are not observed. But they are characteristic for the basin zone which corresponds to the Transylvanian "plain," with unimportant tributaries, and are accentuated on the Tisa plain in keeping with the steppe climate of the Pannonian depression.

On its final stretch, however, the Somes could be adapted to navigation.

The Crasna (2728.75 sq km), joined with the Zalau stream divides its waters during floods of the Somes and Tisa, feeding the Eced swamps.

It is characterized by the instability in its system and it is contained in the basin of the Somes Rivers.

Basin of the Cris Rivers (15,834.11 sq km). This includes the Barcau, with sources in Plopis, the Cris Repede, the Cris Negru and the Cris Alb, which join two by two on Hungarian territory and then form a single course, joining the Tisa in a low swampy area. They all drain thickly populated depressions, former gulfs on the Pannonian Lake, which penetrates deep into the interior of the mountain chain.

The Cris Repede has had the most interesting evolution which, depending on the variations of its basic level at various stages, has penetrated through regressive erosion into the Huedin depression where it has its sources today, collecting in turn the Surduc, Dragan, Sebes Calata, (on the left) and the Peic (on the right). All these have an initial course toward the north, flowing partly into the Simleu gulf and partly into that of the Almas. The old paths are shown by gravel from Vladeasa which is found at many levels above the Osteana saddles (northern Ciucea) marking the course to the Simleu gulf (for documentation: R. Ficheux: "The Hydrographic Net of Northern Bihor").

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At present the Almas is characterized by a very strong regressive erosion connected with the basic level variations of the Somes, preparing the diversion of the Cris Repede and Calata and their drainage toward the Almas gulf again.

All three Cris rivers have similar characteristics with two distinct divisions:

(a) The mountain division, with steep gradients, narrow valleys, rapid flow, high densities, ample and steady discharges, and mean levels over the low-water mark due to the large amounts of precipitation falling in the Apuseni mountains.

(b) The hill and plains division, with wide valleys, very low gradients and densities, and an unstable system marked by exceptional rises and sharp drops below the low-water mark in keeping with the steppe climate.

The Mures Basin. This is the most important in the western group, with a total area of 28,188.15 sq km. The Mures along with the Olt and the Bicaz has its source beneath Hazmasul Mare and flows about 880 km to its mouth. Through the Giurgeu (Gheorgheni) depression it flows sluggishly due to the low gradients. It receives some small tributaries, having however a rich discharge in keeping with local climatic conditions. Because of this no drops below the low-water mark are recorded.

Between Toplita and Deda it flows through its first defile cut through the eruptive formations of the Caliman and Gurghiu massifs for about 40 km.

In the defile it abruptly changes its character, becoming a typical mountain river active in the processes of erosion and

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transport with the longitudinal and transverse profile characteristic of a young valley fed by unimportant tributaries.

It enters the Transylvanian basin at Deda north of Reghin.

At Reghin it joins the Gurghiu. From there it flows diagonally across the Transylvanian basin marking the boundary between the Tirnava hills and the Transylvanian "plain."

The steppe climate of the "plain" is immediately felt, not only in the usual drops below the low-water mark, but also in the scant tributaries (the Nireaj, Comlod, and Ludus). Also in keeping with the climate, the maximum level is reached early (in April).

The tributaries from the Tirnava rivers (the Tirnava Mica and Tirnava Mare, meeting at Blaj) have a more pronounced stability and discharge, due to the precipitation system.

During the evolution of its basin the Mures fought a silent battle with both the tributaries of the Somes and those of the Olt. According to Ioachim Rodeanu, the Mures emerged victorious from the struggle with the Olt, receiving the Tirnava Mare which had formerly flowed southward over the present course of the Visa (tributary of the Tirnava) and the lower course of the Cisin.

From the Apuseni Mountains it received successively the Aries joined with the Iara, and the Hasdatele rivers, which cut the famous Turda gorges, the [name illegible], the Galda rivers, the Ampoi with the Ampoita and the Geoagin.

The rivers with sources in the southern Carpathians make a much more important contribution: the Sebes, Cugir, and the Strei joined with the Riu Mare and the Farcadin; from the Poiana Rusca massif it receives the waters of the Cerna which waters the great steel town

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of Hunedoara. Fed in great part by snows at great heights (over 2.000 m) these tributaries have a direct effect upon the level variations of the Mures, which barely registers maximum values for this sector (Alba Iulia, Simeria Veche) in May when the snows melt in the mountains.

Between Deva and Rodna, for approximately 100 km. the river cuts its long bed with typical defile sectors at Branisca, Zam, Soimus, Lipova, mostly epigenetic. The narrow transverse profile causes more pronounced increases over the low-water mark, so that at Branisca the Mures shows the highest values (610 cm in 1932) of its entire course and has never dropped below the low-water mark.

As soon as the Mures enters the Tisa plain at Lipova, the steppe climatic influences are accentuated, as shown by the arrival of maximums in April, the great fluctuations, and the pronounced drops below the low-water mark (Arad, Periam Port).

In keeping with the variety of the physical and geographic conditions of the relief areas it traverses, the density of the hydrographic net in the basin presents great variations. In the area of the source of the Mures and the Tirnava rivers, the values vary between 0.70 and 0.90; they remain between 0.50 and 0.70 in the higher plateau area and fall below 0.50 on the tributaries on the Transylvanian plain. The low-lying tributaries from the Apuseni Mountains and the southern Carpathians reach values of 0.60-0.70, while in the plains area the man-made canals maintain a density of about 0.40 sq km.

With all its great variations in density, level, and discharge, the Mures transports even at the low-water mark (summer and autumn) a considerable amount of water (36-45) cu m), so as to be navigable

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up to Deva and adequate for flotation up to Tirgu Mures. It could be made navigable by special arrangements up to Reghin (620 km) for small craft.

2. Southwestern Group. Among the direct [sic] tributaries of the Danube there is also Beghei, a tributary of the Tisa, with characteristics common to this group.

The Beghei, with sources in the Poiana Rusca massif, is an old course of the Mures (Fichenux, Gh. Pop) abandoned at 310 m when a lateral shift takes place at Tataresti-Zam, which gives the rivers its present features.

Receiving only one important tributary at Beregsau, the Beghei was dredged in the last century above Timisoara and is navigable for 40 km on Rumanian territory, but the system of locks is not entirely adequate.

The direct tributaries of the Danube are: the Timis (7,352.0 sq km), with the Hideg Bistra, Paganis, and Birzava Caras (1311.34 sq km), Nara (1452.25 sq km^2), Sirzasca and Cerna joined with the Mehadia (1511.25 sq km).

Weak Mediterranean influences are revealed by the dual periodicity of increases (spring and autumn).

The steppe climate of the Banat plain explains the very strong level and discharge fluctuations (879 cm on the Timis at Parcul-Rudna, 1926), which cause heavy inundations as well as pronounced drops below the lowwater mark.

With fertile soil and a climate favorable to irrigation it offers the best conditions for cultivation of rice (Partos, Deta, Denta, Banloc, etc) and other valuable crops.

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3. Southern Group. A whole series of Danube tributaries are included in the sector between Turnu-Severin and the confluence with the Siret. The Olt marks the border between the Oltenian and Wallachian streams, distinguished from them by certain specific characteristics. West of the Olt, as also in the Banat group, two spring increases (April and June) occur and two in autumn (October, November), the latter being less pronounced. The smallest is in September. This feature is more prominent on the Jiu. With the exception of the lesser steppe arteries (the Drincea and the Desnatui) the others (the Jiu and Olt, south of the Carpathian ring) do not register drops below the low-water mark, a fact which is explained by the considerable contribution of the Carpathian tributaries.

From this point of view, a division can be seen at the Olt between the northern Carpathian sector where quite pronounced drops are to be seen in summer, and the Subcarpathian sector where even at the minimum the low-water mark is not reached.

East of the Olt the steppe climatic system is accentuated and this is felt in the great fluctuations of level as well as in the scarcity of water in the largest rivers.

Differences of level and discharge are very characteristic of the Ialomita at Cosereni, where it receives the important contributions of the Prahova and Teleajen, and at Slobozia, in the Baragan, where it also registers high values and the extremities of the climate cause huge drops due to losses on the way (evaporation, lack of precipitation and tributaries, infiltration, etc) (Mihailescu, Rominia).

Except for the depressed area of Petrosani, where high densities (0.70-0.90) are found, related to local conditions of climate, relief, and vegetation, the whole network of rivers fed from the

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southern Carpathians or the area of curvature is marked by a relatively low density (0.50-0.60) in keeping with the climatic differences (especially precipitation) between the northern and southern slopes of the Carpathian ring. Densities then drop progressively in the Subcarpathians and the Getic plateau to only 0.10-0.20 km sq km in the southeast of the Rumanian plain.

From west to east, the arteries of the southern group are as follows: the Drincea and Desnatui, both with sources on the Getic piedmont, typical steppe rivers with courses cut in alluvium. In the dry season they lose most of their water while they flood in the wet season.

They feed the fen lakes on the Danube meadow (the Drincea flows into the fen lake at Ochi, and the Desnatui into the one at Cirna).

The Jiu Basin (10,626.85 km [sic]). The Jiu is one of the most capricious rivers in the land. After the confluence of the two opposite branches, (the Rumanian Jiu and the Transylvanian Jiu) in the Petroseni basin, the river enters the Salbatic defile of the Surduc (Lainici) which it does not leave until near Bumbesti after a stretch of about 30 km. There have been several different hypotheses about the passage of the Jiu through the Vilcan-Paring chain.

Lahmann assumes a preceding diverting fissure through erosion but does not succeed in identifying its traces.

Inkey is clearly for erosion attributing the formation of the present Jiu to diversion of the upper course of the Strei by a torrent on the Oltean slope with more active erosion. But he has not dated the diversion.

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Mrazec eliminates the tectonic hypothesis by a careful study of the geology of the Surduc, which reveals no trace whatever of a fissure. But he points out a transverse syncline of the Lainici, assuming also a course anterior to the present one.

Murgoci is of the same opinion; he also assumes a preexisting course along a syncline of the Getic water table.

De Martonne admits diversion of the Jiu at the expense of the Strei, accomplished, in his opinion, in the Pliocene.

Burileanu admits an antecedent of the Jiu.

Most Rumanian geographers support the diversion hypothesis.

From Bumbesti onward the Jiu digs itself a wide valley with terraces. In the Tirgu depression the Jiu receives the Susita with the Jales from beneath Vilcan peak as well as the Bistrita with the Tismana, which cuts especially beautiful valleys in the limestones at the foot of the massif.

At Filiasi there is an area of local stoppage, in which are clustered the most important of the tributaries of the Jiu: the Gilotru, with very wide terraces, springing from Paring, and the Motru, joined with the Cosustea and a series of other tributaries crossing the limestone plateau of the Mehedinti, with interesting karst phenomena. The only tributaries from the hill area are the Amaradia and Rasnicu, with confluence points near Craiova. Down to the Danube the meadow widens considerably and is often inundated, as the bed of the Jiu cannot channel under normal circumstances the waters received simultaneously from all the tributaries group in the Craiova-Filiasi area during periods of torrential rains. With its normal discharge (80 cu m/sec) the Jiu could be made navigable for small craft as far as Craiova (80 km).

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The Olt Basin (924,884.35 sq km). The Olt is the most important of the southern rivers both in length (over 600 km) and in mean discharge (160 cu m/sec).

It takes its source from beneath Hasmas Mare and drains along a very sluggish course the Ciuc depression. It cuts its first defile at Tusnad, between Pucios and Baraolt. As it enters the broad plain of the Trei Scaune depression it becomes calm again and receives the contribution of the Riu Negru with sources in the Ciuc Mts.

In Tara Birsei, where it keeps its plains character, it also collects the Piatra Craiului from Bucegi, the Ghimbav joined with the Timis [sic], then the Birsa and Vulcanita.

Twisting northward, it receives the Baraolt and Virghias, after which it enters the second defile at Racos (between the Baraolt Mountains and Persani).

In Tara Oltului it drains another area of extended plain, receiving the Homorod from the Tirnava plateau and a series of tributaries with unstable systems, and several rivers from Fagara which are swift, clear, and with permanent discharges, capable of supplying large amounts of hydroelectric power (the Sinca, Sebes, Posorta, Simbata, Arpas, etc).

Before penetrating the southern Carpathian chain, it receives the Cibin joined with the Hirtibaciu and the Sad.

The three depression centers (Ciuc, Tara Birsei, Tara Oltului) represent the wide bottoms of old Pliocene and post Pliocene lakes drained by a series of successive diversions. The present course of the Cibin and, in continuation that of the Secas seem to represent, in some opinions (Inkey, Bela Bula), the old path of the Olt when it was a tributary of the Mures.

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In the southern Carpathians it traverses the roughest sector of its course through the Turnu Rosu-Ciineni-Cozia defile for a distance of about 50 km.

The one great tributary, the Lotru, joined with the Latorita and the Valea lui Stan (with gold bearing deposits), descends from Paring and joins it at Golotreni, passing through Voineasa with its mica mining and through the important forestry center of Brezoi.

After the confluence, the Olt cuts through the wildest part of its defile (the Olt bends) between Capatina peak and the Cozia massif.

As in the case of the Jiu, several hypotheses have been advanced on the impressive penetration of the southern Carpathians by the Olt.

Eugen Reclus attributes the formation of the Olt to a flow of waters from the area of the present Lovista depression.

Lahmann admits not only simple erosion but also some initial fissure line, as for the Jiu.

Inkey assumes a superficial fracture which would prepare the way for a later break through and which, in his opinion, was completely obliterated by subsequent erosion.

He also notes some tectonic disturbance of the two slopes which he brings in support of his contention.

Rahmann and Romer see no possible explanation other than the tectonic one, proposing a sunken area through which the river cut its present valley.

Burileanu admits an antecedent valley.

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Murgoci assumes, as for the Jiu, a transverse syncline of the water tables from local pressures.

De Martonne's diversion hypothesis admits a mountain Olt as a continuation of the Lotru having as tributary the valley of the Calinesti rivers and a Transylvanian one in continuation of the valleys of the Baiasi rivers, flowing either on the site of the Fagaras depression or into the Mures, on the course of the Cibin-Secas.

The Rob and Cozia peaks formed the watershed between these two rivers.

A tributary of the Calinesti rivers could cut through this peak, reversing the course of the Transylvanian Olt with a higher basic level.

For the defile sectors (Turnu Rosu and Cozia) De Martonne also admits an epigenetic phenomenon.

At Calimanesti the Olt enters a Subcarpathian area, receiving on its right the Olanesti, Govora, Bistrita, and Luncavat and on the left the Topolog rising beneath Negoiu. It then cuts through the formations of the Getic piedmont and at Slatina it can be regarded as a plains river. The river meadow widens extensively; meandering is accentuated and flooding more frequent. The Oltet joined with the Cerna and Plesca, and then the Teslui are the last important tributaries, the Teslui having a typical steppe character.

At Islaiceni the meadow is so wide and low that the Olt often changes its course in times of great floods. From Draganesti on it is accompanied on the left by the parallel course of the Siiu, which is one of its old paths. At present the Olt is suitable for flotation from Turnu-Rosu and could easily be made navigable to Slatina.

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By further arrangement the navigable sector could be extended to Feldicara (530 km).

There are a few minor rivers between the Olt and Arges with typical steppe systems: the Teleormanean Calmatui, which feeds lakes Suhaia and Vedea (6,135.35 sq km) and the Cotmeana, the Cina rivers and Teleorman, which flow for about 30 km on the Danube meadow parallel to the Danube, flowing into it near Giurgiu after traversing a series of lakes.

The Agres Basin (12,879.45 sq km). The Agres is the first of the great rivers of the southern group undergoing more pronounced steppe climatic influences since most of its basin consists of low relief units (piedmont and plain) in which this climate prevails.

The great fluctuations often cause considerable inundations both in the area of the Titu-Potlogi separation and in the lower river basin.

Thanks to the contribution of the Dimbovita, it maintains a considerably heavy discharge (23 cu m) at Budesti on the plain even in November. The lower meadow lends itself very well to irrigation and cultivation of rice, cotton, vegetables, etc. It is also the first large river to deviate to the southeast in conformity with the vertical movements of the Rumanian Plain have successively abandoned its old courses (Teleorman, Dimbovnic, Neajlov).

It rises in the glacial lake of Capra (Fagas Mountains) and then flows through a wild defile to enter the Subcarpathian area where it joins the Vilsan.

At Pitesti, in an area of local stoppage it collects a group of tributaries: the Riu Doamnei, with the Bratia, the Riu Tirgului, and the Argesel.

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Except for the Dimbovita, the other tributaries (the Neajlov with the Dimbovnic, Glavacioc, and Cilnistea on the right and the Sabar on the left, and the Colentina, a tributary of the Dimbovita) traverse steppe and forest-steppe areas only undergoing the effects felt in great fluctuations of level and discharge.

The Ialomita Basin (10,822,11 sq km). The Ialomita deviates sharply to the east, abandoning its old course (the Mostistea of today) in the stoppage area of the lower Siret.

It is characterized by exceptional variations of level and discharge in the plains area and by the asymmetry of its lower valley, being conditioned to a great extent by the frequency of the north wind.

It is suitable and intensively used for irrigation. It can be made navigable for small craft as far as Urziceni (200 km).

It rises under the Omul Massif (Bucegi), cutting a series of three gorges in the mountain area (the Tatar, Zanoaga, and Orza gorges).

The Moreni hydroelectric power plant was recently put into operation here, one of the great achievements of the people's democratic regime.

In the high area it receives the Ialomicioara, which opens the way to Sinaia, and upon leaving the piedmont region it receives the Cricov Dulce and the Prahova joined with the Doftana, Teleajen, and Cricov Sarat, all with important oil deposits in their basins.

From there to its mouth it has almost no tributaries which fact helps accentuate its drops in discharge and level.

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The Mostistea, a veritable string of lakes and swamps, as indicated by its name, and the Brailean Calmatui, the former course of the Buzau, typical steppe rivers, water the eastern part of the Rumanian Plain, running almost entirely dry in times of drought.

During large floods the waters of the Buzau often stray over the old course, one of the connecting links with the Calmatui, called the Valea Buzoelului.

4. The Eastern Group. The Siret Basin is the most extensive, since the total area on Rumanian territory amounts to about 44,555 sq km. The Siret has at the same time the most typical asymmetrical basin, receiving most of its tributaries on the right from the eastern Carpathian ring.

The contribution of water and alluvia brought by the Carpathian tributaries flow into it toward the east, conditioning the formation of its asymmetrical valley and the wide arcs at the points of confluence with the Suceava, Moldova, Bistrita, and Trotus.

In forming these arcs the river cuts directly into the formations of the Moldavian plateau which is 200-300 m higher than the low meadow.

The width of the meadow varies between 2-3 km to Roman, 3-6 km at Bacau, and 15-30 km in the lower basin. The exceptional width at the mouth is due, however, not only to the activity of the river but also to the Focsani-Namoloasa-Galati stoppage area.

On its course the Siret often narrows its meadow because of the massifs which it cannot cross and thus forms a series of narrows: Vf. Cimpului (1.5 km wide) between the Zaranca (522 m) and Bour (477 m) massifs; Dolhasca Lespezi (2 km wide) between the Tararusi

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(470 m) and Dealul Mare (593 m) massifs; Cleja-Racaciuni (2.5 km wide) between Pietricica (746 m) and Colonesti (568 m).

Directly connected with these narrows there are also gradient variations (1.2 m/km) at Racaciuni, compared with 0.85 m/km in the northern area and 0.23 m/km in the mouth area.

The rate of flow and consequently the evacuation period of high water varies along with the gradient, which brings on frequent and very extensive flooding.

In the upper basin, as far as the confluence with the Suceava, the water remains below the low-water mark almost all year long.

The Carpathian tributaries contribute directly to the rise in the Siret's level and discharge. It registers constant increases and the highest annual mean of all waters of the country: 285 cm (Mihailescu, Rominia) even at Lespezi.

Below the confluence with the Trotus, the steppe climatic influences are more and more in evidence in quite pronounced drops in discharge.

The large amounts of alluvia pretty well preclude navigation of the Siret, so that it remains only a flotation artery like the Bistrita and Trotus.

However, it could be made navigable and its regularization for this purpose in the Galati-Bacau sector is envisaged in the electrification plan.

The Siret rises beneath Obcine Lunga (USSR) and flows 535 km to its mouth. It enters Rumania near Orasul Siret, whence it flows in a north-northwest to south-southeast direction in conformity

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with the general inclines of the Moldavian Sarmatic plateau.

The first important tributary is the Suceava, with the Putna and Sucevita, which meets it at Liteni. The Somuz Mic and the Somus Mare, between Suceava and Moldova, bring in small amounts of water, having sources only in the Subcarpathian area.

The Moldova rises beneath Obcine Lucinei and receives the Moldavita at Vama and the Humora at Gura Humorului, all of them draining beautiful depression-troughs with the appearance of long fields. The Suha, Risca, and Neamt, on which the Humulestii of the great Rumanian writer Ion Creanga are located, and the Topolita bring their waters from Stinisoara peak.

The Moldova joins the Siret at Roman, opening the way to Transylvania via its upper course over the Mestecanis pass and aiding intensive forest exploitation.

The Bistrita is the most important tributary of the Siret. It rises beneath Prislop (the Rodnei Massiv) and receives successively the Cirlibaba, Dorna with the Tesna, in the basin of the Dorna rivers, Neagra, Sarului, Barnar, Neagra Brostenilor, Bistricioara, Bicaz, Tarcau, and Cracau, all typical mountain rivers.

The Bistrita is used intensively for flotation, along with most of its tributaries. It has a great hydraulic power potential.

The V. I. Lenin hydroelectric power plant at Stejar alone will furnish Moldavia with 210,000 kw, and the dammed lake will be able to irrigate about 300,000 hectares of the dry areas.

It also has an especially picturesque valley, especially in the Toance sector.

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It delivers lumber to the Vad forestry combine, the enterprises in Buhusi and Bacau, and the cellulose and paper mill at Letea.

The Trotus, with the Ciobanas, Uz, Slanic, Oituz, and Casin on the right the Asau and Tazlau Mare with the Tazlau Sarat on the left, opens the way not only to Transylvania via Ghines-Palanca, but also to the important coal, oil, and salt deposits which are the object of some important exploitation projects as well as to the beautiful Slanic-Moldovei spa. It flows into the Siret south of Adjud.

The Zabraut and Susita, much smaller streams, remind us of the heroic resistance of the Russian and Rumanian troops in World War I

The Putna, with the Zabala, drains the beautiful Vranca depression, their twisting course being explained by a series of local diversions. Issuing from the area, rich in foothills, of the Moldavian Subcarpathian curvature, it also receives the Milcov and Rinma with very unstable systems.

The Putna Seaca, a waterless stream as its name indicates, is merely the former course of a direct tributary of the Siret.

The present lower course for a stretch of 50 km represents an extinct branch of the Siret recently used by the Putna in one of its great floods.

Ay Calieni, the strip of land which separates it from the Siret is only 100 m wide and will very soon provide it with an opportunity to shift from its new course (Simionescu, Tara Noastra).

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The Rimnic Sarat flows initially toward the southeast past the town of the same name and turns abruptly to the northeast, attracted by the stoppage area of the lower Siret, abandoning successively the former pointsof confluence with the Buzau, a tributary of which is represented by the present Jirlau Amara and Balta Alba lakes.

Buzau is the Siret's last tributary on the right. It has a most tortuous course due to the irregularities of the area of curvature which has caused a series of diversions. In the mountain area it receives a whole series of Bisca rivers: the Bisca Mica, and Bisca Chiojdului with the Bisca Fara Cale after having previously cut an antecedent valley in the mountain.

The Slanic, Niscov, and Cilnau are concentrated in the Subcarpathians, around the town of Buzau. The river then turns to the northeast, leaving its old bed (the present Calmatui). It has a pronounced steppe character and meanders a great deal. By correcting its course, it could be made navigable as far as Buzau.

On the left the Siret receives a few minor tributaries except for the Birlad, which with its ramified basin drains the whole central Moldavian plateau. It flows initially toward the southeast, as though toward the Prut.

In this area it receives the Sacovat, Stavnic, Racova, Vasluet, and Crasna, the last three concentrated in the marshy area south of Vaslui. It curves them to the southwest, taking the form of a huge question mark, a curve which must be attributed to the low area of the lower Siret.

In this sector it decapitates a series of tributaries of the Prut, on the left, and on the right it collects parallel streams of

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the rivulet type, as the Simila, Tutova, Zeletin with the Berheci, and their tributaries.

Under the steppe system the Birlad registers exceptional increases, causing large inundations at flood times and becomes unrecognizable in times of great drought, when it flows as a thin trickle of dirty water. The density of its network varies between 0.30 and 0.60.

Finally, the valley of the Ger marks the northern limit of the Rumanian Plain and it flows into the Siret at Piscui.

The Prut Basin (23,952.40 sq km in its entirety). The Prut marks the USSR border for 470 km from the town of Lunca, where it enters Rumanian territory, as far as the confluence with the Danube.

It rises under the Cerna Gora massif (USSR) and flows 882 km in all.

As far as the town of Radanti, the northernmost point in the country, it has a very wide meadow, with many abandoned branches, meanders, marshes, and willow and poplar thickets.

The valley is of the following type, the asymmetry of the slopes being very typical:

Between Radanti and Stefanesti the valley cut by epigensis narrows greatly, reaching the maximum width of 300 m and presenting beautiful chains of meanders.

In the Tortonian limestone passes at Stefanesti the valley takes on the appearance of a true gorge (100 m across).

It widens in the Jijia depression to 5 km. Here it also receives its most important tributaries, the Baceu and Jijia joined with the Sitna, Meletin, and Bahlui.

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Another narrow, south of Iasi (Poarta Tutrei) is the result of the more resistant formations of the central Moldavian plateau.

Downstream, the meadow widens progressively, exceeding 10 km at the mouth. The tributaries are minor: the Prutet, Elan, etc.

The Prut has a typical steppe character, receiving only one mountain tributary (Ceremus), on USSR territory. The other tributaries are small plateau streams with very unstable discharges. Because of this although the Prut (882 km) is longer than the Siret, it has a smaller source basin (23, 953 sq km) and a mean discharge half that of the latter (150 cu m).

But because its gradient (0.10 - %0) is much less than the Siret's (0.59 - %0) the evacuation of water is very slow and more favorable to navigation which can be carried on with ease.

The steppe features are even more pronounced in the case of the rivers of the Jijia depression which sometimes dry up almost completely, forcing the population to store water in innumerable ponds (today partly filled in), and sometimes register increases up to 6-7 m over the low-water mark causing destructive floods (1932).

The abundant alluvia which they bring in in suspension are deposited on the Prut meadow in the form of silt which blocks the confluences, thus forcing the tributaries to flow parallel with the main stream for very long distances (66 km for the Jijia).

At present an unremitting effort is being made to exploit as effectively as possible the [one word illegible] of the flood plain, which are being transformed by levees into rice fields, gardens, etc.

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V. Southeastern Group (Dobrogean). The Dobrogean rivers are tributaries partly of the Danube and partly of the Black Sea, both groups emptying either directly or through lakes, small and large, or estuaries.

They are all small rivers, dug deep in the loess formations or the tubular sediments of the Dobrogea plateau. The steppe climate almost dires them up in summer, though they register great increases during torrential rains, causing inundations due to very low flow gradients.

The following rivers flow to the Danube via river estuaries rich in fish: the Girlita, Oltina, Mirleanu, Limpezis, Cochirleni, Carasu, Roman, Perceneaga, and Carna.

The Telita, Taita, Slava, and Casimcea flow towards the sea, also via intermediate lakes or estuaries.

Lakes in the RPR

General Classification. The water network of Rumania is completed by a series of lakes scattered over the entire territory.

Although there are over 2,500 of them, most of them are of minor proportions, not over one sq km, so that in total they occupy 1% of the area of the country. Only eight of the lakes are more than 50 sq km in area -- Razelm, Sinoe, Potelu, Golovita, Greaca, Calarasi, Brates, and Smeica.

The variety of forms of relief, the petrographic constitution which is so varied, the disturbed geologic and morphologic history, the climatic shifts, the passage of a river the size of the Danube across the country, the nearness of 236 km of seashore of the Black Sea, as well as the intervention of man constitute the main causes

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which explain the great number of lakes, so different in nature, on Rumanian soil.

Taking account of the great variety in form, genesis, and physical and chemical properties of the lakes, a whole series of classifications can be made.

We shall group them, however, by the relief units in which they are located, considering the causes of their formation and, in the more typical cases, their physical and chemical properties.

According to relief units there are the following types:

1. Mountain lakes
2. Hill and plateau lakes
3. Plains lakes

1. Mountain (Alpine) Lakes. In the geologic past the mountain lakes were much more extensive not only in number but particularly in area.

Most of the present intra-Carpathian depressions, of tectonic origin, were formed back in the quaternary period with extensive lakes which disappeared either through silting up or drainage by rivers.

The climatic conditions peculiar to those times influenced the growth of a luxuriant vegetation from which came coal deposits which today constitute the wealth of these depressions. Among mountain lakes are the following types:

(a) Glacial Lakes. Among the present lakes, much reduced in number, the most important categories are the Alpine lakes formed either in the old glacial periods and consequently by erosion, or behind morraine barriers accumulated after melting of the ice and consequently by damming (barrier).

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Both categories (erosion and barrier) are distributed in massifs over 2,000 m in Rumania, in which there was a rather large extension of quaternary glaciation.

They generally occur in zones 1800-2200 m high, according to type: those formed by erosion at greater altitudes and those formed by barriers at lesser altitudes.

They are generally round, with clear and cold water and are called by the natives "goggle eyes."

They are not very large. Bucura in Retezat with its ten ha being the largest. Their depth is slight: the deepest, Zanoaga, also in Retezat, is barely 22.5 m.

In the eastern Carpathians the glacial lakes are fewer and smaller.

The Rodna massiv has 12 lakes. Lala, beneath Ineu, and Buhaescu, beneath Pietros being the biggest.

However glaciation had a much greater extension in the southern Carpathians, where glacial lakes also have a wider distribution.

The easternmost among them, Lacul fara Fund in Siriu, is considered of nival origin.

In Fagaras the lakes are strung out in chains, especially on the northern slope.

Bilea is the most picturesque, with a cascade of 60 m and reaching a depth of over 9 m. The deepest lake in Fagaras is Podragul of 16 m.

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Also in the Fagaras massif are: Capra, the source of the Arges, Podragoiul, source of the Arpas Mare, Urlea, Caltunul, Buda, Avrigul, etc.

The Iezerul massif, which had limited glaciation, contains only one important lake: Iezerul.

Glaciation in the Cibin and Sebes mountains was also limited, where two lakes (Iezerul Mare and Iezeral Mic) are the most representative.

Paring now has several lakes (over 30) but most of them are minor.

We shall mention: Gauri, Gilcescu, (3 ha in area and 10 m deep), Paseri, Rosiile Iezerul, Slavoiul Muntinul, Urda, etc.

In Retezat, Th. Krautner mentions 40 large and small lakes: Bucura, at the foot of the Peleaga massif, is 14.2 m deep and about 10 ha in area, the largest in the entire Carpathian chain; Zanoaga, 22.5 m in depth, Taul, the Gemeni (two lakes side by side), Taul Negru, Zanoguta, Custura, Peleaga, Valea Rea, etc.

The glacial lakes in Godeanu and Tarcul are few in number and small in size. Most of the lakes mentioned were formed in the old glacial periods.

A glacial lake formed by morraine barrier is Girdoman, 1800 m high in the Codean massif.

(8) Lakes in Volcanic Relief. The only instance of this category is Lake Sfanta Ana in the crater of an extinct volcano in the Ciomadul Mara massif. 950 m high, it has a diameter of 650 m and a depth of 12 m, with a perfectly round shape. There have been similar lakes

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in the craters of our volcanic chain, but they were drained by the rivers which penetrated the interior of the chain by regressive erosion.

(c) Lakes Formed by Natural Barriers. Lake Rosu (Ghilcos) was formed around 1850 by the sinking of part of Mt. Suhard into the bed of the Bicaz, which blocked it and gave rise to and interesting barrier lake. It is 1,300 m long, with a ramification of 400 m in one of the secondary tributaries. It is 980 m high in an especially picturesque region and it has given rise to the establishment of a beautiful resort.

(d) Lakes Formed by Artificial Barriers. These are created by man for various purposes.

Acquisition of the necessary discharge for the transport of lumber on smaller streams. The famous "Haituri" (eastern Carpathians) or the "Tauri" (Apuseni Mountains) are in this category. They are of an intermittent character, the water being received only in periods when logs must be dispatched.

Acquisition of reservoirs for hydroelectric plants.

Acquisition of reservoirs for industrial centers, irrigation, raising trout, etc.

2. Hill and Plateau Lakes. These are more numerous than mountain lakes, but less varied in nature, and they are in general a direct or indirect result of human activity. In the category of hill and plateau lakes are those actually located in the lowest areas of these natural units.

Their maximum distribution is thus to be found in the Transylvanian plain and the Jijia depression.

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(a) Ponds or pools are strung along small streams in steppe areas. In many cases the barriers are natural, through blockage of the main course by alluvia brought in by their tributaries or through sliding of strata on slopes into a river.

These are more frequent on the Transylvanian plain, which is foremost anyway from the point of view of landslides. Very many of the ponds, however, are made by man with artificial dams. Moreover originally natural barriers have also been perfected by man.

Although the ponds had a wide distribution in the past, they were greatly diminished in number long ago, either through silting up or being filled with acquatic vegetation, due to neglect or draining by man to acquire more arable land.

In the Jijia depression there are innumerable ponds used by surrounding towns.

The most important is the pond at Dracsani.

Balatau is a typical barrier lake. Barrier lakes were once much more plentiful even on the "Transylvanian plain," most of them being at present on the way to extinction. Among existing lakes the most important are Taga, Geaca, Catina, Zaul de Cimpie, Sintejude, etc, which have come to be repaired in recent times because of their importance to the national economy.

(b) Lakes Formed in Karst Relief. Although karst phenomena are quite wide spread in Rumania, the only typical lake is Ponoare on the Mehedinti plateau, formed in one of the many local valleys.

(c) Salt Lakes. According to their genesis they fall into two categories:

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1. Lakes formed in old abandoned salt cones (Telega, Ocna Sibiului, Turda, Cojocna, Ocnele Mari, Ocna Muresului, Sic (71 m deep), etc.

2. Lakes formed by natural means through dissolving of salt massifs and subsequent subsidence of strata of protective rock from above (lakes Ursul, Alumis, Negru, Sovada, etc). They are very numerous but also very small in area and generally sink quite rapidly.

Both types are used therapeutically today, to such an extent that most of them have given rise to a series of spas in their neighborhoods, some of them very famous (Sovada, Ocnele Mari, etc). It is of interest to note the heliothermic phenomenon characteristic of all salt lakes, but more productive at Lake Ursul at Sovada, where on the surface is found a thin layer of fresh water, a few cm under which the salt water is 16 - 20^{o} C, while at 3-4 m it reaches 60^{o} C, which increases its therapeutic value even more.

3. Plains Lakes. These are the most varied, both in shape and origin, and at the same time they are the most numerous category and the most important one from the economic point of view. According to their genesis they are divided into the following groups (Figure 14):

Depression Lakes. According to some researchers these have a marine origin, representing the last remains of the Leventine Sea which occupied the Rumanian plain, but according to others they were formed in depressions of eolian origin or from loess deposits which covered Baraganul especially. The second hypothesis is the more likely.

Their salinity in the latter case is due to the phenomenon of the leaching of salts from the soil either by rainwater or ground waters.

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The most important depression lakes are Ianca, Plopul, Movila Miresei Iazul Coltea, and Tatarul, located on the eastern part of the Rumanian Plain.

Valley (Meadow) Lakes. These are strung out along the larger rivers which have formed them and appear in two forms.

(a) The meadow lakes, the result of inundations or of abandonment of meanders; they also occupy the greater area, being grouped in the larger area on the broad meadow of the Danube and other rivers, and they form the most important class of lakes in Rumania. Those on the Danube meadow are called fen lakes.

The fen lakes are expanses of water, generally shallow (1 - 2 m) without high banks and with a highly variable perimeter dependent upon the fluctuations of the rivers which feed them. They usually form behind alluvial hills which serve as natural barriers. They are classed as meadow lakes because they occur almost exclusively in that morphological unit. In a great many cases, occupying old abandoned meanders or rivers, they often also retain the shape of these meanders and are called belcinge.

The most typical fen lakes in Rumania are those on the Danube meadow stretching in a chain from Turnu Severin to the mouth of the Danube. According to their grouping, shape, and size, the fen lakes on the Danube meadow can be divided into several sectors.

1. From Turnu Severin to Cetate. Here are found small fen lakes, isolated or grouped, their distribution being almost confined to the left bank of the Danube which is maintained at a quite high level. The most important of these is the fen lake at Ochi, fed by the Drincea, which comes down from the Mehedinti plateau.

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2. From Cetate to Giurgui, the Danube meadow gradually broadens, but in Oltenia it is invaded by sand from the dunes. The fen lakes are ranged in parallel rows, with an elongated shape and sometimes quite extensive areas: Fintina Banului, Coldova, Rastu, Bistretu Nasta, Cirna joined with Nedeia, fed by the Desnatui, and then the large fen lake of Potelu (105 sq km), west of the Olt; east of the Olt: Berceul, Suhaia (48 sq km), fed by the Calmatui Teleormanului, and Maharu fed by a ramification of the Vedea.

3. From Giurgiu to Calarasi the Danube meadow widens further, reaching 16 km in width. In this sector there are large fen lakes, of more or less rounded shape, associated with a series of small fen lakes: Balta Lata, Greaca (92 sq km), Boian, and Calarasi (80 sq km).

4. From Calarasi to Braila are strung a multitude of fen lakes and small streams, some outside the branches of the Danube but the majority are included within these branches in Balta Ialomitei and Balta Brailei. We mention: Coscovata, at the mouth of the Ialomita, Lunguletul, Lacul Serban, Orza, Ulmul, etc in Balta Brailei: Blastamatiile, Mistreata, etc. in Balta Ialomitei.

5. From Braila to the mouth are found a first series of fen lakes associated along the Danube on the right bank (Jijila, Popina, Crapina, and Plosca), and a second group of numerous fen lakes and small streams among the branches of the Danube on the delta (Fortuna, Gorgova, Matita, Merheiul Mare, Paiul, Lacul Rosu, etc).

The fen lakes on the delta, even in time of low water, occupy 360 000 ha.

In the class of valley lakes can be included Lake Comana on the Neajlov meadow, and Lakes Maxineni and Namoloasa on the Siret meadow.

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(b) River estuaries are to be found especially in the lower Danube basin, from the mouth of the Arges to the east. This basin corresponds, moreover, to the lowest area of the plain.

They have developed along the old abandoned courses or at the mouths of small tributaries blocked by alluvial deposits of the main stream. In general they maintain the elongated and serpentine shape of the valleys in the bed of which they are formed, and they sometimes attain considerable depths (Snagov 5-10 m). In some cases human society has also contributed to their formation by erecting levees.

On the left bank of the Danube are the more typical Mostistea and Galatui, west of Calarasi, as well as the extensive Lake Brates at the confluence of the Danube and the Prut. But most of them are grouped on the right bank, in southwest Dobrogea (Girlita, Oltina, Mirleanu, Limpezis, Vederoasa, Cochirleni, etc).

In this category there are also the estuaries: Costeiu, Nisipuri, Jirlau, Amara Balta Alba (on the left of the Buzau) appearing to be old mouths of the Rimnic, successively displaced; Lake Sarata, apparently formed on an abandoned branch of the Danube, with a very high saline content and a therapeutic mud on the bottom; Curcubeu, Jilavele, Fundata, Amara (80 gr of salts per liter), Ezeru, Strachina (on the left of the Ialomita), Snagov, Caldarusani (on the right of the Ialomita), etc.

(c) Lakes with artificial barriers, created by man to retain water along small watercourses threatened by drought (Baneasa, Tei and Colentine in the vicinity of Bucharest) and a series of lakes for fish hatcheries on the Danubian plain and the Tisa plain.

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4. Maritime Estuaries. These form one of the most important classes of lakes in Rumania. They extend along the shore of the Black Sea, the largest ones constituting the group of "Great Dobrogean Lakes" which are connected with the sea (Razelm, Golovita, Smeica, and Sinoe) and whose total area amounts to 690 sq km. They are connected with the sea through the very narrow opening of Portita.

The small ones, the so-called "ghioluri", are completely separated from the sea and are quite a distance apart (Tasaul, Siutghiol, Mamaia) with waters sweetened by continental sources: Techirghiol, with a concentration five times higher than the Black Sea, Tatlageac Ghiol, and Mangalia.

Most of them are former maritime gulfs (the Razelm group) or old river mouths, blocked by sands and partially or totally isolated from the sea. The concentration of salts, in all cases higher than the Black Sea, is due to the excessively warm and dry climate which prevails in Dobrogea, especially in summertime. Because of the properties of the water in some estuaries only a limited number of plant and animal species live there (crustaceans, algae, etc), and their bottoms are covered with a stratum of fine mud very valuable for therapy. In addition to their therapeutic importance, the maritime estuaries are very rich in fish especially those with sweetened water.

Razelm ranks foremost, being fed with sweet water through channels connecting with the Danube (the Dumavat and Dranov), for at any moment its great salinity threatens its rich fish population with extinction.

The southern lakes of this group (Smeica, Since, Tuzla, and Coranasuf) constitute veritable catch basins for saline waters in which often in summer, in times of great drought, salt is even

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deposited on the bottoms. The problem of rational fishing in all these areas is now a permanent concern in raising the economy even higher in full development at Dobrogea.

We might also mention a class of lakes of multiple origin and properties, among which the most typical are the lakes Baile 1 May and Victoria near Oradea.

Formed near the Padurea Craiului massif, which is mostly limestone, they might be lakes formed in valleys (Natalia Senchea).

The water of these lakes, with a constant temperature of over 26° C, comes from great, warm artesian springs coming from the interior of the earth's crust and which are related to local tectonic phenomena. The concentration of salts in solution increases their very high therapeutic value.

The economic importance of the lakes is immense: fishing, tourism, hygiene, irrigation. hydroelectric power reserves, etc.

With the most rational possible exploitation of their varied resources, they could achieve a general rise in the living standard of Rumania.

The Black Sea

Surrounded on all sides by the continent, with a narrow gateway to the Mediterranean through the Bosporus, the Black Sea is in the category of closed continental seas.

Since the whole hydrographic network of Rumania, without a single exception is tributary to the Black Sea, we can assert that the RPR belongs in entirety to that basin. The overwhelming importance which that maritime window has in the life of the Rumanian people requires acquaintance with it, at least in the sector which adjoins the country.

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Genesis of the Black Sea. Russian and Soviet researchers have made the most detailed studies of the genesis, evolution, and properties of the Black Sea.

Its evolution from the oceanographic point of view has been clarified only in the last few decades. After the older works of Sokolov and Andrusov, some hypotheses were made by Arkhangelskiy and and Mirchinik and more recently by Sokolskiy Nikitin, Muratov, etc.

The evolution of the remote past of the Black Sea does not interest us in detail, since its present form dates barely from the end of the Quaternary period.

Because of the breaking of the connection between the eastern and western Mediterranean, in the Sarmatian period, the present basin of the Black Sea was part of the well known Sarmatian Sea. By the end of the Pontian period the Black Sea was greatly reduced in area. collecting water in its tectonic, sunken bottom where its area of maximum depth is still located (Figure 16).

It thus became an enclosed lake into which a series of continental waters flowed. The waters of lake became brackish and the Pontain fauna developed under optimum conditions being represented especially bymollusks.

The evolution of the Black Sea basin became more complicated in the Quaternary period.

Relying upon the very rich factual material and the synthesizing bibliography of the Russians and Soviets, Constantin Bratescu clarifies this problem in his work Oscilatiile de nivee ale Marii Negre [Oscillations of the Level of the Black Sea].

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He reconstructs four periods in the Quaternary evolution of the Black Sea.

I. The Lacustrian period, as a recess of the Caspian Sea, which was much larger than at present, in the Guenz period, and as an isolated lake in the interglacial Guenz-Mindel period.

II. The period of the Mediterranean-Caspian sleeve, or the Mediterranean Gulf, in accordance with the glacial and interglacial periods.

III. The isolated lake period, a situation which the Caspian Sea and the Sea of Marmora have in common. The straits are now occupied by rivers. Toward the Black Sea, on the present course of the Bosphorus, there is a short river (northern Bosphorus) and on the same course the southern Bosphorus flows toward the Sea of Marmora and joins the present Alibei and Kiathane, flowing into the gulf of the Golden Horn. The present shelves become dry for most of their area, with river valleys cutting into them which now are submerged and which are brought in evidence of movement of the isobaths.

IV. The period of the present basin, which took this form in alluvium. The evolution of the straits, especially the Bosphorus, is very interesting since the latter played an especially important part in the evolution of the Black Sea. Research on the present route of the Dardanelles shows conclusively, on the basis of the continuation of the various sedimentary strata, that up to the Levantine period there was no strait in this area. Subsidence took place toward the end of the Quaternary period as in Wurm II, which determined the straits. The Bosphorus was formed somewhat later, being preceded by a division into two rivers flowing in opposite directions, one to the Black Sea and the other to the Sea of Marmora. (Figures 17, 18, 19).

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The oscillations of the levels of the Mediterranean and Black Seas, due to variations in climate in the Quaternary period as well as the epirogenetic, isotatic, and erogenetic movements, contributed not only to the formation of these straits but also to the determination of the general morphologic aspects of the Black Sea basin. Certainly the melting of the glacial caps was the main cause of the intrusion of the Mediterranean waters through the Dardanelles and Bosporus into the Black Sea.

The level of the Black Sea waters was raised by at least 100 m, supported to a great extent also by the huge quantity of karst river water from the north and northwest (the Don, Dnieper, Dniester and Danube).

The lower part of the continent was thus invaded by water, giving rise to the present shelf. The river valleys were inundated either completely or only partially, causing them to flood the secondary ramifications of the basins. Thus many maritime gulfs were formed along the shore, the largest among them being the site of the formation of the Danube delta. Then followed a great period of sea and river alluvial formation, in which we still find it. In the first place the Danube formed its meadows and small streams, damming its fen lakes and forming its delta. The slight steppe waters, in the Baragan and Dobrogea, with limited discharge, were blocked, forming many river estuaries in Dobrogea (Girlita, Oltina, Mirleanu etc); in the Baragan (Mostistea, Galatui), and in the Black Sea littoral area between the Prut, Dniester and Bug.

The intrusion of Mediterranean waters through the straits played a definitive part in the present formation of the Black Sea basin, and in its new physical and biological features, due to the following causes:

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1. The rise in level of the waters, extension of the area and increase in depth of the Black Sea;

2. The extension of the shore line through inundation of the river valleys, so that it subsequently was evened by sand deposits, so that the shore line is now regular;

3. Formation of two opposite currents flowing in the Straits of the Bosphorus;

4. Stabilization of a characteristic thermal system;

5. Stratification of waters according to source and degree of salinity.

Physical and Geographical Description of the Black Sea Situation. The Black Sea is located in the heart of the Eurasian continental masses, in the area where the two meet, belonging to the Soviet Union, The Rumanian People's Republic, the Bulgarian People's Republic, and Turkey. The locale has the advantage that it is at the crossroads of three continents (Europe, Asia, and Africa), through the intermediary of the Mediterranean and having as such a particular economic and political importance.

Its position in the heart of the continent also has some disadvantages. Thus, in the first place it is a continental sea, almost isolated and distant from the ocean. The connection with the Mediterranean through the Bosporus and the connections by river routes with a series of other seas, due to canals built in the USSR and to those being built in the people's democratic countries (Danube-Oder) as well as to the canals through which the Danube connects with the Rhine and indirectly with the Rhone have appreciably remedied these deficiencies.

Another obstacle is the surrounding terrain, with differing altitudes. To the east, south, and southwest the Black Sea shores are

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lined with high mountain barriers (Caucasus, Pontic, Stranjii Deg, and Balkan Mountains) which shut off the warmth of the Mediterranean.

But to the north the broad Russian continental platform, represented by the Ukrainian plains and continued by a very low shoreline allows free penetration of air masses from the Siberian highs into the maritime basin.

Due to these conditions of surrounding relief, the Black Sea influences the surrounding dry climate very little and only in some areas (Crimea, Colchis) but undergoes strong influences from the extreme continental climate.

Area and Depth. Its location in the middle of extensive and very irregular continental masses is aggravated by the fact that the Black Sea has a quite limited area and depth. Along with the Sea of Azov it occupies an area of 462,565 sq km^2, and an area of 411,540 sq km^2 without it.

The formation of its bottom is quite varied. Bathymetric maps prepared by Soviet researchers (Sokolskiy and Nikitin, 1923-1926) have established a mean depth of 1,147 m the maximum depth being 2,246 m off Asia Minor. But the depth varies unevenly from the perifery to the center. While along the coast of the Caucasus and Asia Minor the depth increases rapidly with only a few km of shelf to reach 2,000 m after 70 km, along the northern and western coasts there is a wide shelf which drops gradually to great depths. Off Odessa, 500 km from the shore, the sea is 200 m deep, and off Constanta, 150 km from the shore, it is already down to 2,000 m (Figure 20).

The water level of the Black Sea is not constant but oscilllates annually in conformity with the amount of fresh water brought in by the

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great rivers (an 83-cm layer) and the precipitation falling on the surface. Periodic changes of level are also registered because of strong winds; they consist of gently rhythmic motions similar to the tides and reach only a few cm.

Temperature. Since the Black Sea has a typical continental basin, the temperature of its surface waters registers the variations of the surrounding land. It could thus be established, according to prolonged observations by the oceanographic station at Sevastopol, that the surface layers of the Black Sea are affected by the thermal fluctuations of the atmosphere down to 50 m in depth on the high seas and down to about 100 m near the shore (Mihailescu, Rominia).

From 50 to 150 m the temperature remains almost the same, showing, even toward the bottom, some tendency to warm in spring and summer.

On the surface the temperature follows the seasons. In spring it remains between 6° and 8°, to go up to 23° in summer; it is unchanged for 50 m down. Between 50 and 75 m it is colder than the surface. At a depth of 2,000 m, slightly rising, the mean temperature is around 9°. In the corner between the Danube and the Dniester where the water is more brackish, the sea is sometimes frozen for three months; in hard winters even the piers at Constanta are frozen in.

Salinity. The continental influence also affects the composition of Black Sea waters. Due to the contribution of fresh waters brought by the great rivers (the Danube, Dniester, Bug, Dnieper, and Don), the relatively low evaporation, and the narrow connection with the Mediterranean, the water of the Black Sea has a brackish

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character. But the salinity varies with depth. In the surface layers it is low, remaining around 17-18% and dropping toward the Soviet and Rumanian shores to just below 10%. Toward the bottom it gradually increases to 21% at 200 m and 23-24% at great depths (2,000-2,200 m). Of the Bosporus, at 60 m depth, it has a maximum of 36.49%, reflecting the salty current from the Mediterranean. We can accordingly classify Black Sea waters in regard to salinity into the following stratifications:

1. A surface layer, brackish, with limited density, with a thickness of about 25 m.

2. An intermediate zone between the surface layer and the deep strata, 25-100 m down, with a medium density and salinity.

3. A mass about 2,000 m thick, with pronounced density. This stratification is also a result of the shallowness of the Bosphorus (48 m average depth, 660 m wide, and 28.5 km long) and it has a great biological importance, since it does not permit exchanges between surface and deep waters because of the high density of those on the bottom.

This explains the most original feature of the Black Sea; namely, the presence of H_2S 200 m down near the shore and 150 - 180 m down offshore.

While H_2S is found between 160 and 200 m in quantities of 0.5 cu cm per liter, at great depths, at about 2,000 m the amount of H_2S reaches 7 cu cm per liter, almost the same proportion as oxygen at the surface.

The amount of oxygen itself drops from 7 cu cm per liter in the surface zone to 0.5 cu cm toward 150 m depths. From 180 m on down it is completely absent.

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The source of H_2S and its increase toward the depths is due to reduction of the sulphates contained in the organic matter falling from the surface under the action of bacteria of the genera Microspira and Bacterium Hydrosulphuricum Ponticum discovered by Isachenko. It is a process similar to that which goes on, on a small scale in Lake Techirghiol.

Currents. The peculiar character of the Black Seas is also due to the horizontal circulation between its basin and that of the Mediterranean. After a series of detailed researches it was established that there are two currents in the Bosphorus: a surface one with fresher water from the Black Sea to the Mediterranean, evacuating about 152 cu km of water per year, and another deep one from the Mediterranean to the Black Sea carrying about 173 cu km a year. This saline current is diluted as it moves, so that it drops from 36.67% at the bottom of the Sea of Marnora to 22.80% at the bottom of the Black Sea. In general the Black Sea receives from the Mediterranean, from precipitations and from the rivers which feed it about 1,000 cu km of water a year; of this 152 cu km is evacuated through the discharge current of the Bosphorus and the remaining 850 cu km are evacuated by evaporation.

The intensive evaporation causes a loss of a great quantity of heat to the sea and leads to important temperature variations. The horizontal surface currents are formed under the direct influence of the prevailing winds (Figure 2).

The most important of these currents is the one caused by the north wind. Coming from the northeast, the north wind penetrates with ease the low lying shore area between the Crimea and the mouths of the Danube, striking the surface waters of the sea in a southwesterly direction. To it is added the current of water expelled by the Danube from its mouth.

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Its direct action is reflected in the fact that the shore level is much smoother and that, because of this sedimentation, there is a pronounced difference between the eastern and western parts of the Black Sea. When it reaches the Bosphorus, because of the narrows, the current loses only a small amount of water, continuing on its way toward the Asiatic coast, due to the propulsion from behind of the waves driven by the north wind. It thus becomes a cyclonic current, circling the whole Black Sea basin. Because of the central narrowness of the Black Sea basin, the cyclonal current forms a double circuit, with one circular current in the eastern part and the other in the western part.

A circular current can also be traced in the interior of the Sea of Azov, a circular coastal current in the Gulf of Balchik, and a current from the Crimea toward the Rumanian coasts.

The deep currents coming through the Bosphorushave a movement opposite to the surface ones. There are also vertical currents in the Black Sea, but only in the superficial stratum (200 m), which aerated in this way tolerate life.

Life in the Black Sea. All life in the Black Sea is restricted to the upper oxidized layer. Below 200 m, in the central layer devoid of oxygen, living organisms disappear almost entirely, with the sole exception of anaerobic bacteria and a few protozoa. Since 85-90% of the volume of the Black Sea is abiotic, its life is much less developed than that of the other seas. Due to the great local variations in milieu, the animal associations are quite varied:

According to origin, the Black Sea fauna can be divided into three groups:

1. Relict lacustrian forms from the old Pontic basin;
2. Mediterranean forms, which came through the Bosphorus;

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3. Fluvial forms adapted to the brackish Black Sea milieu.

The flora consists of very numerous green, red, or blue algae, which do not go below 75 m, and innumerable plant microorganisms: sulphurous, nitrificant, and luminous bacteria.

The only mammals are dolphins, which are quite numerous, and only one species of the seal family (Monachus albiventer), which lives, in the smallest forms, on the fish around Cape Caliacra.

About 200,000 dolphins are caught annually, and according to Soviet research their number is increasing from 800,000 to 1,000,000 head. Fish are the most numerous. 150 species are presently known. Among these 18% represent relict Pontic forms, 60% are Mediterranean, and 22% are fresh water fish adapted to the brackish environment. Over 80 species are useful. The dog fish, (Squalus acanthius) is the most representative among the sharks, reaching 1.5 m in length. It is extraordinarily rapacious. Very important from the economic point of view are the ganoids (morun, nisetru, pastruga, sipca) from which cured filet of sturgeon and black caviar are derived. They lay their eggs along the rivers and return to the sea in autumn. Also valuable are Danubian herring, rizeavca, gray mullet, calcanii and limba de mare [flounder], blue herring, anchovy, tuna, gingirica, etc.

Recent Soviet studies, particularly by Vodyanetskiy, Golochenko, and Zusser have shown that some of these species, considered occasional migrants (tuna, gingirica, etc) stay in the Black Sea all year and are found in very great quantities, but this was not previously known. Besides fish there is also a series of edible lamellibranchia in the Black Sea, the most important being oysters and mussels, along with crustaceans, of which the crab is the most representative. But

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compared with other seas, the Black Sea is poor in animal life. This, however, is not a permanent situation, since in time the surface layer of water will become continually thinner, and since the discharge of water to the Mediterranean is the greater one.

While initially the biotic layer will shrink, when most of the Black Sea waters are of Mediterranean origin, the vertical movement of air will be able to reach the bottom, and then the biotic area of the sea will be considerably increased and populated primarily by Mediterranean species.

The Rumanian Littoral of the Black Sea. From Gura Chiliei to Vama Veche, the Rumanian shore of the Black Sea extends some 236 km.

In accordance with its general nature and economic importance, it can be divided into two sectors, Cape Midia being the dividing point.

The northern sector takes the form of a low shore (10-15 m) with numerous streams in the sand and elongated fen bogs good for fishing sturgeon.

South of the Sf. Georghe branch, on the site of the old Halmiris gulf, there are now four large lagoons threatened by low water: Razelm, Golovita, Zmeica, and Sinoe. The coastal bars have closed off almost completely the link with the sea of the old gulf, into which the Greek ships at one time sailed as far as the fortress at Histria. The only connection with the sea today is through the narrow opening of Portita, and fresh water comes into the northern lagoons (Razelm and Golovita) through channels connecting with the Danube. Zmeica and Sinoe, however, are much more saline than the Black Sea.

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At present navigation is very difficult in this sector because of the coastal bars, and it is possible only parallel to the coast. The only approach to the mainland is the Sulina branch, where lack of a route into the interior of the country has forced man to modify not only the seacoast but also the river branch to make it navigable.

The most important human settlement of this whole stretch is the port of Sulina. The other settlements are fishing villages or the very numerous fishing depots.

The second sector of the shore extends from Cape Midia to Vama Veche. As in the northern sector, here also are plainly old gulfs or river mouths being barred and completely isolated from the sea, which process has transformed them into very concentrated salt lakes when they are not fed by waters flowing from the mainland. The first Sarmatian limestone formations appear at Cape Midia, which explain the presence of the promontory.

From Constanta to Vama Veche the shore becomes a high and steep cliff alternating with a wide beach, with loess walls which are sinking and compact Sarmatian strata.

Constanta, the chief Rumanian maritime port, is also the most important settlement on the littoral.

A number of spas have become real towns: north of Constanta is Mamaia, with its famous beach; to the south there is a chain of spas: Eforie, Vasile Roaita, Techirghiol on the shore of the lake of the same name, and Managalia further south. A series of future adaptation projects will be able to transform the littoral lakes into marvelous sheltered gulfs for the installation of ports.

The Economic Importance of the Black Sea. For Rumania the Black Sea is especially important, a "window" creating favorable

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conditions for economic, social, and political development.

Long before our era, the economic and cultural expansion of the Greeks had already transformed the western littoral of the Black Sea into a flourishing region. Tomis, Histria, and Callatis were a few of their most important towns, being not only fortresses but also particularly active centers for the exchange of the agricultural products from Dacia (wheat, rye, honey, fish, etc) for manufactured goods brought by the Greek ships (olive oil, fine fabrics, ceramics, Greek wine, etc). The flourishing state of the Black Sea littoral is also mentioned in the Roman period, when the old maritime fortresses continued their agricultural activity. The Romans linked all these fortresses by a highway parallel with the seashore and built defense ramparts in Dobrogea, ruins of which can still be seen today.

Tomis, Ovid's place of exile, was sung in his verses.

Later, during the time of the formation of the Rumanian provinces, our masters made costly efforts to add the Black Sea coast.

Mircea the Old succeeded in making himself lord "as far as the Black Sea."

Under the Genoese the fortress-ports carried on an intensive commerce with the Rumanian provinces.

During all these periods, however, a tendency of the various temporary masters (Greek Roman, and Turkish) to exploit the natives is to be seen.

After the rule of Mircia the Old in Wallachia and Stefan the Great in Moldavia, the sea no longer belonged to us. The domination of the crescent transformed it into a "Turkish lake," and it remained

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in this state for about 300 years. The only ships that sailed in this enclosed lake were Turkish.

Navigation ceased completely. The mouths of the Danube silted up and Constanta, the Tomis of old, became a mere fishing village of some 60 families.

During this period the Russians fought repeated wars with the Turks, whom they defeated, imposing peace terms very favorable to the Rumanian provinces.

The peace of Kuchuk-Kainargi (1774) was the first step in reviving commerce on the Black Sea, as the Russians and other nations gained the right to navigation. After 1829 this revival is even more evident.

The decay of the Ottoman Empire was exploited by English, French, and other capitalists to extend and consolidate their domination over the countries of southwest Europe. Constanta developed, especially after 1858, when the English, in whose interest it was to get their hands on our cereals as readily as possible, built a railroad between Cerna Voda and Constanta.

In 1877 Dobrogea was returned to Rumanian rule after the War of Independence, which we won with the help of the Russian armies, at whose side we fought against the Turks. In 1877 Constanta was still a primitive port.

In 1896 the construction of the present modern port was begun, which was completed after 1900 and in which elevators and great storage tanks for oil and grain were installed, since these were the most important commodities sought by the capitalists of Western Europe.

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The town grew rapidly from 4,000 inhabitants in 1878 to about 60,000 in 1930, and over 80,000 now.

The Port of Constanta, inadequate for present needs, will be expanded and thus will be able to specialize in certain branches of commerce, the more so since our trade relations with the USSR have increased extraordinarily.

However, the Black Sea is also particularly important to Rumania for its fish resources. In addition to the varieties known in the past, recent Soviet researchers have reached the conclusion that the Black Sea is much richer in fish than has so far been recognized. Before World War II about 90,000,000 kg of fish per year were caught in the Black Sea, of which the USSR fished 52,000,000 kg, Turkey 23,000,000 kg, Bulgaria 5,000,000 kg and Rumania 3 to 5,000,000 kg of fish and dolphin.

Compared with the Caspian, where 410,000,000 kg are harvested annually, and the Sea of Azov, from which 26,000,000 kg are taken annually, Black Sea fishing returns less, due to the limited biotic area, the lack of shores with protruding shelves, the lack of islands, and the presence of great depths, but, as Vodyanetskiy and other Soviet researchers have shown, it is also due to a lack of detailed knowledge of its true wealth in fish.

Its whole capacity of about 800,000,000 kg of mollusks (oysters and mussels) per year can likewise be exploited, present fishing being very limited.

The fishing fleet which will soon be built will mark an unprecedented advance in Rumanian fishing on the high seas, receiving in this respect truly invaluable support from the USSR.

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Conclusions

1. The hydrographic net of Rumania includes water tables, springs, river systems, lakes, and the Rumanian sector of the Black Sea.

2. The water tables vary in water supply and depth, depending upon the amount of precipitation, evaporation, aridity indexes, thickness of the permeable stratum, relief features, vegetation cover, etc.

3. The springs are most varied in form, temperature, and chemical composition. The large number of mineral springs is related in most cases to volcanic eruptions, areas of diapyrism, and tectonic lines.

4. The country's river system is greatly ramified, the Danube being the sole collector except a few minor Dobrogea rivers.

As regards river systems, they show the following features:

(a) Adaptation to relief by the general direction of flow, grouping in basins, general radial formation, parallel formation on gently inclined plateus, concentration in depression basins, dispersal on former alluvial fans, etc.

(b) Adaptation to geologic structure by the various characteristics displayed by the longitudinal and transverse profiles of the valleys, in accordance with special adjustment to rock erosion.

(c) Adaptation of the hydrographic net to tectonics, through concentration of fluvial arteries in areas of subsidence and dispersion in areas of bulging of the relief, by orientation along lines of subsidence, etc.

(d) Great variety and density of the hydrographic net in basins of types 3 and 4, according to climate, massiveness of relief, geologic structure, soils, vegetation, the human factor, etc.

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(e) Pluvionival source for the whole hydrographic net, related to the climatic system of the country.

(f) The level variations show pronounced fluctuations indicating continental climatic influences. Double periodicity of their increases and decreases is characteristic, and great amplitudes and abrupt shifts between extreme levels are frequent.

(g) Seasonal fluctuation of discharges related to amount and frequency of precipitation.

(h) Division into permanent and temporary fluvial organisms, depending upon climate, gradients, geologic structure, vegetation, etc.

(i) Grouping of the net into several associations (west, southwest, south, southeast, east), depending upon the general features of the watercourses, conditioned, in their turn, by the differentiation of the physical and geographical factors.

5. There are over 2,000 lakes on the territory of the RPR, most of them small. There are only a few exceptional lakes over 50 sq km.

6. The great number of lakes is explained by the variety of the forms of relief, disturbed geologic and morphologic past, climatic changes, the passage of a river the size of the Danube over the territory, the presence of 236 km of Black Sea littoral, the intervention of human civilization, etc.

7. The classification of lakes is based upon the relief in which they occur, their genesis, and their physical and chemical properties.

8. The hydrographic net of Rumania plays a particularly important part in its economic, political and social life.

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[Pages 230-255] SOILS OF THE RPR Florea Nicolae

Before 1900 the study of soils did not constitute a problem for Rumanian scientists, so that before that date the literature is devoid of soil studies. But Rumania can pride itself on the fact that it is the first country in the world outside Russia where the new concepts and new method of the "school of Russian naturalists," created by V. V. Dokuchayev at the end of the nineteenth century were applied. G. Murgoci, the founder of pedology in Rumania, adopted from the beginning the fruitful principles of Russian genetic peology in soil research.

In Dokuchayev's concept, soil is considered as the upper part of the lithosphere, resulting from the action of a complex of natural factors (vegetation, climate, rock, relief, age); it therefore represents a natural body, which is born, grows, and changes. Consequently, soil research cannot proceed apart from the terrain in its natural setting, where consideration can be given to the actual physical and geographic conditions of its formation and evolution; the basis of definition and classification of soils is the genetic type of the soil, characterized by a definite morphological aspect of the profile of the soil, which comprises the whole history of the soil's development. In connection with soil geography, Dokuchayev also establishes a general law of zonality of soils: this is, the distribution of soils on the earth in zones which have developed in a correspondence with zones of climate and vegetation.

G. Muragoci and his collaborators, in applying this new concept of soil, succeeded in a short time in drawing up a map of the soils of Rumania on a scale of 1:2,500,000 which was presented at the international conference in Budapest in 1909. In 1923, the map of soil zones was published on a 1:1,500,000 scale.

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In recent years soil science in Rumania has taken on a new impetus: the plains area in particular has been investigated, where important problems have arisen in connection with the socialistic transformation of agriculture. The new research projects are oriented along the lines laid down by V. R. Vil'yams, who demonstrated that soil is formed by the prevailing action of plant formation, and he also develops a doctrine of phases which parallel the latter. Relating pedology to practice, Vil'yams has shown that the essential quality of soil is fertility, and that therefore soil should be investigated not only as a natural phenomenon, but also as a means of production.

Zonality of Soils in the RPR

Because of oreohydrographic, climatic, and highly varied botanic conditions in the RPR, most soil zones are to be found in Rumania despite its relatively small area. This is true both in horizontal, (plains and plateau) and in vertical, mountainous, area. The soil zones in the plains area of Moldavia and Wallachia are a continuation of the corresponding zones in the south of the USSR, which they closely resemble, so that in the classification of these soils the Russian peological principles were adopted from the beginning by G. Murgoci, and even the Russian terminology was used.

The following soil zones (vertical and horizontal) appear in the RPR, proceeding from the highest areas to the plains.

Zone of Alpine meadow soils.

Zone of primary podzolic soils (brown, acid podzols, primary podzols.

Zone of secondary podzolic soils (brown podzols and light gray forest soils or secondary podzols;

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Zone of red-brown forest soils, brown forest soils, and gray forest soils

Zone of chernozems, degraded and levigated for forest-steppe

Zone of chernozems, with common chernozems (properly speaking), chocolate chernozems, and chestnut chernozems

Zone of light brown steppe soils

The first two zones belong to the vertical zonal group, and the last four to the horizontal group; the secondary podzol zone appears in both zonal groups.

By 1911, G. Murgoci had noted the fact that "between the Danube and the mountains, for a distance of about 150 km, we find all the soils of Russia between the Black Sea and the Baltic. Therefore, the study of soil zones is more interesting and perhaps more promising in Rumania, where everything is concentrated, but distinct in a small area, than in other countries, where the zones are on a colossal scale, so that only certain zones are represented."

The soils peculiar to each soil zone constitute the so-called zonal soils, in whose formation and evolution vegetation and climate play the principal part, and which are distributed over a wide area forming continuous bands. However, within a soil zone may be found, usually in a restricted area, in isolated spots or belts, intrazonal and azonal soils (or soils with local distribution) whose genesis is influenced by local conditions (rock, relief, ground water, or age). As examples of such soils can be cited: rendzin, saline soils, alluvial soils, etc.

The distribution of the soil zones is influenced by the Carpathian chain, which proceeds in a long line parallel to them. However, no direct relationship has been established between soil zones

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and orography or geologic formations; this is to be seen especially in Moldavia and Wallachia, where the forest soils dispute their domain with the chernozems, both on the plateaus and on the plain (G. Murgoci). Nevertheless, in some local cases relief and the nature of the soil-forming rocks have had such an influence upon the genesis and evolution of soils as to give rise to soils, other than the zonal ones (the case of rendzine, [humic-carbonated soils], sandy soils, shifting sands, etc). We also note that recent river valleys and terraces, as well as regions of diversion of rivers, interrupt soil zones in relatively narrow bands with young soils, while at other times they determine the advance of some zones above the river terraces.

However, it is clear from comparison of the soil zone map with the vegetation or humidity zone maps of the RPR that there is a close connection between these zones (N. Cernescu, P. Enculescu).

We present in the following pages a brief description of the natural conditions and principal soils in the soil zones which appear in the RPR, from the mountain areas down to the plains.

Soils of Vertical Zonality. Vertical zonality of soils is characteristic of mountain massifs where the soil distribution is closely connected with altitude, being conditioned by changes of vegetation and climate in accordance with the altitude. The soils of the vertical zones are analogous to those of the horizontal zones but not identical; the former in comparison with the latter generally have a shorter profile, with the horizontal lines unclear, contain more skeletal material, and are usually subject to strong erosion.

We find the following soils in the vertical zonal group:

Alpine meadow brown soils appear in Alpine barrens and high-mountain barrens and high-mountain meadows, occupying gently inclined

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plateau areas; they form scattered islands with highly irregular contours, distributed at altitudes of over 1700-2000 m, conglomerate, polygenous, limestone, etc. The climate in this area is humid and cold, with violent winds and strong insolation in summer; the period of vegetation is relatively short. The flora of these soils is in the association of grasses with Nerdua stricta, Festuca supina, Carex curvula, etc. Wood vegetation is represented by bilberry bushes, azaleas, dwarf willows, etc; toward the forested area jnepeni and ienuperi [junipers] appear

The formation process of the Alpine meadow brown soils is characterized by:

Accumulation of humus (acid) as the result of humification of vegetal organic substances (remains of grasses) at low temperatures;

Predominance of processes of physical disaggregation of rocks, the deterioration consisting of debasing of silicates followed by their decomposition into silicas, aluminum hydroxides, and iron without formation of clay.

The profile of the Alpine meadow brown soils is generally thin (40-70 cm) with indistinctly differentiated horizons and containing numerous fragments of mother rock. It shows one horizon with humus (A) of 10-15 cm, brown and sandy, followed by horizon B, 30-60 cm thick, rust brown; horizon C, of accumulated carbonates, is missing.

The humus content is high, 10-25%, in horizon A, generally becoming 2-7% in B, sometimes remaining 5-20%. They are acid soils (pH below 5.5) and unsaturated with a base, the degree of saturation dropping even below 20%

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Alpine meadow brown soils are used for pasture; excessive pasturing, however, often has negative effects on the physical properties of these soils, a fact which favors their development into peat soils.

In Alpine barrens there often appear, in depressions below white moss (Sphagnum) vegetation, the peat bogs of high regions and peat soils, with a very acid reaction. On the other hand, in open spaces and on sunny plateaus beneath a strongly zerophilous vegetation, the soils begin to take on the nature of the black soils of the cold steppes.

Primary mountain podzols are found only in high mountain areas (1,000-1,800 m), with humid and cold climate. Precipitation in these areas is 900-1400 mm, and the mean annual temperature is 2.9-5.2 C; the aridity indexes are over 55. The vegetation is forests of juniper and spruce (sometimes also fir and beech), with associations of Vaccinium, Sphagnum, etc. The soil-forming rocks are most varied, but they are usually massive rocks (eruptive rocks, crystalline schists, sandstones, conglomerates, etc).

The genesis of the primary podzols is characterized by:

Formation of strongly acid humus, weakly saturated with a base, and its accumulation in subhorizons A_1 and B_1;

Advanced deterioration of minerals, with direct destruction of the silicates, freezing the silicas (which accumulate residually in the horizon above (A), iron and aluminum hydroxides (which accumulate in the next horizon (B) and bases, which are separated from the profile).

A_0 stratum with organic substances in course of decomposition, 2-5 cm thick, dense, looking like peat.

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A_1, 5-15 cm thick, grayish black, without structure, with an accumulation of humus and silicas.

A_2, 8-15 cm or sometimes thinner, grayish white, without structure, residual accumulation of silicas.

B_1, 5-15 cm thick, brown-black rust color, with accumulation of humus and iron hydroxides.

B_2, 15-80 cm thick, brown with slight rust coloration, without accumulation of humus.

Horizon C is generally lacking, the carbonation being completely spread through the whole profile.

Sometimes fragments of parent rock appear throughout the profile.

They are very strongly acid soils (pH = 3,5-4,5) with a very low degree of saturation dropping even below 10%. The fertility of these soils is very low. They are not used in agriculture, since neither the climate nor the relief permit it. They are generally covered with forest vegetation or Alpine meadows. The latter must be pastured rationally to prevent soil erosion, which can become a very serious problem due to the steep gradients.

The secondary mountain podzols appear in mountainous regions and high hills, usually below 1,000 m; they are formed beneath deciduous or mixed forests. These soils, like the mountain podzolic brown soils, which accompany both primary and secondary podzols, appear both in the vertical and horizontal zonal groups, so that we shall describe them with the latter, where they are found with more typical characteristics.

<u>Soils of Horizontal Zonality.</u>

The distribution of soils in level regions in successive zones parallel to zones of climate and vegetation constitutes horizontal

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zonality. The soils of horizontal zones display their most typical characteristics on flat surfaces.

In Rumania the following soils are found in the horizontal zones:

Secondary podzols or light gray forest soils appear in forest regions in plateau or low-hill areas, occupying watersheds and gentle, uneroded slopes. They are found on the Getic plateau, in the Subcarpathian hills, in the northwestern half of the Central Moldavian plateau, on the western hills, in the eastern part of the Tirnava rivers plateau, and on the Somes plateau.

The climate of the secondary podzol zone is temperate — humid, with annual precipitation between 630-1035 mm and mean annual temperatures 5.9-10.2^{o} C; the aridity index is 35-55. The characteristic natural vegetation is deciduous forest (beech, evergreen oak). The relief is much cut up by the deep valleys separated by hills or highlands more or less subject to erosion processes. The soil-forming rocks are most varied, but generally poor in calcium carbonate; eruptives, crystalline schists, and various sedimentary rocks (sandstones, clays, sand, gravel, etc).

The genesis of the secondary podzols is characterized by:

Formation of acid humus, readily soluble, after decomposition of the forest bed (layer of leaves) mainly through fungi.

Very intensive levigation of soils readily and not readily soluble due to abundant precipitation and the action of humic acids, especially fulvic acids.

Quite advanced breakdown of mineral material, with formation of clay and partial secondary breakdown of clay into silicas, which accumulate residually in horizon A, and iron and aluminum hydroxides, which are transferred and accumulated in horizon B.

Extensive transfer of clay (as well as iron and aluminum hydroxides) to horizon B.

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Advanced debasing of the colloidal complex in the soil.

The profile of a secondary podzol under forest vegetation shows the following horizons and subhorizons:

A_0, or bed of 2-5 cm of leaves (not found in cultivated secondary podzols).

A_1, horizon of humus accumulation, 5-20 cm thick, gray, without structure or with structure of small unstable clods which readily disintegrate into a fine dust; shows accumulation of humus and residual accumulation of silicas.

A_2, the subsoil horizontal, characteristic of these soils, 20-30 cm thick or sometimes thicker, light gray or grayish white, without structure or sometimes somewhat leafy but unstable; does not present a visible accumulation of humus but may often contain up to 10-15% yellow fulvic acid, the presence of which is not morphological evidence.

B_1, the aluvial horizon, about 80-100 cm thick, reddish brown, often with gray and rust colored spots, with clear accumulation of clay and iron, aluminum, and manganese hydroxides, compact, with a prismatic structure and numerous concretions of iron and manganese oxides.

C, the horizon of accumulation of carbonates; yellow may often be lacking, the carbonates being levigated into ground water.

In the case of the mountain secondary podzols, the soil profile usually presents thinner horizons, with horizon C lacking.

The chemical properties of the secondary podzols are unfavorable to the growth of cultivated plants.

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The humus content is low (1-3%) even in subhorizon A_1 and drops rapidly in the profile; they also have a low N content. They show an acid reaction (pH 4.8 - 5.9) They are not saturated with a base, the degree of saturation frequently dropping below 70%. Very poor in nutritive elements. Their physical properties are also unfavorable; they are not structured, and they are heavy; in horizon B they have little permeability and are poorly aerated. Subhorizon A_2 shows the most positive chemical and biological properties.

The mountain secondary podzols have a more pronounced acidity and a much lower degree of saturation, and their physical properties are even more unfavorable.

The secondary podzols are used for orchards, pastures, or even for cultivation of crops. But they are the least fertile soils for agriculture. In the first years, right after the forests are cut, they yield abundant harvests, then their productivity drops sharply. To improve their fertility it is necessary to introduce rotation with perennial grasses to create a granular structure and increase the humus content, to use organic and mineral fertilizers to enrich the soil with nutritive elements, treatment with limestone or marl (corrective), in the case of very acid secondary subsoils to neutralize or alleviate their acidity, gradually deepening of the arable stratum, etc.

Reddish brown forest soils are found in the subzone of oak forest, being widely distributed especially in Oltenia (in the transitional area from the plain to the Getic piedmont), and Wallachia (on the western plain), and then in northern Dobrogea, on the outer Transylvanian plain, and in the transitional area between the Tirsa plain and the western hills.

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The climate in this area is less humid; annual precipitation averages 540-700 mm and mean annual temperature 7.8-11.9°C. The aridity index is 28-36. In Oltenia and western Wallachia the Mediterranean climatic influence is felt, with very mild winters. Natural vegetation typical of this area is oak forest mixed with other deciduous species -- hornbeam, elm, linden, ash, and maple (belt forest). The relief is in general represented by plains or plateaus disected by streams and therefore well drained; the rocks are mostly loess or loessoid deposits, diluvial clays, old alluvia, and sands.

The formation process of the reddish-brown forest soils is characterized by:

Limited accumulation of humus in horizon A, due to humification of the leaf stratum and the remains of the roots of grasses and shows an angular granular structure in horizon A.

Advanced levigation of readily and not readily soluble salts.

Deterioration of silicated mineral material with formation of clay and liberation of iron, which is deposited on the surface of the ground in the form of ferrous hydroxides, which after dehydration gives the soil a reddish tinge.

Slight debasing of the colloidal element in the soil.

Slight transfer of clay to horizon B.

The profile of the reddish-brown forest soils shows an A horizon 30-40 cm thick, brown or dark brown with a reddish tinge, and an angular granular structure; a B horizon 100-150 cm thick, reddish brown to rust brown, with a nuciform structure in the upper part of the horizon and prismatic in the rest, with more clay and more compactness than horizon A, with small concretions of ferrous

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and manganese oxides; horizon C follows, yellow, with an accumulation of calcium carbonate in the form of efflorescences and well consolidated concretions.

The reddish-brown forest soils contain 2-4% humus; the nitrogen content is quite low. They have a weak acid reaction (pH 6-6.5). The degree of saturation varies between 80-90%. The physical properties are relatively good due to the granular structure. But through irrational cultivation they are gradually losing these good qualities, becoming compact and forming a crust.

These soils have quite good natural fertility. They require nitric and even phosphate fertilizers. They are used extensively as agricultural soils and also for orchards and vineyards.

In the transition to the zone of secondary podzols (and even in the zone of these soils, on rocks rich in calcium carbonate) brown forest soils appear generally under deciduous forests. They are distributed especially in Moldavai (in the southeastern part of the central Moldavian plateau) and in Transylvania. Reddish brown forest soils have not been found in Moldavia, nor east of Mizil in Wallachia). The climate under which forest brown soils is formed is more continental than that for reddish brown forest soil; the mean annual temperature is lower (8 - 9.5°C), and the winters are colder. The profile of the brown forest soils resembles that of the reddish brown forest soils, distinguished by the brown-dark brown color (without reddish tinge) in horizon A. The physical and chemical characteristics are similar in both. The fertility of these soils is also quite good.

Brown podzolic soils are also found over a wide area; they mark the transition between the brown soils and the secondary podzols.

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In brown podzolic soils, horizon A is differentiated into A_1, brown, and A_2, with a gray tinge; sometimes podzolization appears morphologically only through powdering of the structural aggregates, with a fine whitish dust of silicas. They contain less humus and are not saturated with a base.

Brown podzolic soils pass imperceptibly into secondary podzols with which they are generally associated especially on slopes.

Gray forest soils mark the transition to forest soils and degraded (levigated) chernozems. They are generally not very widespread in Rumania, occupying narrow belts at transitions between the forest-steppe and forest areas, especially in the eastern half of the country under the influence of the continental climate. They have been little studied so far.

Levigated chernozems, generally called degraded chernozems in Rumania, are distributed in the forest-steppe area; they appear in the northwest and southeast of the Oltenian plain, in the southeast of the central and northern part of the Wallachian plain, in the north of the Covurlui platform, in the southeast of the central Moldavian plain, on the Tisa plain (a belt with an Arad-Timisoara axis), and in northern and southern Dobrogea.

In the forest steppe, the mean annual temperature varies from 9.1-11.4°C, and annual precipitation averages between 460-580 mm. The aridity index varies between 24-29; humidity is quite low but permits the growth of wood plants. The vegetation characteristic of this area consists of forests, with sparse trees, weakly developed in general, of November and downy oak and various shrubs. These forests contain extensive meadows with grasses. The soil-forming rocks are loess, clays, eolian marls, or sands, and the relief is

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generally represented by plains, more or less dissected, and terraces; the ground water is quite deep usually more than 5 m.

The soil-forming process in the forest steppe is characterized by: Accumulation of humus in the upper horizon, which also has a granular structure, more or less angular.

Quite advanced levigation of salts readily and not readily soluble.

Deterioration of part of the silicated minerals, with new formation of clay.

Weak debasing of the colloidal portion (clay and humus in the soil).

From limited to considerable transfer of clay to the intermediary horizon (B).

The profile of the levigated chernozems shows an A horizon 35-50 cm thick, black-brown or grayish black, with structure running from weakly granulated to purely angular type; a B horizon from weakly to well expressed, over 40-50 cm thick, chestnut brown, sometimes with a reddish tinge, with a nuciform or even prismatic structure and more compact than the upper horizon; horizon C follows, yellow with whitish spots due to the accumulation of calcium carbonate in efflorescent form, spots and concretions well consolidated. Sometimes mole burrows appear in the profile, especially in the intermediate horizon. They have a high humus content (3-7%) and nitrogen content. The acid reaction is weak to neutral (pH 6.5-7.2). Saturation 85-95%.

The levigated chernozems have, due to their properties, a high natural fertility and are chiefly used for cultivated crops, being

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located in an area with a relatively more humid climate: crops on levigated chernozems are less exposed to drought than the steppe chernozems. In some cases, nitric and phosphate fertilizers are necessary on these soils.

The chernozems are found in the steppe area of the RPR, in the southwest of the Oltenian plain, in the south and east of the Wallachian plain, on the Moldavian plain (the Jijia and Bahlui steppe), in the western part of the country on the Tisa plain, as also on the Dobogean platform and the south of the Covurlui platform.

These areas have annual mean precipitation varying from 420 to 510 mm. In the seasonal distribution of the precipitation we find a maximum in May-June, when the rains are usually torrential. The mean annual temperature is between 9.6-11.4^{o}C. The dry winds, quite frequent, cause high evaporation in summer, drying up the soil. Aridity is 20-24. The characteristic vegetation consists of associations of Stipa (feather grass and spikenard) and Festuca (hay), characteristic of the steppe. Wood vegetation does not appear on the steppe except on river meadows where forests of white woods (riverside groves) are to be found. In small depressions on the steppe, more humid than the rest of the plain, shrubs may appear: Prunus spinosa, Rosacanica, Amydalus rana, Prunus chamaecerasus, Crataegus, etc.

The relief in the chernozem area is that of an extensive plain, weakly dissected in places. The parent rocks most widespread are loess, sands from old dunes, marls, clays, and alluvia.

In the chernozem area the soil-formation process shows the following characteristics:

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Accumulation of humus in the upper horizon, particularly from roots of grassy plants.

Levigation of readily and not readily soluble salts, the latter accumulating in the lower horizon.

Limited deterioration of the silicated mineral part with weak new formation of clay.

Formation of the granular structure which is typical of the chernozems.

These characteristics of the formation process of chernozems appear in various parts of the chernozem area with particular intensity. They have been classified into three subtypes of chernozems in Rumania on a quantitative basis: common chernozem (true chernozem), chocolate chernozem, and chestnut chernozems, which are distinguished among themselves by a different development of the soil profile. All the chernozems, as distinguished from the levigated chernozems, lack horizon B (with accumulation of clay).

Common chernozems or true chernozems are found in Rumania on the steppe of the Moldavian plain (Jijia and Bahlui basin); usually these soils are formed on rocks that are richer in clay and calcium carbonate, (marls or marl clays).

Common chernozem is characterized by the following profile: horizon A 50-70 cm thick and accordingly well developed and rich in humus, almost black, large granular structure, very stable; the transitional horizon is 20-30 cm thick, of uneven coloring with spots of dark color (due to the humus), and horizon C, yellow brown, with a heavy accumulation of calcium carbonate. Mole burrows are rare or lacking because of the argilization of the soil.

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Chocolate chernozems appear in the more or less dry part of the Rumanian steppes. They have the following morphological features: an A horizon 40-60 cm thick, quite rich in humus, dark brown or black brown, with a typical stable granular structure, loose; a transitional subhorizon (A/C) 20-40 m thick, gray-brown, with small clod structure, friable, sometimes levigated with carbonates; horizon C, yellow, with whitish spots due to accumulations of calcium carbonate in efflorescent form, spots or concretions well consolidated. Effervescence appears in the case of chocolate chernozems towards the base of the transitional horizon. There are many mole burrows in these soils, attesting the activity of fauna in the soil, which often mix material from different soil horizons; sometimes for this reason effervescence can be found in the upper part of the profile.

Chestnut chernozems are found in the dryer part of the steppe. They show an A horizon with an accumulation of humus, rather undeveloped (30-45 cm), chestnut brown, with small granular structure, quite stable; a transitional subhorizon (A/C), 25-30 cm thick, grayish brown, unstable small clod structure; horizon C, yellow-brown, with an accumulation of calcium carbonate in the form of efflorescence and weakly cemented concretions. In the whole profile, but especially in the lower horizon, there are many mole burrows. The calcium carbonate is generally leached from the upper part of horizon A, so that efferescence, upon treatment with acid, appears toward the base of horizon A.

The chernozems have, compared with other soils, a high humus content; it rises from 3-4-5%, in the chestnut chernozems, to 4-5-6% in the chocolate chernozems, and 6-8% or more in true chernozems. The nitrogen content is also appreciable and increases the same way as the humus. Their reaction is from neutral to weakly alkaline (pH 7-7.7). The colloidal complex is saturated with a base, calcium

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predominating. The chernozems have good physical properties due to their stable granular structure; they have good permeability for air and water, their water capacity is high and they are easily warmed.

Of all the soils, the chernozems have the highest natural fertility, especially the common and chocolate chernozems; they are used extensively for this reason for cultivation of crops with only small areas reserved for pasture. But irrational cultivation of these soils lowers their effective fertility. To maintain the fertility of these soils primary emphasis should be given to maintenance of the good physical properties of the soil and especially to creation and maintenance of a stable structure in the soil, which can be achieved by grassland crop in rotation. Likewise all measures that increase the water reserve in the soil (retention of snow on the ground, reduction of water evaporation by the action of protective belts, etc) increase the fertility of the chernozems. Fertilizer is required, especially in special crops.

The cultivation of cotton can be extended to the chernozem area.

Light brown steppe soils, formerly called blonde soils, are distributed in central Dobrogea, and in a narrow belt in the eastern part of the Rumanian Plain, along the Danube.

In this area, the annual mean precipitation is usually 320-420 mm. The seasonal distribution of precipitation is uneven, showing a minimum in summer. The rains fall more in the form of cloudbursts. The mean annual temperature is 10.4-11.4°C. In this area strong and dry winds blow which accentuate the dryness. The vegetation is markedly zerophilous. Grassy plants grow in the form of

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isolated tufts, Artemisia austriacia predominating among them. Woody plants are not found; shrubs are very common in depressions. The soil-forming rocks are loess or loessoid deposits and alluvia, the relief is flat, sometimes with slight undulations.

The soil formation process in the area of dry steppe light brown soils is characterized by:

Limited accumulation of humus due to poor soil cover of grassy vegetation and the great intensity of aerobic microbiological processes, which lead to mineralization of the organic substances in the soil.

Complete levigation of readily soluble salts and poor levigation of those not readily soluble (for which reason calcium carbonate from the surface is found in the soil).

Very limited decomposition of the mineral parts of the soil with or without very scant new formation of clay.

The profile of the dry steppe light brown soils is the least differentiated. It presents an A horizon 20-35 cm thick, light brown to brown, with a structure formed of unstable and small glomerular aggregates, loose; there is a transitional horizon A/C, 20-30 cm thick, lighter in color, with fine efflorescences of calcium carbonate, almost without structure, slightly more compact; then horizon C, of accumulations of carbonates, yellow-brown, without structure, with numerous efflorescences and spots of calcium carbonate and even small and weakly consolidated limestone concretions.

There are mole burrows throughout the whole profile, traces of the activity of rodents and soil diggers. Effervescence with hydrochloric acid appears in most cases on the surface.

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The dry steppe light brown soils have a low humus content, usually below 2-3% in horizon A, and they are also poor in nitrogen. Their reaction is weakly alkaline (pH 7.5-8.1), and the colloidal complex of the soil is saturated with a base. They show an unstable structure, good permeability, and a medium capacity for water.

These are used chiefly for farming and to a small extent for pasturage. In rainy years they yield rich harvests, which attests a relatively good natural fertility; however, most of the time the harvests are small because the plants get insufficient water. To increase the fertility of these soils measures must be taken to increase the reserves of water in the soil: establishment and maintenance of a stable soil structure, especially through the grassland crop rotation, improving in this way the water and air system of the soil; planting a system of protective forest belts which contribute to the even distribution of snow on the fields in winter and decrease evaporation of water in the sun in summer. Where possible irrigation is recommended to supplement the water supply. Nitric and phosphate fertilizers are particularly necessary.

Intrazonal and Azonal (with Local Distribution) Soils

In the following we describe only the most important of these soils, which appear in restricted areas in association with zonal soils; their genesis is determined by local soil-formation conditions.

Soils of skeletal nature (rich in skeletal material) appear in areas with uneven relief, both in the zone of primary podzols and that of secondary podzols, on steep slopes and massive slightly disaggregated rocks. The skeletal podzols are more widespread even than the typical podzols in these zones. These soils are characterized by a very thin profile, poor differentiation of the horizons, and high content of coarse fragments of parent rock; they are subject

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to continuous erosion. In the high part of the mountains there are also skeletal-peat soils with a very thin profile (10-30 cm) showing a horizon with acid humus and peat material mixed with coarse rock fragments.

Rendzins, or humic-carbonated soils. These are chernozems with an accumulation of humus which appear in podzol zones and brown forest soil zones on rocks rich in calcium-limestone, dolomite, marls, and gypsums. They appear in extensive areas on the limestones in the Almas and Seminic mountains; in limited areas, they appear throughout the mountain and hill regions where limestone, dolomites, and gypsums are to be found. Their profile is very similar to that of the chernozems; generally they are more argillaceous and show fragments of limestone in the profile, which in general is quite thin. The presence of calcium in the soil, and accordingly in solution, constitutes an obstacle to the development of the podzolization process, determining on the other hand the accumulation of humus in the soil (3-10%). They show a neutral or weakly alkaline reaction. The natural fertility of these soils is much better than that of the podzols or of the brown soils with which they appear.

Red soils are formed on limestone with impurities rich in iron, in the area of subsoil soils in the west of the country, in climate with a Mediterranean influence. They are found particularly on material resulting from the disaggregation of titonic limestones bordering the northwestern part of the Oltenian Subcarpathian depression. These soils show a high content of weakly hydrated iron sesquioxides (which give it a deep red color) resulting from deterioration of minerals rich in iron which adulterate the rock and the residual accumulation of the oxides formed when the calcium carbonate is dissolved and levigated. They are acid soils suitable for orchards (nuts, cherry, etc).

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Stony soils are soils of the brown forest type, the reddish brown type, or levigated chernozem type formed on gravel which is more or less limestone. They are found on the deltas of rivers or on terraces (the alluvial fans of Prahova, Putna, Birsa plain, the Ciuc depression, the Bistrita terrace, etc). They are in general sandy soils, rich in gravel (sometimes even on the surface) and to some depth, between 30 and 100 cm, they show a patch of gravel cemented with calcium carbonate. They have limited fertility; they require organic and mineral fertilizers.

Depression soils appear conditioned by the microrelief, in hollows in the plains areas of the chernozems and reddish brown forest soil zones (snow and water from rains and snows collect here). Thus, in the chernozem zone there are chernozems levigated by depression, with better developed profile, richer in humus, and more fertile than soil formed on flat relief. In the reddish brown forest soil zone, in depressions, depression podzols are found, very rich in concretions of ferrous and manganese oxides, and with an evident claying in horizon B; they are soils on which water stagnates for a long time in spring and even in summer, due to the impermeability of horizon B, and which have a limited fertility.

Slough and swamp soils are those formed in wet regions on mineral substrata in which ground water is found at shallow depths. They appear under these conditions on river meadows, terraces, or in depression areas. They are more widespread between Feldioara and Targu Sacuiesc along the Olt and Riu Negru, Moldavia west of Falticeni, north and southwest of Satu Mare, and in the Banat northwest and southwest of Timisoara. They show a horizon of humus accumulation 40-60 cm thick, are bluish-black when wet or dark blue when dry, most often with rust colored spots or traces of ferrous hydroxide

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and concretions of ferrous and manganese oxides, then a horizon of clay of variegated color, spots of blue green alternating with spots of red or orange; then follows a water-bearing stratum. They are soils with limited fertility because of the excess of water and poor aeration as well as the presence of some toxic substances arising in the reducing medium in the soil. They are generally used as pastures. After these soils are drained and their water system regulated, they can become useful agricultural soils in a short time.

Peats of low-lying regions or bog peats are formed in deep depressions, continuously fed by water from a water-bearing stratum, in which hydrophilous plants (rush, reed, and cane) grow. They are more widespread in the Ciuc depression and west of Satu Mare. The peats of low lying regions have an almost neutral reaction and are rich in nutritive elements, so that they can be used as fertilizers.

Salines are formed in Rumania in dry climate areas or in dry periods in summer, (dry steppe, steppe, forest steppe) when the ground water, usually mineralized, lies at a shallow depth (as far as the critical depth). They are widespread in the Rumanian plain north of Ialomita and on the plain in the west of the country (known as "sicuri") on river meadows, valleys, and deep depressions, in the form of belts or islands; they occupy huge areas in the Valea Calmatui.

Only halophilous plants grow on these soils; ordinary crops do not grow because of the large saline content or the unfavorable physical and physical-chemical properties. Improvement of saline soils necessitates drainage of ground water to lower its level and the application of a series of meliorative agrotechnical and agrochemical measures.

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Three types of saline soils are known in Rumania: solonchaks--saline soils without structure and high salinity of the surface (over 2-3%) and which are progressively salinized under the influence of ground water; solonetzes or saline soils with structure, formed by partial desalinization of solonchaks and solods, or sweetened saline soils, representing a more advanced stage of desalinization.

Solonetzes and solonchaks are usually found together, distributed as a complex, in which the solonetzes occupy the highest parts of the relief and the solonchaks the lowest. Solods have been found on several plateaus with deeper water on the north of the Rumanian Plain.

In addition to these continental saline soils there are also marine salines on the coast; residual salines may also appear on salt-bearing rocks.

Alluvia and alluvial soils represent the most recent pedological formations, found in some soil zones along large and small rivers. They are poorly evolved soils, with undifferentiated horizons. Their natural fertility is highly varied, due to their granulometric structure, degree of cultivation, hydrological conditions, and degree of salinization. They are used as pastures, meadows, riverside groves, or as farm land. They are easily irrigated.

Shifting and stable sands are found in areas with dunes subject to wind erosion on the Tecuci plain (on the lower terrace of the Birlad), south of the Buzau and Calmatui, in southern Oltenia, and on the plains of the northwest. To be firmly fixed, they must be afforested.

Soil Erosion

The soil plays a very important part in the life of human society,

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since only cultivated soil can give man food, fuel, fibers for cloth, and the other raw materials required by industry. Therefore the soil, as Marx said, "is an eternal resource of the community, indispensable to the existence and reproduction of the succession of human generations."

The soil thus constitutes the chief means of agricultural production, and from this point of view -- the agronomic one -- the most important part of the soil is the upper part of horizon A, that is, the horizon in which most plant roots grow. But if it is not rationally cultivated, soil formed over a long period can be quickly destroyed, under certain conditions, by external agencies. Water and wind, in their movement over the surface of the soil, dislodge and displace soil particles. Under natural conditions of soil formation the vegetation cover protects the soil, but if the soil is deprived of natural protective vegetation as in the case of most cultivated soils, the soil particles are subject to the direct erosive action of water and wind.

Through cutting forests or plowing up meadows and irrational soil cultivation or excessive pasturage of fields, man has unleashed upon lands lying on slopes or those subject to wind action a powerful process of erosion by water and wind which leads ultimately to the destruction of the soil. But the erosion process affects even more the river meadows and low plains, whose soils can be covered with unfertile material transported by water from eroded areas. The consequences of soil erosion are very grave, since removal of the fertile layer of the surface of the soil enormously reduces its productivity, affecting the economy of the country not only in the present, but also in the future, since soil reclamation is a very long process.

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Water erosion takes place on slopes areas, usually on those with a gradient of over 3%, being the more pronounced the steeper the slope is. It is of two types: surface erosion (when a certain part of the soil profile is removed over the whole area) and erosion in depth (when the land is dissected by gullies) generally erosion in depth is associated with landslides, when the geologic substratum of the slopes is formed of alternating strata of sand and rock with strata of clay or even with clay or clay-marl strata alone.

As Comrade Gh. Gheorghiu-Dej points out in the Report on the Nation's Electrification Plan, "The prevention and repair of erosion has been totally neglected in the past. About 700,000 ha completely destroyed and about 2,300,000 ha in course of deterioration are widespread throughout the country. The continuation of this process, with a permanent drop in agricultural production, also endangers projects relating to water courses, public highways, human settlements, etc. A series of soil conservation measures are therefore necessary both on the main watercourses and their tributaries and measures to reclaim lands which have suffered erosion or are deteriorating." (Articles and speeches, third edition, p 494).

Water erosion is particularly prevalent in mountain and hill areas. The Somes plateau and the Transylvanian plateau are less affected by erosion; but where they are affected there is prevailing erosion by landslides.

Eolian erosion is found in all the dune areas; we find it in the dune relief on the Tecuci plain, on the plain south of the Buzau, and the one north of the Calmatui, in the sands in the south of southwest Oltenia, as also in those in the northwest of the country.

To combat erosion, there are a series of soil conservation measures which can be preventive or fundamental soil reclamation.

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The drive against soil erosion begins with proper organization of the whole area of a hydrographic basin, a fact which has been realized in the introduction of the Dokuchayev-Kostychev-Vil'yams system.

Grassland Agriculture System, or the Dokuchayev-Kostychev-Vil'yams System

V. R. Vil'yams has shown that the main feature clearly and qualitatively distinguishing rock soil is fertility. By fertility of soil is understood its capacity to provide plants with the conditions necessary to their growth; that is, to satisfy their vital needs, among which the most important are water and nutritive substances.

Karl Marx distinguishes natural or potential soil fertility from actual or effective fertility. Natural soil fertility is the result of the soil formation process, uninfluenced by man and therefore dependent upon the physical and geographic conditions of soil formation. Effective fertility is the result of human activity and depends upon the technical and scientific resources which man has available to him; it depends, that is, upon the progress of the natural and agricultural sciences. Effective fertility of the soil is closely related to the type or organization of human society, depending upon the degree of evolution of the latter; it therefore differs from one social orientation to another. In presocialist orientations, the agricultural systems used could not assure maintenance of soil fertility, the harvests reaped becoming smaller and smaller and more dependent upon the climatic conditions of the particular year. Only in the new socialist orientation has advanced agricultural science laid the foundations of a new agricultural system, assuring a steady increase of harvests, fertility of soils, and yield of stable harvests independent of climatic conditions. This

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system of grassland agriculture, or the Dokuchayev-Kostychev-Vil'yams system, named for the experts who conceived the measures, envisages a system which can be applied only in socialist, collective agriculture, where the selfish interest of small cultivators has been eliminated.

This system is a combination of principles, methods, and measures to organize the production, protection, and rational cultivation of the soil and assure the development of all branches of agriculture plant production, animal production, and production of raw materials for industry.

In the case of soils, this system is concerned particularly with reducing the loss of their natural fertility and particularly the two requirements of fertility -- richness in nutritive elements and soil structure -- and partly periodic restoration of fertility lost through harvests, raising it each time to a higher level than before.

This system, applied on a large scale in the USSR, consists of the following steps:

1. Rational organization of the territory.
2. Creation of protective forest belts.
3. Rotating crops with grasses.
4. Rational execution of agrotechnical projects.
5. Rational use of organic and mineral fertilizers.
6. Use of selected seeds of types adapted to the local natural conditions.
7. Development of irrigation with local waters and construction of reservoirs.

All steps in the system are of equal importance and should be applied as a whole, to be as effective as possible. There are, however,

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some which should be applied initially, among which are rotation with grasses in areas which are not very dry and the protective forest belts.

The need of this system has also been felt in Rumania along with the socialist transformation of agriculture, the more so since the first experiments made in the experimental stations of the Institute of Agricultural research and on some state and collective farms have shown good results. Thus, by human activity, the soild has been transformed into a "product of labor."

[Pages 255-284]

VII. VEGETATION AND FAUNA

Raul Calinescu

1. Geographic Distribution of the Chief Forms of Vegetation in Relation to the Relief

Orographic factors, conditioned by relief, play an important part in the distribution of the vegetation cover. Among them are: altitude, slope gradient, geographic orientation of slopes to which exposure to the light and heat of the sun is closely related, prevailing winds, rains or droughts, etc.

Altitude also causes variations in other climatic factors. Thus, from plain to mountain top there is a lowering of temperature between day and night, more powerful irradiation, intensification of air movements, a shortening of the vegetation period, etc.

In relation to the variations of these climatic factors, which correspond to relief, plants are zoned according to altitude, depending upon their climatic and edaphic requirements.

And so, from the mountain peaks to the low plains are ranged vegetation of the Alpine peaks, forest vegetation, and steppe vegetation.

An analogous shift in the composition and nature of vegetation is to be observed in the aquatic domain; from the flowing and stationary

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waters of the mountains to those of the Danube delta and the Black Sea littoral.

(a) Vegetation of the Alpine Peaks

Special conditions for the existence of vegetation prevail on the Alpine peaks: low temperature, low humidity, maximum irradiation, very strong winds, and acid soil.

Because of these special conditions, the forests thin out progressively toward the top, until they disappear altogether at about 1,800 m. The trees become increasingly stunted and are reduced to tatters by the prevailing winds, which rip off their tops and branches in the direction from which they blow violently. The trees on the higher levels are replaced by stunted and creeping trees which form shrubbery, primarily a belt of jnopeni and ienuperi [junipers] more or less interspersed with clearings, then a stretch of islands of stunted woody vegetation, a few cm high, surrounded by grasses of which the extensive Alpine meadows are formed (barrens or Alpine barrens). According to the general appearance of the vegetation we distinguish an upper Alpine and lower Alpine zone.

Upper Alpine zone. Alpine meadows. The upper Alpine zone is represented by barrens and high mountain peaks and consists of islands, more or less isolated, with very irregular contour, surrounded by vegetation of the lower Alpine zone which sends up numerous extensions. The zone of Alpine meadows occupies, at times, extensive areas throughout the southern Carpathian chain. It is almost entirely lacking in the eastern Carpathian chain, where it is underdeveloped even on Ceahlau. But it reappears on the Caliman and Rodna mountains, on Maramures, Birgau, Tibles, Gutiu, and other mountains. The lower limit of this zone ends along the Carpathians from west to east and north, staying over 2,000 m in the southern Carpathians and descending to 1,800 m on Ceahlau and to 1,700 m north of Ceahlau (Caliman, Rodna mountains).

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The chief characteristic of the Alpine meadow zone is the complete lack of higher wood vegetation, which has been replaced by stunted and thick shrubbery: rhododendron, mountain currant, bilberry and mountain ash, azaleas and dwarf willow; higher wood vegetation is lacking here for the following reasons: the mean annual temperature is below 7° C, that is, below the requirement (10°), snow lasts very long in spring and falls early in fall, so that the vegetation period is short (3-4 months) and insufficient for higher woody vegetation; the wind blows strong and almost constantly, affecting vegetation not only through mechanical action (breaking off leaves and branches as well as the tops of the trunks, in the direction from which it blows) but also physiological action (intensifying transpiration through movement of leaves and causing disequilibrium in absorption, with unfavorable effects upon the trees); the soil of the Alpine zone, rich in humic acids, due to the low temperature is prohibitive for higher wood vegetation.

Thus, for example, the daily temperature variation and the wind have a particular importance, condition the reduction in size of the plants and the woody substance, thus giving rise to shrubbery, which is the usual result of the struggle of vegetation against wind. And the plants can still fight effectively in the form of shrubs or in creeping form even against the low temperatures of the Alpine zone. In this way, they not only protect themselves from the mechanical and physiological action of the wind, but they also grow in the warmer stratum of air close to the ground.

Another adaptation to the low temperatures is the arrangement of leaves on the trunks and branches, very close together, so that they often form rosettes on the surface of the ground or a little above; other Alpine plants (Silene acaulis, Saxifraga moschata,

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Saxifraga androsacea, Draba carinthiaca, Minuartia sedoides, etc) grow in dense and short clumps of shoots, forming hemispheres from which the blossoms and fruits project; the old, dead leaves remain around the shoots, preserving moisture for weeks on end, absorbing surface water through capillaries and storing it like a sponge, and limiting transpiration to the extremities exposed to the sun and its light.

The great intensity of the light and the relative dryness of the air condition the growth of fibres, reduce the surface area of the leaves lower the number of stomata, bend over the edges of the leaves, and thicken their flow of chlorophyll, growth of pellicle, etc. Because of all these zerophilous adaptations, the need of water, which is acid here, is diminished, which reduces transpiration, which on Alpine peaks is accelerated by the relatively dry air and the movements caused by winds.

The Alpine plants react to the brevity of the vegetation period of the Alpine milieu by the great speed with which they fulfill their growth cycle. Some of them flower even while the snows are melting, piercing the snow with their stems (example, Soldanella).

The intensive light conditions the formation of some large blossoms, though they rise only slightly above the leaves, as well as their bright coloring.

Alpine vegetation is represented especially by graminaceous and other perennial monocotyledons to which are added a considerable number of dicotyledons. The other plants have bulbs and roots full of nutritive substances enabling them to complete their growth cycle rapidly.

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An acceleration of this cycle is also observed in all Alpine plants which complete it during the short Alpine summer, since in August it is almost entirely dry. The subterranean portions are highly developed. Clumps are common. The thickening of the leaves, the formation of the pellicle, the covering with hairs, though diminution of the central part of the leaf and twisting of the leaves are also quite common characteristics of Alpine herbaceous vegetation.

The Alpine meadows are composed of Gramineae with large leaves, narrow, good for pasturage as the various species of Poa; but those with leaves turned outward, toward the lower side of the land, as the various species of festuca, nardus, and some thin sedges (carex), are somewhat more widespread. The dicotyledons are varied: in June, with white flowers (anemone, Alpine cock's foot grass), blue, red, and green flowers (dwarf primrose, Alpine violets, Alpine pinks, Alpine hellebore and May flowers), and later throughout July and August, yellow and reddish flowers (Alpine poppy malaoaie, hawkweed, various orchids, pinks, and especially rhododendron). There are also the Alpine forget-me-not. various Saxifragae carnosae, Crassulaceae as false grass and sempervivum, Compositae with small and hirsute leaves, such as the floare de colti, and various Labiates, such as mountain savory and thyme, which perfume the Alpine atmosphere.

The areas not growing Gramineae in the upper Alpine zone are occupied by herbaceous vegetation; a few Saxifragaceae and Crassulaceae are found on skeletal-peat soils; gentians and Alsinaceae grown on soil with humus in crevices and rock fissures; around peat bogs alongside Gramineae and mosses, there are also a few acquatic plants; and throughout the rocky cliff areas the floare de colti grows.

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In open areas and on the plateaus (Bucegi, Ceahlau, etc) are found dry tundras formed by plant groups of a zerophilous nature, in which lichens predominate. Thus on Bucegi, among others, there are the Iceland lichen (Cetraria) and the reindeer lichen (Cladonia), in various species, to which some Gramineae (Deschampsia, tussock grass) and bilberries are added.

In depressions (such as that between Polita lui Ghidion and Ocolasul Mare, on Ceahlau) there are humid tundras composed in great part of hydrophilous mosses and the white peat moss (Sphagnum), which form large clumps along with the Polytrichum moss. Among these grow some Gramineae (Deschampsia, plains reed) and Ericaceae (mountain currants, bilberries).

Lower Alpine zone (juniper belt). Below the Alpine meadows extends the lower Alpine or juniper zone, so-called because this zone is characterized by shrubbery consisting of jnepeni and ienuperi, Ericaceae, and dwarf willows, some of which may be replaced by Alpine meadows.

The upper limit of the lower Alpine zone is a serpentine line at which the more developed junipers begin, at an altitude of 2,150-1,900 m in the mountains of Oltenia and Wallachia (Fagaras, Bucegi), going down to 1,750-1,700 m on Penteleu, and 1,600 m on the Suceava mountains.

The junipers form thick shrubbery, without crooked branches creeping along the ground, rising to 70-150 m [sic] in the air. Their trunks, however, may be long, thick and ramified, but they are creeping.

Another widespread association is that of the ienuperi, which form more stunted and thicker shrubbery than that of the jnepeni and cover more ground.

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More rare than the preceding, and more often in the valleys, especially in the low lying part of the subalpine zone, the mountain alder grows in dense, somewhat higher shrubbery with branches that creep downhill but are very flexible.

Alternating with the jnepeni shrubbery and often occupying very large areas, there is stunted Ericaceae or bilberry shrubbery, formed of a single species or usually more. They sometimes also extend below, but they are usually high, becoming increasingly stunted, up to the Alpine zone.

Subshrubs forming stunted shrubbery are: rhododendron mountain currant, mountain ash, bilberry, and broom. The last two usually grow in wet, peaty places, as also around peat bogs -- and, along with jnepeni and less often with ienuperi, they are the only ones which can grow on peaty soil or even approach it, as it is prohibitive to all higher woody plants.

Here and there stunted shrubs of other Ericaceae (Bruckenthall and Loiseleuria) which range to the upper Alpine zone.

Herbaceous vegetation of the lower Alpine zone is formed particularly of Gramineae, but also of various dicotyledons, showing a pronounced zerophilism and the same features as in the Alpine zone.

The lower limit of the lower Alpine zone is a serpentine line at which, from a more massive form, it thins out more and more, and the trees become more and more stunted until they disappear. This limit is highly irregular and serrated by numerous extensions in valleys sent up by the forest.

In the mountains of Oltenia and Wallachia, the lower limit is at about 1,700 m; in the Buzau mountains it ranges between 1,600 - 1,400 m, as also on Ceahlau, while in the Suceava mountains it even reaches below 1,400 m.

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The lower limit of the lower Alpine zone coincides with the upper limit of the forests, which terminate here in various ways according to the various types.

Types of Forest Termination. As a rule the forest ends toward the Alpine peaks of the Carpathians in resinous forests.

But this formation does not end abruptly; it thins out progressively, forming smaller and smaller groups of trees, which become isolated and interspersed. Everywhere is to be seen stunting and shredding of the firs by the wind as they advance upward. The isolated trees have a very characteristic appearance; their crowns are asymmetrical, due to the wind, which rips off the tops and especially the branches in the direction of the prevailing wind, branches which do not grow at all on many trees. Some are bent in the direction of the wind. Others have dried-up branches in the direction of the wind. The last firs are interspersed with junipers, with the stunted form of subshrubs of the size of molehills.

At other times the forest ends at the Alpine limit in beech forests in which case these formations stop abruptly without a transition zone. Only here and there are isolated beeches to be seen, more stunted and deramified with branches and tops bent and broken, scattered among junipers or bilberry shrubbery, sometimes on grassy meadows. Very rarely the beeches form low shrubs up to 2 m in height in the shelter of rocks or on cliff walls.

Use and Improvement of Alpine Meadows. The Alpine meadows of the Carpathians have been used from ancient times for pasturing livestock, especially for flocks of sheep which were brought to the mountains in spring and taken back to the plains in fall.

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However, these pastures were irrationally used in the past, without system and without anything that could be regarded as improvement.

From time to time the shepherds set fire to the junipers to clear and enlarge their pasturage, the ashes contributing to the enrichment of the soil, but this method is very dangerous because they may set fire to the forests, and huge forest areas have fallen prey to fire in this way.

There are several types of natural pasture in the USSR, estimated at hundreds of millions of hectares. Accordingly, the importance of these pastures for raising animals and increasing their productivity is especially great, and the rational use of green fodder on natural pastures constitutes a great and important state problem in the USSR.

If the pastures are irrationally used and at the wrong time with insufficient measures for their improvement, the grass becomes stunted and the pastures become covered with mounds and shrubs and prohibitive plants and their productive capacity drops.

The following measures have been taken for the improvement of Alpine pastures in the USSR: 1. Clearing pastures of shrubbery and spiny shrub, and poisonous (hellebore, etc) plants; 2. Clearing pastures of rocks and debris; 3. Removal of mole hills and anthills; 4. Study of local grasses and their associations with a view to disseminating the best varieties; 5. Rational, controlled pasturage.

Following the example of the Soviet Union, Rumania is working on the improvement of Alpine pastures in the Carpathians. A team composed of members of the Institute of Agricultural Research of the RPR and the Institute of Experimental Research on Forestry, working under the direction of the Academy of Sciences of the RPR is

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proceeding to apply the Soviet methods of improvement to the Alpine pastures (Bucegi, Ploesti Region, Lucina, Suceava Region, then in the Maramures and western Carpathian mountains).

(b) Forests

Forests are the most extensive plant formations in the RPR.

The forest area begins with the lower limit of the lower Alpine plain of the Carpathians and ends on the plain, including mountains, at varying heights, according to latitude and exposure, from 1,800 - 1,900 m to 1,500 m, hills, plateaus, and higher and less arid plains.

The types of Rumanian forests are zoned in relation to altitude according to their climatic, edaphic, and climatic requirements, constituting several vegetation zones: the zone of resinous (Coniferous) forests, of beech forests and hill belts, and of oak forests and plains belts. The transition from forest to steppe is made by forest-steppe oak forests. Along the valleys extend forests or riverside groves of whitewood.

These zones show us where the respective plant formations can grow and where they previously existed. In former times Rumania was covered even on the plains with secular forests (the "Vlasia Forest," etc) interrupted here and there by glades. But as the population grew and their need of construction wood and fuel increased as well as their need of more farm land, the forests continually lost ground to the axe and the saw, until they reached their present fragmentary state, in patches, the more so since the political regimes which came in succession after that paid no attention either to the rehabilitation of cut forests or to the reforestation of lands damaged by deforestation.

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What happened to the Vlasia Forest also happened, on a larger and more intensive scale, to the Ardeal plain between Somes and Mures, where once were extensive oak forests and where now are forest-steppe formations, due exclusively to the destructive activity of man over the years.

Resinous forests. The coniferous forests cover the higher altitudes of Rumania, from 600 m up to about 1,800 m. Great coniferous forests grow especially in the eastern Carpathians.

The upper limit of the coniferous forests varies in the eastern Carpathians between 1,400 and 1,500 m, and in the south of the country, between 1,650 and 1,800 m. However, the exposure of the land causes landslides on the southern and northern slopes of the southern Carpathians. For this reason the limit of the coniferous forests is much lower on the northern slope, which is more shaded and cooler than on the southern one, which is warmer. Another cause of variation in the upper limit of the coniferous forest is the isolation of the mountain massifs, which has as a direct consequence a permanent exposure to winds from all directions, which results in a considerable lowering of the upper limit of these forests.

The coniferous zone is quite well characterized by its perpetually green forests, dark and humid, in which a great monotony and a deep calm prevail. The prevailing types in these forests are fir and white fir, in whose shade nothing can grow but one deciduous species. Therefore the subforest as well as the herbaceous vegetation on the coniferous forest soil are very limited and almost nonexistent, except for ferns, fungi, and a few other shade plants.

While the white fir of central European-Mediterranean origin seeks warmth and a soil of feldspar rock, readily disintegrated, which

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is why we find it on sunlit ridges and in the lower part of the resinous zone, partly mixed with beech, the fir, a northern species, thriving on cold and indifferent to soil, has a much wider area of distribution, being able to grow well on shaded ridges and in the upper part of coniferous forests, where it forms pure blocs.

Besides fir and white fir, in these forests also grow pine, especially in the eastern Carpathians, sporadic yew, larch toward the upper limit of the forests, where it can even form pure blocs -- with zimbru approaching and among the junipers, black pine on the limestone soils on the Mehedinti plateau, etc.

Beech forests. The zone of beech forests occupies an area larger than that of the coniferous forests, extending to the mountain foothills on the hill and plateau areas. The upper limit of beech forests varies between 1,420 m (the Banat) and 1,270 m (Maramures), being in general 1,360 m in the southern Carpathians and 1,320 m in the eastern Carpathians, and on Mt Bihor, 1,320 m.

This limit is higher on mountains without firs, on which beech forests can reach 1,500 m.

The lower limit varies between 600 - 300 m, depending upon relief, exposure, and shelter. Often they go down to 200-150 m, in groves or as isolated examples on northern slopes or along narrow valleys, reaching an altitude as low as 60 m in the southern Banat (Orsova and Moldava Noua).

In places, the beech is often found in insular distribution, here and there outside its continuous area.

The prevailing type of beech forest, which is pure, is the common beech (Fagus Sylvatica).

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Besides the common beech, there are three other types in Rumania: the Balkan beech (Fagus sylvatica var. moesiaca), the eastern beech (Fagus orientalis), and the Tauric or Crimean beech (Fagus taurica).

The Balkan beech is distributed especially toward the lower limit of the beech zone, where it often forms pure groves, i.e. in the Banat, on Mt Domugled and at Maru, Caransebes raion; in Oltenia, in the Bucovat forest near Craiova, at Polovraci, Horezu raion; in Wallachia, on Mt. Cozie, at Mihaesti, Muscel raion, and in the Niscov valley, in Buzau raion, and in Ardea, in the valley of the Galda, and in the Trascau mountains.

The eastern beech, growing sporadically throughout the common beech forests in the southern part of the Banat (Svinita, Plavisevita, Dubova, Ogradena, and through Almas raion, Timisoara Region).

The Crimean beech also grows sporadically throughout the forests along with the common beech in the south, i.e. in the Banat (Saska Montana, in the Nera valley, Oravita raion, Svinita, Baile Herculare, Almas raion, Tarcu mountains), in Wallachia, (Cozia, Corbi mountains, Rimnicu Vilcea raion, Contesti, Racari raion, Mt Ciucas, the Nisov-Buzau valley), in Dobrogea (Luncavita), in Valea Fagilor, Macin raion.

Besides the common beech, which is the prevailing type of beech, there are also in these groves mountain plane trees, mountain ash, etc to which are added toward the lower limit, evergreen oak (Quercus sessiliflora, Quercus petraca), and other Quercineae.

In the beech forests of the Banat and Oltenia there are some Mediterranean types as: sfineac, black ash, sumac, good chestnut, wild walnut, wild lilac, Turkish hazel, simbovina, and fig.

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The subforest and herbaceous vegetation of the beech forests is scant because of the shade produced by the dense crowns of the beeches, under which only ferns can grow well. In the glades, however, the richest meadows in the Carpathians grow, formed of various grasses such as Deschampsia, etc, Mayflowers, cock's foot grass, vinarita, hare sorrel, Telekia, etc.

Various edible fungi grow in the humid soil of the beech forests: chanterelle, white mushroom, cockscomb, morel, ear fungus, brown mushroom, iutisori, etc, or poisonous ones, such as the Amenita muscaria (red with white spots).

Oak Forests and Plains Belts. The oak forest zone forms an irregular belt on the periphery of the hills and on the plain, as on the edge of the Ardeal plateau, occupying not only on the exterir but also on the interior of the Carpathian ring, areas located at altitudes between 150-400 m.

The external limit of the oak zone is irregular, and this irregularity is explained by the variation of local conditions, favorable or unfavorable, which have resulted in its greater or lesser extension onto the plain along the wide river valleys, especially when they are very close together, as for example west of Bucharest, where along the cluster of waters which constitute the Arges basin the forest has advanced almost to the Danube (the "Vlasia Forest").

On the other hand the forest has advanced less in areas in which such valleys are less frequent, narrower, and unconnected with the hill areas. It has progressed very little or not at all in areas in which valleys are lacking or are very rare or dry, or the atmospheric precipitation is weak and the water table is very

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deep, as on the Baragan. The forest is also lacking in some areas in which the chemical properties of the soil, for example an abundance of mineral salts is unfavorable to the growth of the forest. This is the case on the Moldavian plain (Jijia-Bahlui depression) and sporadically on the Tisa plain and the Ardeal plain.

As regards the composition of forests in this zone, the fact must be emphasized that they are rarely pure formations of oak or Quercineae (Quercineae groves) but mostly mixed with other deciduous trees, in which Quercineae may prevail or may be outnumbered (belt forests).

The Quercineae which occur here are: Quercus sessiliflora and Quercus petraca, Quercus pedunculata or Quercus robur, Quercus conferta or Quercus frainetto, Quercus cerris, and Quercus pubescens.

To these are added other deciduous species: elm, hornbeam, plane tree, maple, field maple, box elder, ash, trembling poplar, bitter cherry, red or odorous linden, white linden, mountain ash, service tree, forest pear and apple, etc.

Since light penetrates deciduous forests better, it conditions the growth, under favorable circumstances, of the other strata of vegetation, especially the strata of shrubbery and grasses.

Among the shrubs growing here are: hazel, hawthorn, corn and singer [cornel], pistacia, snowball tree, dirmax, pricktimber, elder, dogwood, barberry, etc. The creepers and climbers are: ivy, brony, wild or domestic grape, hops, etc. The branches of some trees are often parasitized by white mistletoe and oak mistletoe.

On forest soils grow: yellow saffron (in sunlit places), snowdrops, sweet violet, primroses, cinquefoil (Potentilla), violet,

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lily of the valley, fruit of the earth, marigold, red root, pastite, vinarita, hare's shadow, strawberry (in sunlit places); some parasites such as jasmine, etc, some fungi such as boletus, etc, and on the bark of trees spunk and lichens.

The following groves grow in the oak zone:

(a) Quercineae groves: mixed forests of pedunculate oak and gray oak; oak groves; oak and mountain-oak groves; forests of mixed oak and gray oak, evergreen oak groves; depression oak groves; mixed forests of oak and gray oak in depressions, etc.

(b) Belt forests: the belt proper, the oak-grove belt; the belt with the oak.

The belt proper is characterized by the presence of the pedunculate oak with hornbeam, white linden, ash, field maple, box elder, field plane tree, odorous linden, and forest apple and pear. In such a grove, the pedunculate oak occurs in a proportion of 2/10 of the other species. The oak belt is characterized by the presence of oak which is found in proportions equal or less than that of the pedunculate oak, while the oak belt is, on the other hand, characterized the absolute predominance of the oak, to which are added only a few of the belt elements, and the pedunculate oak is either entirely lacking or is scattered.

Forest-steppe oak forests occur in the forest-steppe zone, marking the transition from the forest domain to that of the steppe.

These forests occupy, at the edge of the steppe proper, limited areas, being composed of trees such as the gray oak and the Virgilian oak as well as the oak and mountain oak, the wild pear and apple, the elm, box elder, etc. Among these trees the following shrubs grow: hawthorn, verigar, vonicar, sweet briar, cornel, sloe, etc.

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The forest-steppe oak forests have a characteristic appearance due to the unfavorable climatic conditions: the trees are in general more stunted, lower, and punier than those of the forest area proper. The feebleness of the trees is to be seen in the trunks, which are usually crooked, with thick bark supporting, at a low height, a crown with thick, crooked branches, with numerous dried-up patches, and almost entirely covered with lichens. All the trees have trunks creeping at the base, a characteristic due to wind action on the trunks in the early stages of growth. The proximity of the steppe is reflected in the forest-steppe arborescent vegetation of the oak forests by the great number of insects which attack the trees (oak, elm, etc), producing numerous galls through their attack.

Another characteristic of the oak forests in the forest-steppe area is the lack [illegible] in the seed, this type of reproduction being replaced here particularly by sprouts.

In Dobrogea, the forest-steppe oak forests also contain some Mediterranean elements, as sumac, paiur simbovina, jujube, sfineac, etc.

In the wide glades of these oak forest steppe herbaceous plants grow, as: spikenard, barboasa, Deschampsia, spring ruscuta, dittany, wild peony, etc.

Situation of the Forests in the Past. Provisions and Achievements of the Five-Year Plan. In the bourgeois-landowner Rumania the forests suffered more than in any other European country. The devastation of the forests in Rumania was already in full swing in the time of the Turks before the Organic Regulations. The Turks had a true monopoly on the cereals, cattle, and lumber of the Rumanian provinces. The pace of this devastation was accelerated after this monopoly was formed, when Rumanian cereals began to be sold at prices very

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advantageous to the capitalists on western markets. Then began a vast deforestation in order to intensify agriculture and increase the production of cereal grains.

Pasturage also greatly contributed to the loss of forested areas, causing a loss of 500,000 ha of forest, especially on the plain in only 65 years (1850-1915).

Fires have also played their part in the destruction of the forests, particularly in dry years: in 1894 alone 62 national forests burned over an area of about 5,620 ha, to say nothing of privately owned forests.

An enormous waste of timber was perpetrated in 1790 in the Rumanian provinces to pave the streets of the more important towns (Bucharest, Iasi, Craiova, etc) with oak beams which had to continually be replaced. Such streets were called "forests" (for example, "Podul Mogosoaiei" in Bucharest, now Calea Victoriei, and "Capul Podului," now Piata Victoriei, where "Podul Mogosoaiei" end on the outskirts of the town).

The forests, especially on the plain, also suffered from the numerous imperialistic wars which were so often fought on Rumanian territory. Sites of marches of troops and their camps and of military administration are recognizable long afterward from destroyed forests, either from deliberate arson or from inordinate cutting of trees to obtain the wood which they needed here or for their own countries.

During the German occupation in World War I, the devastation amounted to a paroxysm. At that time many forests were cut down not only to obtain wood for construction and fuel, but also for the bark needed in tanning or to make charcoal; the walnut trees were in great part destroyed to make rifle stocks, and the ash trees to

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make airplanes, cars, spokes for wheels, etc. The small forests which existed in the former judet of Ialomita were cut and burnt at the time to run machines and mills. Since even the pastures had been ploughed up, the peasants were then permitted to pasture their cattle in the forests, even in young groves only three to four years old, in view of the fact that the meadows had been requisitioned.

After the agrarian reform of 1918, the small patches of forest fell into the hands of exploiters, through the ignorant peasantry of the time, and were cut down at once or were destroyed by pasturing and random cutting.

The capitalistic exploitation of the forests was also intensified in World War II, and the events of the German occupation of 1916-1918 were repeated with variations by the Fascist German-Rumanian "collaborators" during World War II.

To cope with this alarming situation, the people's democratic regime had to take urgent and effective remedial measures.

These measures were put into active form in the Five-Year Plan, which provides for important silviculture projects:

Forestation of 390,000 ha;

Consolidation of 7,000 ha of slopes.

Forestation of 40,000 ha of deteriorated land.

Forestation of 36,000 had in regions with potential hydroelectric power.

Establishment of nurseries over an area of 5,500 ha with a production of at least 2,200,000 saplings.

A fund of 6,800,000 lei has been provided to carry out these and related tasks.

Compared with all that was done in this field in the 14 year

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period before 1944, the Five-Year Plan projects involve a volume of work hitherto unprecedented in the history of Rumanian silviculture; the largest area planted in the past was about 48,000 ha in 1938, and the total area planted in these 14 years (1930-1944) was about 400,000 ha, equal to that provided for in the state plan for five months alone.

The forestation plan was fulfilled 122% in 1951 exceeding the 1950 achievement by 44.4%. The area planted in 1951 is greater than that planted in ten years under the bourgeois-landowner regime.

Projects to improve land through forestation and to correct and prevent torrents have been carried out in basins with hydroelectric potential, in the valleys of the Bistrita, Ialomita, Jiu, Arges, Buzau, Rimnic, Putna, Trotus, and Ampoi rivers, and also in the Valea Chinezii (Brates), the valley of the Covurlui, on the littoral, and along the Danube between Bazias and Orsova.

(c) Steppe Vegetation

The steppe is a grassy formation characterized by a lack of indigenous higher woody vegetation, which is replaced by thorns or thick, stunted shrubs growing in hollows or valley.

The steppe occupies a remarkably large part of the Rumanian plains.

Thus on the low Danubian plain it forms an irregular and dense belt, interrupted by forest-steppe extensions, which begins in the southwestern part of the country (Turnu Severin raion) and accompanies the Danube meadow down to Giurgiu; between Giurgiu and Oltenita it disappears almost completely because of the forest extensions in this part of the country, to reappear in eastern Wallachia where it occupies the largest area in the entire country (the Baragan plain, the Braila plain, the Buzau plain, that of Rimnicu Sarat, and southern Moldavia).

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Smaller steppes are found in northeastern Moldavia (the Jijia-Bahlui steppe) and in western Transylvania (the Tisa plain from Timisoara-Arad west).

On the extensive plain of the steppe are to be seen, here and there, mounds made by man in historic times; hollows which are soil receptacles, fixed and moving sands near streams (fluvial dunes) or along the sea (maritime dunes, and continental and maritime salt marshes).

Higher arborescent vegetation does not exist on the steppe for the following reasons: the mean annual precipitation is low and usually below 500 mm, while arborescent vegetation requires over 500 mm for normal development the temperature shows extreme seasonal variations, being unfavorable and even prohibitive not only with exaggerated maximums in summer but also minimums in winter; the wind blows almost all the time, destroying the equilibrium between absorption and transpiration; the humidity of the atmosphere is low; the steppe soils are rich in soluble salts which are prohibitive to arborescent vegetation and lie at shallow depths; the water table is very deep and cannot be easily reached by tree roots. In general, the physical and geographical conditions and especially the climatic conditions on the steppes of the RPR are arid; in fact the map shows aridity indexes only on the steppes in the RPR. The aridity index is between 15 and 24 -- that is, the territories in southern Dobrogea and on the sea littoral; in the eastern part of the Baragan they are 15 - 20, and on the rest of the steppes 20 - 24.

The only woody vegetation that can adapt itself to these ecological conditions through various Xerophilous adaptation consists of stunted and monotonous subshrubbery thickets, with or without thorns, such as sloe, dwarf almond, dwarf cherry, dwarf sweet briar,

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bramble, blackberry, genista, etc; and in Dobrogea: paiur, wild jasmine, wood bush, horsetail or Ephedra, etc.

These shrubs used to be much more widespread on the steppes, especially along the paths and boundaries that separated the old estates, and also along the cart roads, highways, railroads, etc, forming places of refuge and reproduction for rodents and insects unfavorable to agriculture.

Therefore the removal of the boundaries isessential to the protection of the crops.

Steppe vegetation proper which can live under the conditions of aridity on the Rumanian steppes is herbaceous Xerophilous vegetation.

From this point of view we distinguish two formations: steppe with dicotyledons (areas with aridity index of 20-24) and steppe with Gramineae and wormwood (areas with aridity index of 15-20).

The steppe with dicotyledons has a general distribution in Rumania, a small part of the center of Dobrogea and a narrow belt in eastern Wallachia, along the Danube, where it is replaced by steppe with Gramineae and wormwood.

The first has a flora formed of somewhat higher plants belonging to such species as: raspberry, sowfennel, etc, umbelliferae; oregano, sage, scorogoi (Labiate); snake's-head, miruta, etc (Boragineae); stone-lentil, green bean, clover, yellow sweet clover, alfalfa, thorny harrow, bean tree, benista (Leguminosae); chiurlanii, etc.

The second has a flora consisting of lower and Xerophilous plants, belonging to such Gramineae species as: darnel, spikenard,

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bulb pea, oat, mouse barley; Iridaceae, such as the dwarf iris, and various dicotyledons such as: Euphorbia, thistles, steppe wormwood, etc.

On the sand dunes, especially the maritime dunes, a psammophilous, arenaceous, or sandy vegetation grows, consisting of dog-grass, rushrass (Iuncus), some species of sedge, wild barley, field reed, sand cabbage (Crambe), horsetail (Ephedra), and even steppe peony (on the dunes at Techirghiol).

A characteristic halophilous vegetation grows in the salt beds, composed of glasswort (Salicornia), broom (Kachia), and marsh rosemary; and on the wet and salt sand of the sea, Cakiles, etc.

Improvement measures for the steppes through application of the DKV [Dokuchayev, Kostychev, Vil'yams] agricultural system. In the process of constructing socialism, one of the main tasks is increasing production. Agricultural production is affected by numerous factors, particularly soil moisture.

The DKV system is intended to control the physical and geographic factors of the soil, especially the water, and to obtain increasingly larger harvests. It is a uniform system of methods and measures to overcome natural adversities and increase agricultural productivity. This system was initiated by Dokuchayev and Kostychev and later developed by Vil'yams.

On the basis of the previous researches of his two predecessors and on his own researches, Vil'yams announced a series of new methods, to give agriculture an opportunity to protect production from the effects of unfavorable climatic conditions, to assure a continual increase in soil fertility, to obtain abundant and stable harvests, and to create a substantial forage basis for raising animals.

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The DKV system was introduced gradually on the Soviet kolkhozes, beginning in 1935, and was made obligatory by legislation for all steppe and forest steppe areas of the USSR in 1948.

The basis of the system is rotation with herbaceous perennials, the ground being planted with graminaceous and leguminous perennials sown in rotations of 1-3 years to rehabilitate the structure of the soil.

The maintenance of the soil structure and its fertility is accomplished by special projects: mulching stubble, fall ploughing, and processing before seeding.

To combat weeds fundamentally the system recommends the use of black fields (tilling stubble in summer and plowing in fall with a plough with a colter, which turns up a furrow in two steps, then in spring the processing of the field to remove weeds begins.)

Soil fertility is raised by rational enrichment in stages, depending upon the requirements of each type of vegetation.

In the dry steppe areas, soil fertility and stability of crops are directly conditioned by the amount of water the plants get from rains and snows, atmospheric humidity, and evaporation.

Where precipitation is inadequate and poorly distributed, where the wind drifts the snow and does not let it cover the crops, or where it increases the dryness of the atmosphere and damages harvests, the measures indicated above are insufficient to assure steady production.

To render production independent of these unfavorable climatic conditions, Vil'yams announced the total use of all local water resources, to irrigate the crops and to create a system of protective

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forest belts on the fields.

Finally, organization or systematization of agricultural territory is a prerequisite of planned agriculture. The relief determines the way the land is used: the slopes for vineyards and orchards, the valleys for pastures, meadows, and vegetable gardens; cereals and industrial plants are grown on the plains and only in emergencies on slopes. The organization of the territory must also determine the exact place for rotation of crops, forage, etc, the placement of protective forest belts, etc.

Advancing along the path opened by Soviet science, the ICAR [Institut de Cercetari Agronomice Romin -- Rumanian Institute of Agricultural Research] has begun experiments at its experimental stations on new methods of raising the soil fertility and increasing production, and on extending their practical application. The introduction of the DKV system in agrotechnology and the Michurin concept in agrobiology have shown favorable results, both at ICAR stations and certain collective and state farms. Through irrigation state farms have achieved higher yields, for example, 1,300 kg of cotton per ha. Protective forest belts were planted along the Valea Carasu and near all ICAR stations, in collaboration with the ICES [Institut de Cercetari Economice-Sociale -- Institute of Economic and Social Research], which prepared a large-scale plan to set up these belts in all the steppe districts, and has even drawn up a map for this purpose.

(d) Aquatic Vegetation -- River-meadow Vegetation. The Rumanian meadows and the shores of their fen lakes are covered with forests of white woods, moi, or riverside groves, composed of willow groves, broom groves, poplar groves, buck-horn groves, and alder groves, and in the white woods forests of river-meadow forests.

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The development and extent of these forests increases toward the plain, along with the widening of the valleys and the development of the river meadows on the plain. While in the mountain valleys and narrows, covered with gravel and rocks at the bottom, white wood forests grow in groves composed especially of white buckthorn (Hippophae) and tamarisk (Myricaria). In the hill area the valleys begin to harbor great riverside groves of black and gray alder. On the plain, as the valleys widen even more and the alluvia become finer, the river meadows bear groves of broom, willow, and poplar, and on the alluvial sands, tamarisk (Tamarix).

Outside of the white wood forests, we also find on the meadows of the greater rivers, especially on their lower courses, meadow forests composed of several hardwood species such as oak, elm, wild apple and pear, hazel, ash, corn and singer, etc, on which climbers grow: wild grape, bryony, hop, etc.

The connection between the development of white wood forests and those of the valley bottoms can be especially well observed on the Danube meadow. In the defiles, where the meadows are narrow or even lacking altogether, the riverside groves are also lacking or occur only on islands (Ogradena, Adacale, etc). Below Calafat, where the meadow begins to widen continuously, the white wood forests become increasingly abundant and more extensive, down to the huge Ialomitei and Brailei fen lakes, where they reach their maximum development, to reappear on the bars in the Danube Delta, especially at Letea and Caraorman, where the white wood forests are mixed with hardwood species, forming a special type of forest rich in salt-marsh plants.

The Letea forest, situated on a triangular bar between the Chilia and Sulina branches, is composed of white poplar, ash, black

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poplar, wild pear, apple, white willow, broom, evergreen oak, elm, mountain oak, black alder, and forest linden, associated with such bushes as hazel, hawthorn, sloe, red broom, sweet briar, black alder, verigar, barberry, dogwood, vonicar, corn and singer, snowball tree, tamarisk, white buckthorn, and among the climbers: wild grape, Periploca, and ivy. Among these species, the most common and abundant is the white poplar, after which comes the ash populating the elongated and parallel depressions among the coastal bars, forming forests called "hasmacuri."

The lianas, that twine on trees and then hang down from the branches like drapery, give these forests a quite special appearance, especially in autumn, because of the variegated color of the leaves -- cherry red to dark red grape leaves, golden yellow periploca leaves, yellow brown bryony leaves, dark green ivy leaves, etc.

Vegetation of swamps and fen lakes. From the Alpine peaks of the Carpathians to the Danube delta, the swamps have an aquatic vegetation corresponding to the ecologic zone in which they are located.

Thus the mountain swamps offer conditions favorable to the development of white moss or peat moss (Sphagnum); such aquatic vegetation formations are called peat moss patches.

Somewhat lower, the vegetation consists of various species of mountain sedge (Carex), for which reason their respective vegetation formations are called caricate or rogoziste.

Here and there on the plain swamp vegetation is composed of reeds (Phragmites), and so it is called phragmitetum or the reed bank.

Through decomposition of the remains of this vegetation a sort of organic mud (sapropel) is formed, which is deposited on the bottom of the swamp where it mixes with the mineral mud.

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When there is much undecomposed organic residue in sapropel, a peat-forming process takes place, which transforms it into peat. The swamp is then called a peat bog.

Many of the peat muds are used for therapeutic baths at Colacel (along Vatra Dornei) Borsec, Stobor, Geoagiu, Baile 1 May and Victoria, the Petea Someseni river, and Malnas.

Most of the peat bogs are situated in the Harghita-Puturos Mountains, on the Ouas plateau, Maramures, in the Buzau-Bretcu Mountains, in the Dorna-Tesna basin, in the Sebes Mountains, in the southern Carpathians, and in the Apuseni Mountains. They are found particularly at the upper limit of the beech forests, the highest at 1,900 m.

Often the peat has had a local, very limited use.

Through the plan for electrification and the multilateral use of streams, peat has begun to be used on a large scale as fuel in thermal electric power plants.

As the inundation zones of the rivers broaden, the fen lakes of these areas become ever larger and the aquatic vegetation more and more developed.

This vegetation forms zonal belts of varying composition in concentric bands in relation to the depth of the fen lake. These zonal belts, from the edge to the center and the depth of the fen lake, are zones of sedge, reeds, rushes, water lilies, broscarita, club moss, duckweed, and water lentil -- and growing on the bottom of the fen lake, a submerged field of Chara.

The external belt of vegetation formed by reeds and rushes form the reed bank. This reed bank extends toward the center of the

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fen lake, the bare rhizomes on the outside being light, which makes them float. From a matting of rhizomes from the reed bank, to which the root tassels also contribute in nodes as well as the various remains of vegetation and even mud which fill the gaps in the texture, a thick vegetation cover of .90 - 1.50 m is formed which floats on the surface of the fen lake to some distance from the shore. This floating vegetation cover is called plaur or plavie. It forms on all fen lakes, for example, on those around Capitala (Cernica, Rasarea, Snagov, Calddorusani, etc) but they have particularly better development on the Danube delta.

Economic Importance of the Reed Bank. Because of the enormous area which they occupy on the Danube delta, the reed banks have a special importance. In fact, out of the total area of the delta of 430.000 ha, the reed banks occupy 267,000 hectares of which 72,000 ha is floating vegetation and the vegetation conditions are so favorable that reeds can grow six m high. The most common use of the reed banks has been limited for some time to use as construction materials and thatch, fences, fishing weirs and seines, and especially fuel in villages on the fen lake shores and particularly in the delta. At greater distances only small quantities of reeds are sent for ceilings, etc.

But the reeds are a very valuable raw material for the manufacture of cellulose, paper, and cellulose fiber, and at Tulcea the people's democratic regime, has established a stufit factory, that is a factory for insulating panels made from the reeds for use in the construction industry.

2. Geographic origin of plants in the RPR

(a) Floral Elements

In Rumania grow about 3,400 species of flowers and ferns. Of

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these only a very few are indigenous, surviving here from ancient times (some as cryptogams) and especially some as Tertiary relicts (chestnut, walnut, simbovina, eastern hornbeam, Turkish hazel, lotus, Ephedra, etc). Most of them came from neighboring areas or further away in the course of time and in relation to the paleogeographic shifts which took place in succession over the geologic ages.

The most numerous elements in Rumania's flora (62%) are species originating in Central Europe (central-European elements). In this category are the commoner trees of the hills and plains: willow, poplar, hornbeam, hazel, birch, beech, evergreen oak oak, elm, hawthorn, plains maple, cornel, ash, snowball tree and dirmox; then the trees and shrubs of the mountains: white fir, yew, mountain elm, maple, plane tree, bilberry, jnepeni, ienuperi, etc.

There are much fewer species originating in the artic areas of Eurasia (artic elements) They populated the mountains of central Europe and the Carpathians during the glacial periods and afterward, and they have stayed contained on mountains and on Alpine peaks where they have survived as glacial relicts. These are: fir and zimbru (originating on the taiga, azalea, dwarf willow, and argintica, and then the various swamp plants -- cotton grass, dwarf birch, ruginarea (Andromeda), Ligularia.

Few also are the species originating in the Alps, which also penetrated the Carpathians in the glacial period (Alpine elements). They are: Alpine gusa-porumbelului Alpine pink, rock cress (Arabis), various saxifragae, dwarf cock's foot grass, Alpine angelica, Alpine forget-me-not, Alpine veronica, Alpine foxglove, Alpine hawkweed, etc.

A few plants came from the Balkan peninsula, populating the

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Carpathian chain as well as the Balkans (Carpatho-Balkan elements). They are: priboi, spring saffron, mountain currant (Bruckenthalia), rhododendron, etc.

Mediterranean elements are richly represented in the flora of Rumania. They come from the Mediterranean subregion and populate the warmer parts of the country (the Banat, Oltenia, Dobrogea, etc) They are: sfineac or carpinita, mountain or black ash, Turkish cherry, simbovina, thistles, wild lilac, black or palasian pine trilobate maple, Turkish hazel, wild jasmine, paiur, jujube, plesni toarea, Periploca, Smilax, etc. These Mediterranean elements populated Rumanian areas in postglacial times, being superimposed upon some survivors of the end of the Tertiary period (Tertiary relicts) such as: lotus, yew, ivy, flueratoarea, hops, benista, etc.

Many plants populated the plains in the interglacial and postglacial periods from the Asiatic Pontocentral steppes (Asiatic central Pontic subregion). They are: wild barley, steppe peony, snake's-head, Persian convolvulus, spikenard, darnel, ruscuta de primavara, luntricica, aster, etc. Some reached the low Danube plain (Pontic elements), others the Moldavian steppes (Sarmatic elements) and others penetrated the low Danube plain at the Tisa plain (Pannonian elements).

Some plants penetrated Rumania, about 10%, and took on new characteristics in keeping with the physical and geographic conditions of these areas, giving rise to new species and subspecies. For example in the Retezat massif, of six different species of hawkweed or Hieracium (subarctic, central Asiatic-west Pontic, west Pontic-Mediterranean, central European, and Eurasiatic-north European elements) 12 species and 42 endemic subspecies arose, as well as new varieties and forms.

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All these new elements (about 340 species), which arose in one of the areas in Rumania, are called endemic Dacian elements (Dimitrie Greceanu, 1898). They are: a species of milfoil (Achillea Schurii), closely related to a similar species in the Alps (Achillea oxyloba) -- or a species of opaita (Melandrium Zawadzki), related to the Balkan opaita (Melandrium auriculatum), etc.

The endemic Dacian elements constitute the Dacian flora (D Grecescu) and characterize the Dacian floral province (Tr. Savulescu) in the Carpathian framework, where they are more abundant and where they grow along with other floral elements.

(b) Phytogeographic Zoning.

According to floral relationships, Rumania can be divided into seven floral provinces, characterized by their geologic past, their present climatic conditions, and in connection with these their flora and vegetation distinct from neighboring provinces and endemic or characteristic species, as well as certain vegetation associations lacking in the other provinces.

These phytogeographic provinces are as follows:

1. The Dacian province, comprising the hills, plateaus, and mountains, 200-1650 m; the vegetation of this province is forest zoned by altitude in regard to species. The beech is its characteristic element, but it contains many Dacian endemisms; to the north it is enriched by central European elements.

2. The Dacian-Alpine province, comprising mountain tops 1,650 m or more in height, consisting of many islands irregular in area; the vegetation of this province is connected with Alpine vegetation and has many points in common with the Alps; from 2,000 m up it is particularly clearly distinguished.

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3. The Pontic province comprises the whole low Danube plain constituting a tentacular extension of the Pontic steppes from the southern part of European USSR.

4. The Sarmatian province comprises two small portions of Moldavia and a certain part of the northwest (Jijia-Bahlui steppe) of it, constituting an extension of Ukrainian flora and being a mixture of steppe and forest flora in which the beech is lacking.

5. The Pannonian province consists of the Pannonian plain, also extending into Rumania as far as the western foothills of the Apuseni mountains; it has a steppe vegetation with many Pannonian elements.

6. The Banat-Oltenian province comprises part of Oltenia, the Banat, and southern Ardeal (in the Hunedoara region) and reflects the conditions of a submediterranean climate, with a flora composed of many southern elements (Illyrian, Mediterranean).

7. The Dobrogean province comprises Dobrogea and reflects not only submediterranean climatic conditions with many Mediterranean elements, especially in the southern part of the province, but also steppe climatic conditions with many Pontic elements.

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VIII. FAUNA

Raul Calinescu

1. Geographic Distribution of Terrestrial Fauna in Relation to Relief

We have seen that vegetation is zoned by altitude in relation to relief and variations in climatic conditions.

A similar zoning is also to be observed in the case of fauna, conditioned not only by relief and climate but also by vegetation.

We distinguish an Alpine fauna, a forest fauna (of mountains and lower altitudes), a steppe fauna, etc.

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(a) The Fauna of the Alpine Peaks

The Alpine peaks are the domain of the black goat. This antelope of the mountains lives only on the highest and steepest peaks of the Carpathians in glacial hollows on Paring, Retezat, Mt. Lotru, Fagaras, Piatra Craiului, and Bucegi.

Among birds of prey only the eagles venture to fly over the Alpine peaks, coming from the forests below. A pure Alpine eagle is the bearded eagle or lammergeier, which nests only on Rezetat, along the subalpine precipices.

Other birds which have penetrated the forest area here are the Alpine finch, the Alpine fisa, the rock thrush, the Alpine brumarita, and the mountain lark; among the reptiles the common viper, black viper, and the mountain lizard; among the batrachians the blue triton, muchiat triton (Triton montandoni), and the brown frog (Rana temporaria).

The terrestrial mollusks which live in the Alpine barren have a smaller foot than the forest forms; their number is small because climatic conditions are unfavorable; the Alpine snails are limited chiefly to areas where there are more sheltered and warmer places in the inclement seasons and where they seek shelter from the cold rains, hailstorms, and snows and where in summer they find shade and humidity.

Many species of butterflies, which live in the forest zones also come up to the mountain tops in the juniper zone or Alpine meadow proper. These are Aporia crataegi (up to 2,000 m) Tinea granella (up to 2,100 m), etc.

Other species of butterfly live exclusively on the Alpine peaks, in typical forms or local varieties, such as Erebia lappona

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(a glacial relict, up to 2,160 m), Evetria turionama, var. mughiana (up to 2,263 m), etc. There are also special forms of Coleoptera, Hymenoptera, Orthoptera, etc, on the Alpine peaks.

(b) Forest fauna

This type of terrestrial fauna is the richest and most varied in Rumania, from the smallest insects to the largest birds and mammals.

There are numerous forest insects, some of which are harmful, as certain butterflies (Porthetria dispar, Tortrix viridana, etc.) whose caterpillars feed on the leaves of certain trees and strip them.

Besides butterflies there are Geometridae, ash beetles, May beetles, cetoni, stag-beetles, Curculionidae, woodborers, forest bugs, earwigs, plant lice, etc, all harmful insects that swarm on the forest soil, in the bark of trees, and in their crowns. There are also various other xylophagous pests which are very harmful and cause great losses.

Under this head come the losses caused by hyphids (Bostrichidae) or bark beetles in various years, but especially in the years 1918-1926 and 1947-1948 in the fir forests of the Eastern Carpathians. Xylophagous insects, harmful to forests, also include some Cerambycidae (woodborers) which attack either conifers (fir borers) or deciduous trees (oak borers).

In the forests of the plains there are such birds as the common jay, orioles and the various songbirds, mostly migratory -- goldfinches, finches, the linnet, the siskin, the woodlark, common and caudate tomtits the green robin, nightingales, the flycatcher, cojoaica, scortar, etc.

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Typical forest birds are: thrushes, blackbirds, green and spotted woodpeckers, the cuckoo, wild pigeons, turtle doves etc.

In the mountain forests are the heathcock, birch cock (only at the sources of the Bistrita), hazel hen, rock partridge (only in the region of Cazane), mountain jay, scissor-tail, mountain cojoaica, etc.

Among the birds of prey, there are eagles, vultures, falcons, hawks, the wood owl, the wood eagle-owl, the great owl, etc.

During their passage in spring and fall, snipe and marsh plover sojourn in the humid forests.

In some forest-steppe oak forests there are colonies of pheasants, raised in artificial hatcheries called fazaneri.

Mammals are well represented in the forest area. Some species are eurytopic: the wolf, the fox, badgers, hares, etc. The others are stenotopic and peculiar to the forest, Among the predators are: the bear and lynx (only in the mountains), marten and beic (especially in beech forests) and wildcat (in all types of forest); among the herbivores are the deer which runs wild in coniferous and beech forests, especially in the eastern Carpathians, and are raised here and there (in the Banat); the roe buck, both in coniferous and deciduous forests, especially of the plains -- partly raised, for example around Timisoara and Bucharest; the wild boar common from the fir forests to the flood area and on the Danube delta around the floating vegetation; the cerblopatar and wild sheep are not only raised in Rumania but are also found in the forests on the Banat plain (Sariota, Bata, Bulci in Timisoara Region) and the Crisana plain (Socodor, Arad Region, Balc, Oradea Region), and the latter at Balc, Oradea Region, and in Hunedoara Region. The rodents are represented by squirrels,

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word illegible], and wood mice, which sometimes cause great losses to nurseries and forest plantings.

(c) Steppe Fauna.

Among the mammals, the most characteristic steppe animal is the popinau, which constitutes the basic food of the steppe polecat and the spotted polecat, both species characteristic of the Dobrogean steppe.

The field mice, which multiply in large numbers in some years, are very harmful to agriculture. This happens especially after winters with heavy snow, preceded by long and warm autumns, with rich food resources which constitute optimum conditions for the growth of these rodents.

Other harmful steppe rodents are: the marmot, the gopher, the small lemming (in Dobrogea), etc.

The most characteristic bird is the bustard, an indigenous species in Rumania, rare because of rapacious hunting, especially in winter, when the cold freezes its wing feathers so that it can no longer fly. More rare than the bustard is the spurcaciu, or small bustard, migratory to Rumania. Other steppe birds are: quail (migratory in summer), partridge (indigenous), meadow land rail, various species of snipe, and especially the long-footed snipe, which dash about the steppe at night piercing the calm nights with their melodious cries. Large and small cranes are to be seen on the steppe during their spring and autumn passage. Much more rare is the gray steppe hen, which makes irregular migrations from central Asia. Flights of common and purple starlings circle about the cherry trees, alighting upon them now and then. More rearely a locustar is seen, especially on the Dobrogean steppe. The singing birds are represented by bundings, prairies woodlarks, and field woodlarks. The

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steppe atmosphere is thick with bee-eaters, which fly in great swarms, especially near any kind of water, calling sadly, and blue rollers perch here and there on the telegraph poles and wires, brightening the monotony of the uniform expanses of the plains. There are many predatory birds on the steppes: the gray and black bald eagles, the steppe falcon, etc, and the steppe goshawks and steppe owlets feeding on the various steppe rodents which they catch in great numbers, being very useful to agriculture in this way.

The species of steppe lizards are varied; the most characteristic are the Eremias, and then the steppe snakes (Elaphis, Zamenis, Eryx, etc), and the long snails, glistening white in color (Zebrina), congregate on warm summer days like so many white tufts or grapes on low, gray bushes of steppe wormwood, especially on the Dobrogean steppe. On the sands or psammophilous plants of the dunes live great quantities of Helicella, which have a good resistance to the high temperatures of the sands in the summer heat.

The insects are numerous and varied, with a predominance of Orthoptera -- that is, locusts, crickets, and calugarita, the last especially on the Dobrogean steppe.

On the Oltenian steppe there are paunchy crickets of the Mediterranean type (Dynarchus); throughout the valleys of the plain, termites dwell in the dired or half-dried roots of the vine stocks.

A characteristic Myriapod of the Dobrogean steppe is the centipede; on the Dobrogean littoral there are spiders of the Mediterranean type, Argiope lobata, which spin their webs among the dicotyledonous plants of the steppes.

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2. The Geographic Origin of Terrestrial Animals in the RPR

(a) Fauna Elements

As in the case of flora, the Rumanian fauna are based upon animal species of the European and Siberian subregions in general and of the central European region in particular: deer and roebuck, red and black squirrel, pirsii, dwarf mice, hares, wild boar, common lilieci, the mole, hedgehog, wolf, red fox, lynx, wildcat, otter, badgers, marten, pietrar, mink, weasel, ermine, common polecat; some sedentary birds: alunar, jay, finch, robin, oxeye, kinglet, owlet, screech-owl, great owl, heathcock, cocos de mesteacan (rare), hazel hen, finch, grosbeak, crested lark, thrushes, blackbirds, linnet, magpie, raven, and bustard; mollusks, among the most common of which are river mussel, fen lake mussel, fen lake snails (Planorbis, Lymnaca, Paludina, etc).

Much fewer are the artic, circumpolar, and Alpine species which came to Rumania during the glacial periods (glacial relicts).

Some small glacial relicts of artic origin have survived in the Carpathian recesses, and especially in the eastern Carpathians: Rotiferae, Dinocharis, etc (In the mossbanks at Poiana Stampii); Hydrocharians, Lebertia, etc (Mihodrea swamp) some Collembolae (Morulina, etc); Planarians (Planaria alpina); Crustaceans (Niphargus puteanus) butter flies (Erebia lappona); and Coleoptera (Nebria, etc).

Although sedentary artic birds are rather sparsely represented in Rumania, for example by the black woodpecker originating on the taiga, the migratory species appear much more thickly during severe winters -- siskin, winter finch, matasar, caudated wood owl, white duck, tufted duck, great duck, sonant duck, sword duck, swallow duck, winter tufted duck, polar duck, swan, Siberian lark, etc.

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Circumpolar elements in Rumania are ciocirlia cu moate (Otocorys alpestris), notatita (Phaleropus Hyperboreus), etc.

Alpine elements are: Alpine chitcan and various snails of the Clausilidae, Vestiginine, and Pupillidae families. Some species came into Rumania from the Balkan peninsula (Balkan elements). They are green lizard, Crimean lizard (Lacerta taurica), horned viper, Eryx snake, jackal, spotted polecat, small lemming (Mesocricretus newtoni), etc.

The others have their origin in the Mediterranean subregion in general (Mediterranean elements) -- Italian weasel, Italian squirrel, bearded, bald, and gray eagles, rock partridge, continental tortoise, and especially the Iberian tortoise. Among insets: Calugarita, paunchy cricket, termite, scorpion, centipede lobate spider (Argiope lobata), bulim (Zebrina Varnensis), etc.

Other species had their origin in the steppes of the Asiatic central Pontic subregion, and especially in the Pontic province of this subregion (Pontic elements). These are marmot, steppe polecat, common starling, steppe eagle, great black eagle, and bustard; and reptiles like the desert lizard (Eremias arguta deserti) in the sands of the Danube delta, and various species of locusts and insects.

We mention Dacian elements, those endemic species or subspecies which exist in Rumania only in certain small geographic areas, and which do not have a general distribution. For example, the gopher of the Balkan peninsula (Spalax monticola) gave rise in Dobrogea to a local form (subspecies transylvanicus); a Caucasian species, penetrating the low Danubian plain, gave rise to an endemic species Spalax istricus.

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The physical and geographic conditions in Rumania had a modifying effect upon many species from outside. This was true in the case of the horned viper (Vipera ammodytes) from the Balkan peninsula, which penetrated Dobrogea and gave rise to a local form (subspecies) montandoni) also the Iberian tortoise (Testudo ibera)which produced a new form on the delta in Dobrogea (dobrogicus), the bittern (Bombinator ignaceus) also produced a new form (danubialis) on the Rumanian Plain, etc. A large number of endemic elements are being formed from species of snails in Rumania.

All these endemic animal species constitute the Dacian fauna and characterize the Dacian fauna province.

(b) Zoogeographic Zoning.

According to fauna relationships, Rumania can be divided, as in the case of flora, into seven fauna provinces characterized by geologic past, present climatic conditions, and in relation to the latter, fauna, as distinguished from neighboring provinces, and characteristic or endemic species, such as certain animal associations lacking in the other provinces.

These zoo-geographic provinces, as in the case of flora, are as follows:

1. Dacian province, characterized by a forest fauna, formed of central European elements (squirrel, deer, roe, bear, lynx, wildcat, marten, heathcock, hazel hen, common viper, mountain lizard, etc), as well as numerous Dacian endemic elements (Miorotus ulpius, Pitymis dacius, Vitrea transylvanica, etc).

2. Dacian-Alpine province, characterized by Alpine meadow fauna and junipers, consisting of glacial relicts originating in the arctic tundra or the Alps, to which was added many endemisms peculiar

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to our Alpine peaks, showing phylogenetic connections either with the polar tundra or the Alps, such as the dwarf mouse (Microtus ulpius), a variant form of the species Microtus nivalis of the Alps.

3. Pontic province is characterized by a Pontic steppe fauna (with many Pontic elements such as the steppe polecat), to which are added some endemisms peculiar to the plains (Spalx istricus, etc).

4. Sarmatian province presents a mixture of steppe and forest fauna, originating in part from the north of the Ukrainian SSR, still insufficiently studied.

5. Pannonian province, characterized by a Pannonian steppe fauna with many Pannonian elements (Spalax hungaricus, etc), and some Pontic elements (steppe polecat, bustard, etc).

6. Banat-Oltenian province, rich in Mediterranean elements, in great part without modification, such as the tortoise, common horned viper, scorpion (with a curved island in the Subcarpathians), the snail Campylea trizona, etc, and others which are modified (mollusks such as Acmebanatica, Helix, Pomatia banatica, etc).

7. Dobrogean province, with many east Balkan and east Mediterranean elements, unmodified or modified, in Dobrogea such as: Iberian tortoise, Dobrogean horned viper, (Viper ammodytes montandoni), buid, Eryx jaculus turcicus, the snail Zebrina varnensis, etc.

3. Aquatic Fauna

a. Fauna of the River Meadows and Riverside Groves

The animals that live in the river meadows and groves alongside flowing and stationery bodies of waters of the RPR are related in their mode of existence to the preceding ones. They spend their lives on the soil of the riverside groves or on the floating vegetation, or in the tree branches seeking food, especially on the edges of the bodies of water.

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In the river meadows and riverside groves there are wolves and foxes, wild boars, hares, and occasional roebucks. On the banks of the streams otters and minks live, feeding on fish.

Among the branches, crowns, and hollows of the trees and on the soil of the riverside groves live various fen lake birds, especially daytime predators like the osprey, the white bold eagle, the whitetailed eage, etc also feeding on fish, as well as many cormorants and various species of stork, berze, etc, feeding on fen lake animals.

(b) Fauna of Flowing Waters

According to their physical, geographical, and hydrological characteristics, the Rumanian streams are those which flow from the mountains (example, the Cerna), from the hills (example, the Cotmeana), and from the plains (example, Calmatui), the great streams that arise in the Carpathians and flow into the Danube present along their courses the hydrographic conditions of the faces of the mountains, hills, and plains.

In mountain streams and rivers, with clear and cold water (under +14°), with slight temperature differences between winter and summer (7 - 8°), rapid flow, and rich in oxygen to the point of saturations (6 - 7 cm^3) the Salmonidae live, psychrostenothermal and oxyphilous fish; i.e. the trout lives in the uppermost part of the mountain waters, in association with several small [one word illegible] such as the boisteen, bullhead, and, more rarely, the loach, and lower down the grayling and the salmon (rare).

The Salmonidae are carnivorous and very voracious fish, feeding on animal food consisting of the smaller fauna of mountain waters (larvae and nymphae of Ephemera, Plecoptera, and Diptera, some Hydrocharians, free nematodes, small crustaceans, many Daphnia and cyclops

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Ephemerae which skim the surface of the water, etc) or even boisteni, which are herbivorous fish, all of which feed on plankton. The latter is composed of microscopic algae and diatoms that cover the rocks at the bottom of these waters like a soft moss, called the "bioderma."

In hill rivers, where the gradient is lower, the rate of flow of the waters slackens, the water is clear and increasingly warm, and the temperature variations are greater (a difference of 18-19° between winter and summer), so that the surface may freeze in winter. The amount of oxygen dissolved in the water is still quite great (5 cu cm), the water level is more stable, and reversals of flow are more rate. Aquatic vegetation becomes increasingly abundant.

The characteristic fish is the barbel, which lives in association with the gudgeon, especially along the osiers and trees fallen in the water, the bream, beldita, roach, loach, eel, pietrar, and hadina.

In the higher region, the passage to the upper zone of the grayling is made by the loach, and to the lower zone by the burbot. In spring the bream ascends the rivers to deposit its eggs and descends to the valley in autumn. Often the salmon, and especially the grayling, descend to the hill stream area, and the pike goes upstream to deposit its eggs.

In the plains rivers, the gradient being very low, the flow of the water is greatly retarded. Much fine alluvium is carried in suspension, making the water turbid. The effect of the seasons is very strong. In summer, in the animals' active season the water is warm (20 -25°C), and consequently oxygen is low. In winter the surfaces of these streams are frozen, although their water is very eurythermic and shows great variations in temperature at the surface

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(20 - 22° C) -- while at the bottom it remains constant (4 - 5° C). On the banks there is a swampy aquatic vegetation, offering herbivorous aquatic animals and adequate supply of food. Fermenting in the warm season, it also contributes to lowering the oxygen content.

During the spring floods the water level rises and backs up to a considerable extent, covering the major bed and driving the various aquatic fauna into the flood zone and through the streams into the fen lakes.

In these waters are the Cyprinidae, enrythermic and herbivorous fish, which in order to live need calm and warm water in summer (at least +10° C) and vegetation food from the clay and sand bottoms and from the back waters onto the flood area and into the fen lakes.

The characteristic fish is the carp, which lives in the upper part of the plains streams in association with the whitefish, and in the lower part, in lakes full of abundant aquatic vegetation, with crucian carp, perch, and pike, and on the muddy bottoms, rich in larvae, viermisori, and molluscs, with the eel, tench, and sheatfish.

(c) Danube Fauna

The Danube and the fen lakes in its flood area form an organic whole by virtue of the complementary conditions of life they offer organisms.

The gradient of the river is low (over a distance of 1,000 km it drops 70 m) and the flow is sluggish. The water is very turbid (1.225 kg per cu m of water). The discharge is subject to great periodic increases (rising from 2,000 cu m /sec to 35,000 cu m in spring) making the water level rise considerably (6 - 8 m over the low water mark) and causing the water to overflow the banks onto the

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flood area. As the waters recede, the aquatic organisms transported by the floods remain either in the large and permanent fen lakes of the river, or on the flood area around them, or in the shallow pools which dry up in summer or freeze solid in winter.

Most of the fish in the Danube and its fen lakes also exist in the lower tributaries, i.e. carp, crucian carp, whitefish, bream, pike perch, eel ruff, perch, tench, sheatfish (up to 300 kg), bleak, avat, roach, rosioara, gudgeon, pike, and sometimes the barbel.

Besides these fresh water fish representatives of two families of marine fish come up the Danube to lay their eggs: the Clupeidae and Acipenseridae (Sturioni). Thus, for example, in spring the Clupideae come up the Danube in the form of the mackerel and rizeafca, which abound in the maritime Danube, often advancing as far as Giurgiu and even as far as the Iron Gate, but without going up the tributaries; the mackerel and sardeluta, the former also going into the Balta Brailei and the latter advancing to around Calarasi, and both lacking in the Danube tributaries; and the gingirica, common on the delta in spring.

The Acipenseridae also enter the Danube in spring -- the viza, which goes into the mouths of the tributaries but not in their fen lakes; the sturgeon, which does not occur in the fen lakes of the Danube and enters mouths of tributaries only rarely; the sip, rare in the Danube and totally lacking in the tributaries; the white sturgeon, only in the fresh waters of the sea off the mouth of the Danube. An exclusively fluvial Acipenserida is the sterlet, characteristic of the Danube. In the Danube fen lakes, the dominant and characteristic fish is the pike perch, since the Clupeidae and Sturioni, more numerous in the maritime Danube, are characteristic of that part of the river.

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(d) Fauna of Standing Waters

The fen lakes in the flood area of the Danube are closely connected with the life of the river. The surplus water from the Danube flows in here during the spring floods. This water flows back into the river when the Danube begins to fall, being at the same time the most secure refuge of many species of river animals while the Danube water is very full of alluvia. These fen lakes are also places of reproduction and growth of the young of most Danube animals and especially the fish. With their clear water, shallow bottoms rich in food, abundant vegetation and large areas of open water easily warmed by the sun, the Danube fen lakes offer optimum conditions not only for hatching eggs but also for the growth of larvae and fry. The abundance of fish in the Danube is due precisely to the fen lakes in the flood area in which they hatch feed, and grow, the Danube being only a reservoir to which they return in autumn to winter in deep water and to escape the danger of the freezing in the fen lakes.

The animals that remain in the pools and fen lakes in the floor area of the Danube are subject to climatic variations and have various means of defending themselves against drought (Anhydrobiosis) or freezes. Most of them have various means of resistance. Some species can hibernate for some time, such as the crucian carp and the eel, which bury themselves in the mud of the fen lakes when the water begins to dry up, or in the mud of quite dry pools, at the bottoms of which they can live in great numbers. Digging to a depth of 30 cm in the dry bottoms, there can be found at this depth in the moist mud eels, tench, crucian carp, fen snails, fen mussels, leeches, etc, all creatures which multiply in moisture and live in mud and can by reducing their vital activity to a minimum last very well in a latent state until the next flood.

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The permanent fen lakes of the Danube flood area have an abundant and varied fauna.

The floating vegetation offers shelter and food to many aquatic animals, and especially fen lake birds, which take refuge here, feed, and hatch their eggs in peace (storks, spoonbills, ibises, wild ducks and geese, white and red wild ducks, swans and pelicans, coots, land rails, gray fen hens, etc.)

In the reeds on the edges of the fen lakes live water snakes, fen tortoises, tritons, and fen bitterns; some species of fish lay their eggs here, such as the pike, and foxes, wolves, and wild boars live here, which are also to be found further out on the floating vegetation.

The floating vegetation interferes with the uniform heating of the fen lakes and, consequently adequate oxygenation of the water, thus creating conditions unfavorable to fish life under the floating vegetation.

The submerged vegetation, under the surface of the water, forms abundant aquatic pasturage, in which the fen animals take refuge during summer droughts. Many fish deposit their eggs in this pasture, as the perch does in the brush, and the whitefish among the frogs. On the bottom live dragonfly larvae, while the adults of these insects perch attractively upon the above-water stems of hygrophilous plants, like the blue dragonfly; among the roots on the bottom live Phryganeidae, defended by the protective roots; fen snails (Planorbis, Limnaea) climb on the stems of the reeds from the bottom to the surface of the fen lakes; on submerged plants and the part of the reeds below water live the adhesive Bryzoans and fresh water sponges; here swim fish, frogs, tritons, leeches, free

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nematodes, and various fen insects; and in the brush, as also among the remains of vegetation fallen in the fen lakes are planari, leeches, and small crustaceans such as Asellus and Gammarus. Also among the submerged plants and on the bottom live fen snails, while mussels remain in the mud. The larvae of many aquatic insects also live on the muddy bottoms (dragonflies, Ephemerae, mosquitos, etc). Crayfish live on the edges of the fen lakes, in holes and under roots. The zooplankton in the middle of the fen lakes is formed of various protozoa, rotiferae, and especially microscopic crustaceans and hydracharians.

The fish in the fen lakes of the flood area of the Danube are the same as in the Danube except for the Clupeidae and Acipenseridae, outside of a few species which also enter the fen lakes.

Interior fen lakes are those in the interior of the country connected with the flood areas of the Danube tributaries or the steppe fen lakes and are more or less saline.

The former, regardless of whether they are river estuaries or not, or whether they are sluggishly flowing waters, these fen lakes (examples, Colentina, Pasarea, etc) have the same fauna as the lakes on the flood plain of the Danube, more limited and characterized by lack of fish of the Clupeidae and Accipenseridae.

Since they are waters with a muddy substratum, mud fish predominate such as the eel, tench, and sheatfish, which live in association with the perch, ruff, rosioara, roach, ide, etc.

As for the saline steppe fen lakes, their fauna varies with the degree of salinity, being more saline the more saline the water is. In such fen lakes fish are generally lacking, the fauna being represented by species of small saline animals, including the small stenohaline crustacean Artemia saline.

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(e) The Littoral Lakes (Maritime)

The littoral lakes have a fauna composed of three classes of elements: fresh water elements, capable of supporting a certain amount of salinity. marine elements, those that exist in the shore area of the sea but very enryhaline: and Sarmatian relicts, survivors of Tertiary marine fauna which populate the Aral-Caspian basin (Aralo-Ponto-Caspian).

All three categories of elements composing the fauna of the littoral lakes can be found in association in these lakes in the transitional area between the marine and fresh water. The lower the saline content of the water is, the more prevalent the Sarmatian relicts are, and conversely, the higher the saline content the more prevalent the recent marine forms are. and when it is equal to or higher than that of the sea only purely marine species live there.

At the boundary between fresh waters and slightly brackish waters live fresh-water elements like fen and river mussels, as well as the leptodactylous crab. Where there is low salinity live Bryozoans fen snails, fen sponges, and fish like the roach, common pike perch, striped pike perch. and even sturgeons.

The marine elements, of recent Mediterranean origin, which occur in both slightly saline and highly saline waters are some marine crustaceans, including the balan and the shrimp; some marine mollusks, as the Cardium. etc, worms like the Nereis, fish like the aterina. gray mullet, hornback, etc.

Sarmatian relicts are the Cordylophore polyp, the Dreisensia mussel, Thaumantias medusa, Limnocardiidae (Monodacna, Adacna) molluscs, some sedentary polychaetae (Hypania, Hypaniola, Parhypania, etc, and some fish (Benthophilus bullhead, lophobranchiate Syngmathus or ac de mare, etc.

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While the various fauna elements prevail in the various littoral lakes according to their degree of salinity, there are cases in which a variation of fauna occurs within the same lake according to varying salinity. Thus, in Lake Razelm, the salinity increases from north to south, so that fresh water elements predominate in the north, brackish water types prevail in the middle. especially Sarmatian relicts, and further south, in Lake Sinoe. there are prevalent marine elements, and Lake Caranasuf (salinity 35.4%) and especially Lake Duingi (salinity 58.7%) there is a supersaturated water fauna (Cardium, Gammarcus, Crangon, Nereis, etc), which die in dry years in the high salinity, being replaced by Artemia and Chironomus larvae.

In Lake Techirghiol the salinity is so high (70%) that no higher fauna can exist in it today, fish and mollusks being replaced by high saline fauna consisting of some protozoa, small species of worms, turbellaria, rotiferae, and annelida, a few species of small crustaceans such as Artemia, Cypris, Gammarus, etc. some Diptera larvae as Ephydra, Erystalis, Cheironomus, and Stratiomys, devoid of any economic significance.

(f) The Problem of Restocking Rumanian Waters

Many of the Rumanian bodies of water were depopulated of fish during the bourgeois landowner regime, due to the following causes: chemical pollution which brought various harmful substances in the stream beds from industrial wastes (sawdust from sawmills, coal dust from washing coal, chemicals, and especially acids, etc), intensive and irrational fishing without regard to season and by prohibited methods (mislad, burdock, dynamite, trotline, lime, etc), deforestation of valley slopes, etc.

Those streams in which the fish were for the most part exterminated by the above-mentioned methods can be restocked in two ways:

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naturally, by halting fishing for a given period, or artificially with fertilized eggs or fry from hatcheries.

The Rumanian people's democratic regime has made great progress in this field, both in establishing salmon hatcheries and restocking the mountain streams and in restocking the other bodies of water of the RPR with fish of great economic value. For example, at Enisala (Constanta region) a pike perch culture station has been established, from which many fen lakes have been stocked and restocked with pike perch: Uslina (in the Danube delta), Morughiol and Jirlau (Galati region), Obilesti, Sindrilita Mare, Sticleanu, and Greaca (Bucurestic region), as well as some hatching ponds at Nucet (Ploesti region), Cefa (Oradea region), Cil and Ineu (Arad region) stations, and ponds, as for example those on the "Path of Lenin" collective farm in the town of Livedea (Bucuresti region) and the Gh. Doja collective farm in the town of Viile Dejului (Cluj region).

Pisciculture stations have also been established, where varieties of selected carp (Galiti and Lusite types) are grown. From this station various rivers and fen lakes have been stocked: Jirlau (Galati region), Sindrilita Mare, Boneasa, Floreasca, Baranga and Balariea (Bucuresti region), Ziduri (Ploesti region), Oltina (Constanta region); the Mures, Olt, Cibin, and Bega.

On the initiative of the people's councils many ponds have been built as: at Sulita-Dracsani and Sarata (Suceava region), in Sipote and Trifesti communes (Iasi region), and Tunari (Bucuresti region).

When as many pisciculture stations as possible have been created and our waters stocked with fish, Rumania will become one of the most important producers of fresh-water fish, since the physical, geographical, and hydrobiological conditions in our waters are very favorable to the development of this important production branch.

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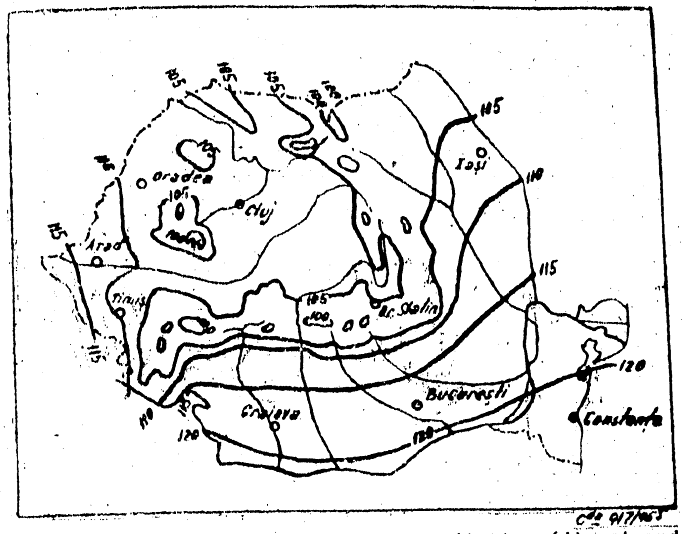

Figure 1. Mean annual intensity of total solar radiation (direct and diffused) in cal/cm^2.

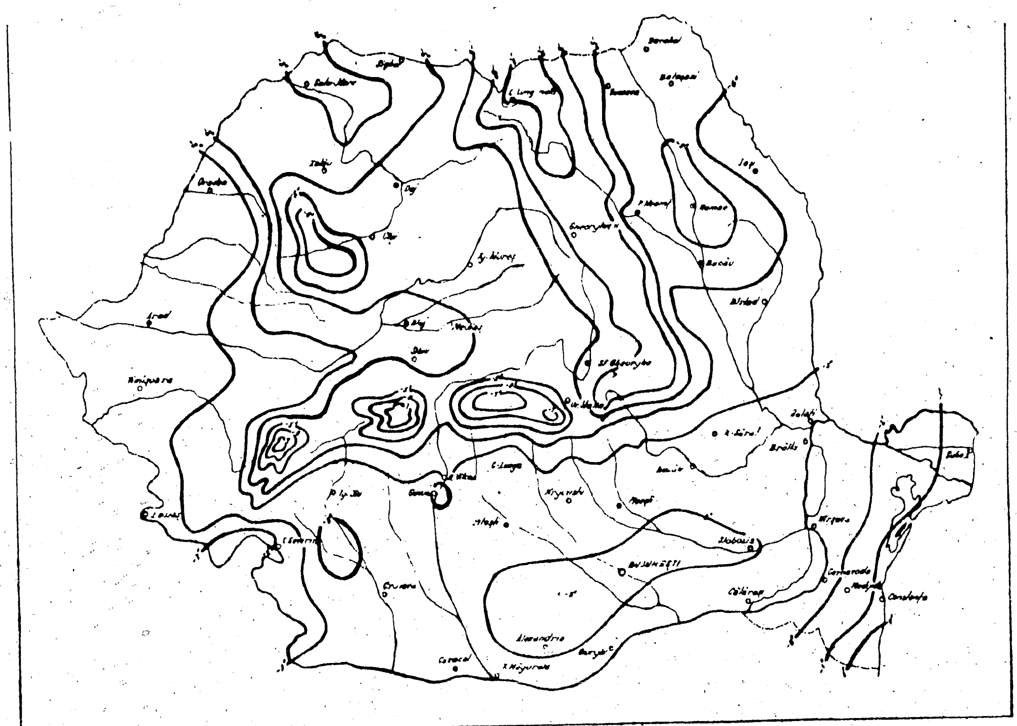

Figure 2. Isotherms for January ($^{\circ}$ C).

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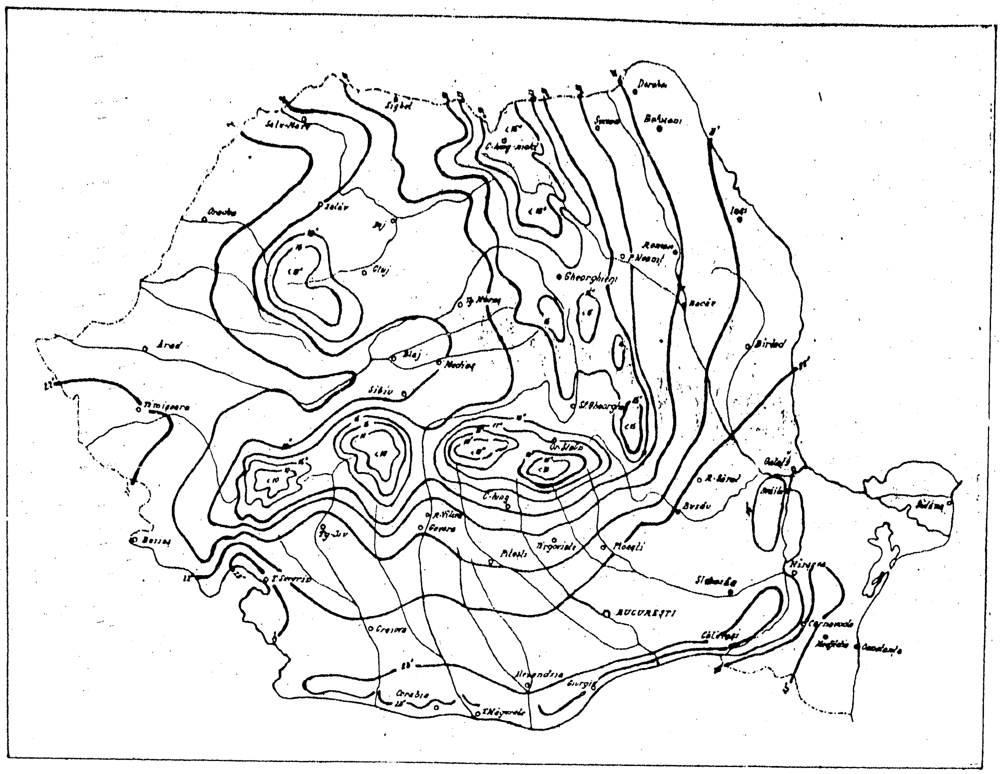

Figure 3. Isotherms for July ($^{\circ}$ C).

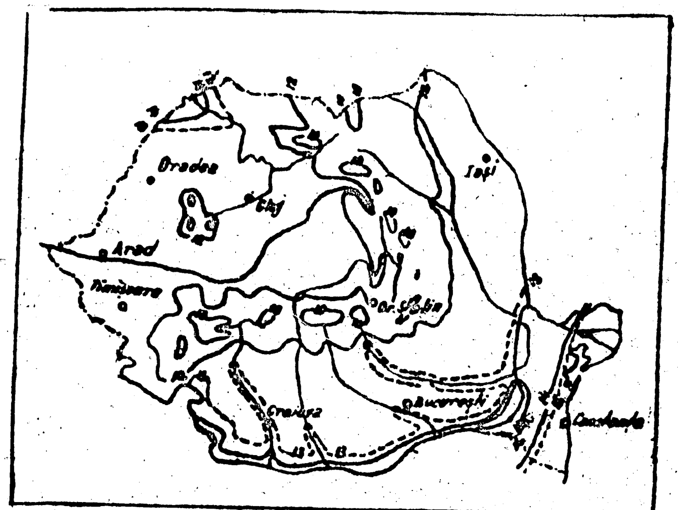

Figure 4. Mean absolute humidity in July g H_2O/m^3 of humid air).

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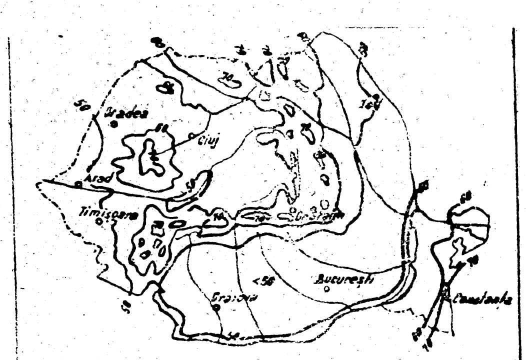

Figure 5. Mean relative humidity in July at 1400 hours (%).

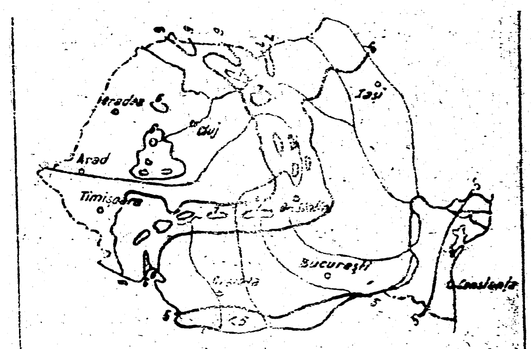

Figure 6. Degree of overcast. Mean annual values (o 10/10).

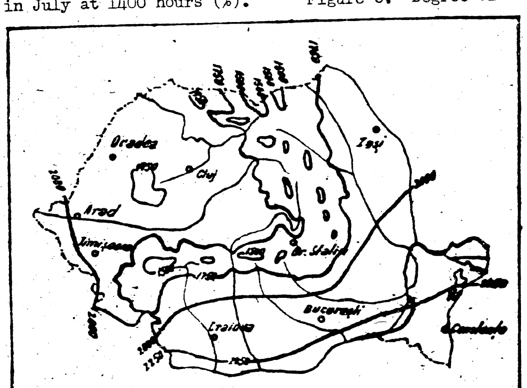

Figure 7. Mean annual duration of sunshine (in hours).

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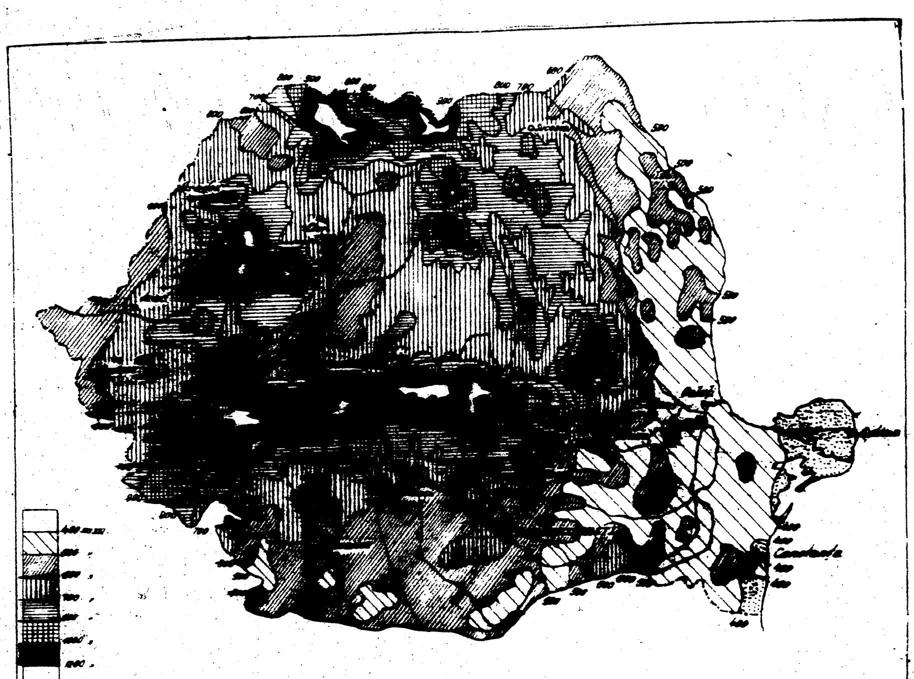

Figure 8. Distribution of mean annual quantities of precipitation (mm or H_2O/m^2).

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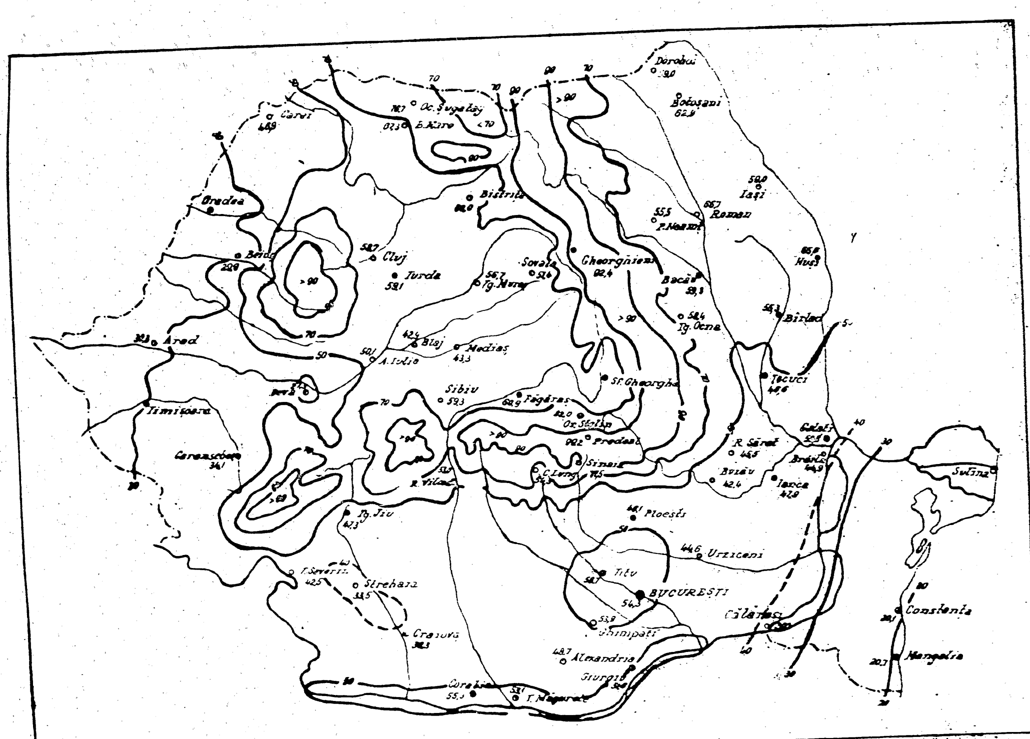

Figure 9. Mean annual duration of the snow cover in days (1926-1940).

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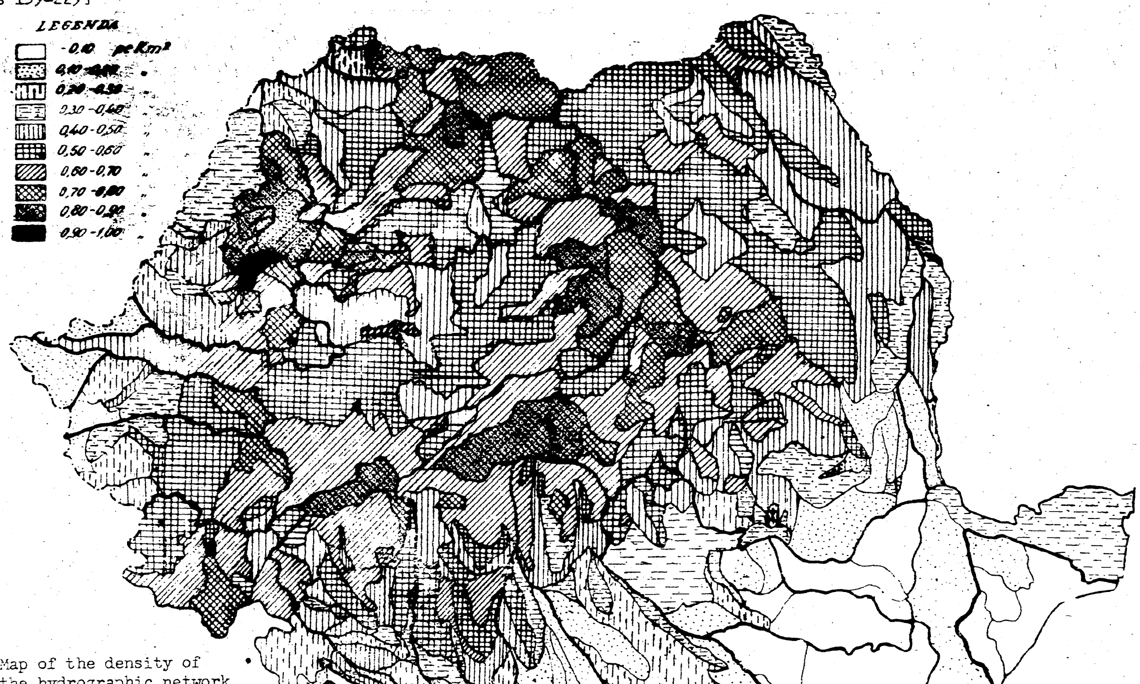

Map of the density of the hydrographic network of the RPR in basins of types III and IV.

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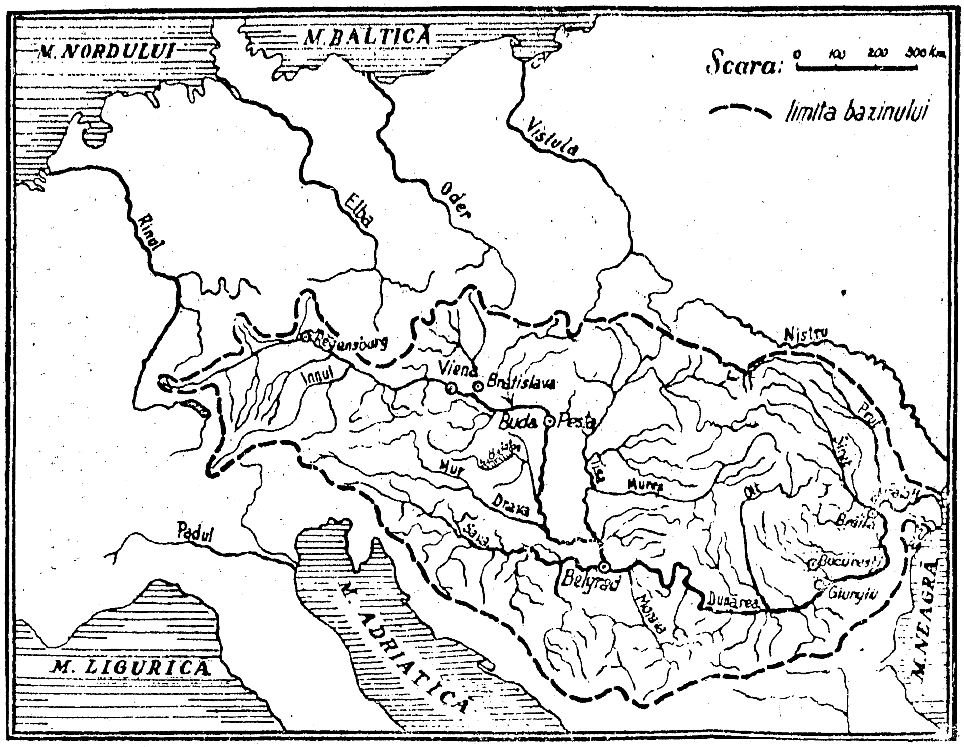
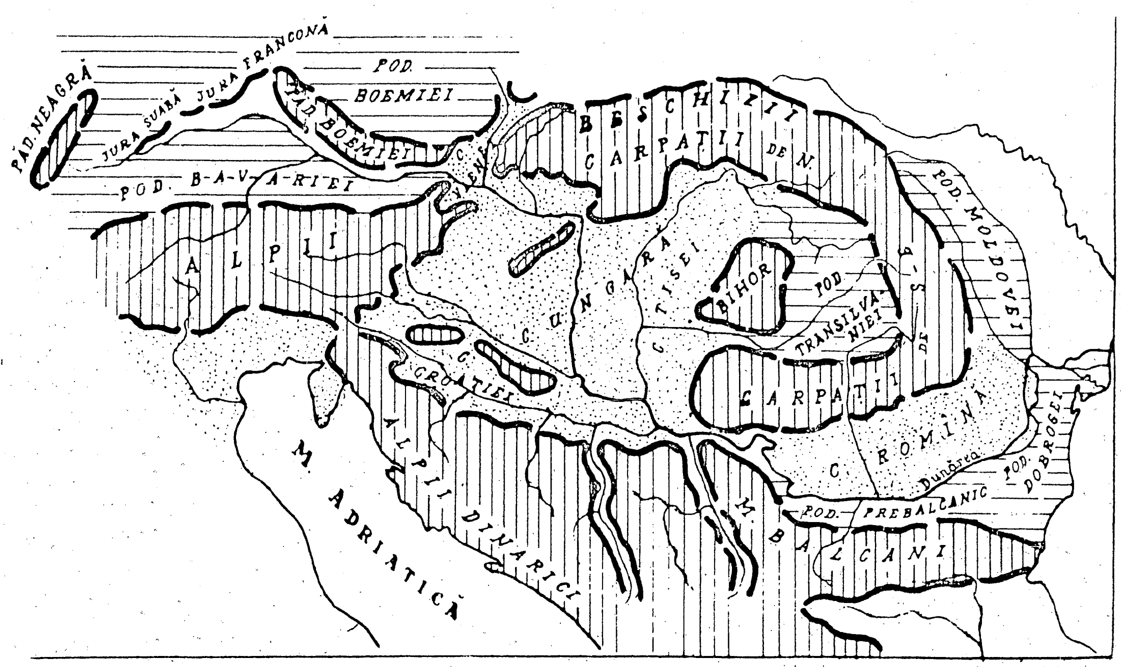


Hydrographic basin of the Danube (after C. Giurcaneanu). Scale: limit of basin.



Large morphological units in the Danube basin (after I. Giurcaneanu).

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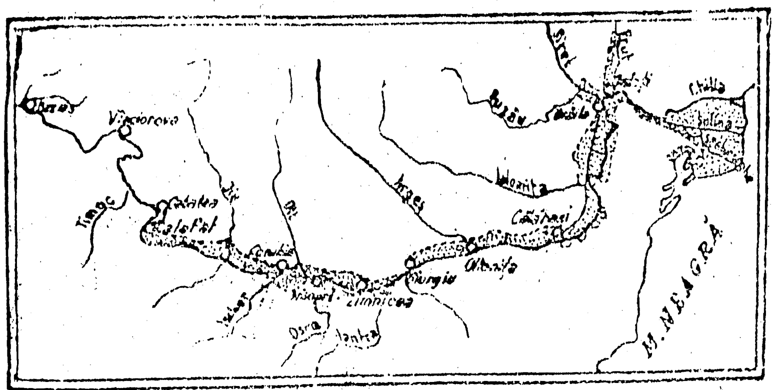

Figure 5. Flood plain of the Danube (after Gh. Vidrascu).

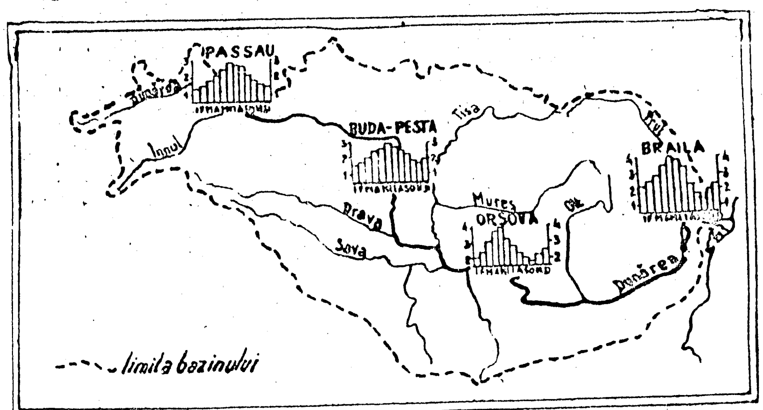

Figure 6. Cartodiagram of the Danube River system (diagrams of the mean levels above the low-water mark) (after A. Penck and E. de Martonne). [Within figure]: limit of the basin.

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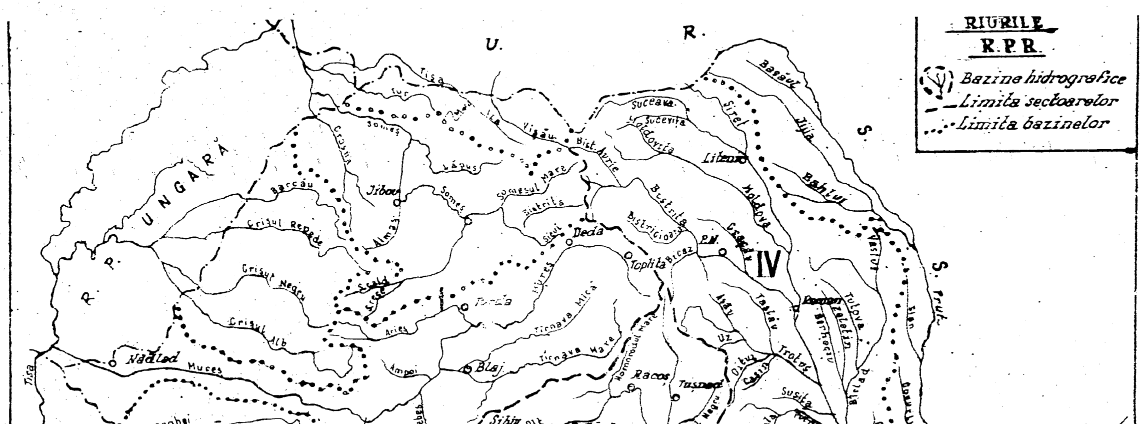

Rivers of the RPR
Hydrographic basins
Limit of sectors
Limit of basins

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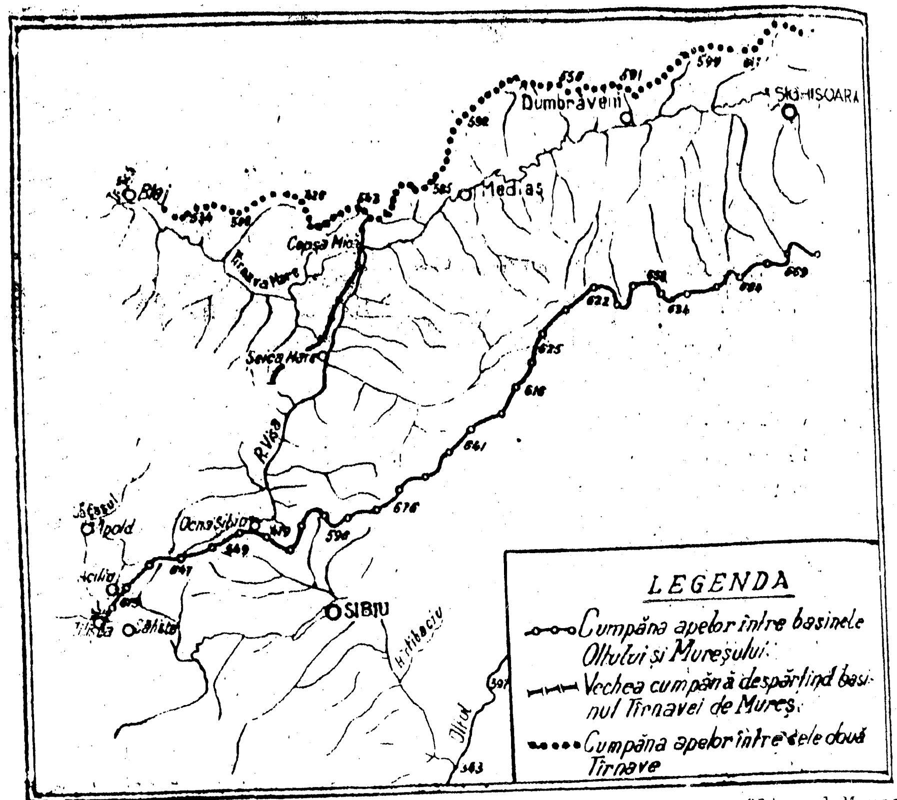

Figure 8. Morphological relationships at the meeting of the Olt and Mures basins (after J. Rodeanu). Legend: Watershed between the Olt and Mures basins; Old watershed separating the Tirnava from the Mures basins; Watershed between the two Tirnava Rivers.

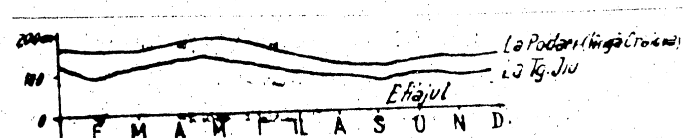

Figure 9. Mean monthly variation for July in the period 1924-1928. There are two increases in spring and autumn as well as the minimum in September (after V. Mihailescu). [within figure] at Podari (along Craiova); at Targul Jiu; low-water mark.

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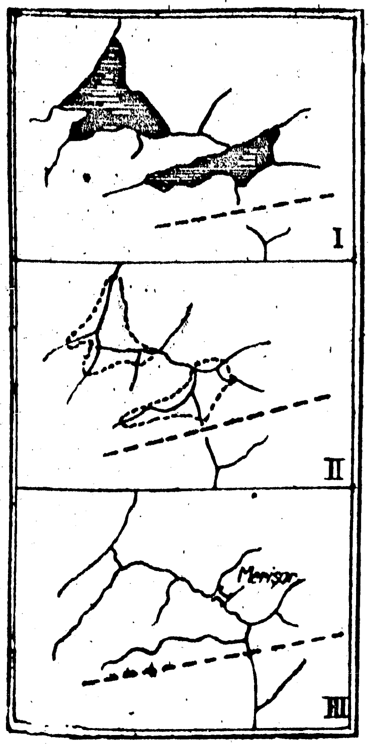

Figure 10. Evolution of the hydrographic network and the frontal diversion of the Jiu (after G. Vilsan).

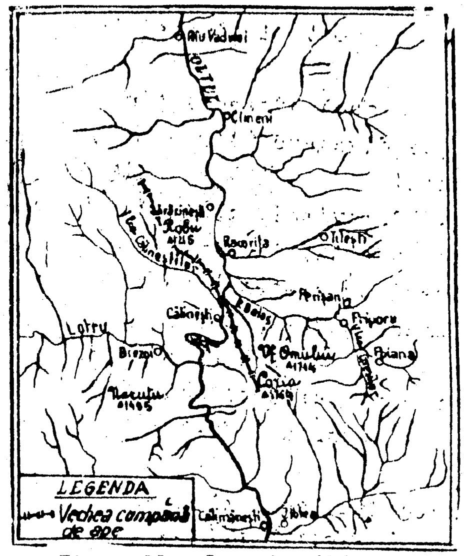

Figure 11. Legend: Old watershed.

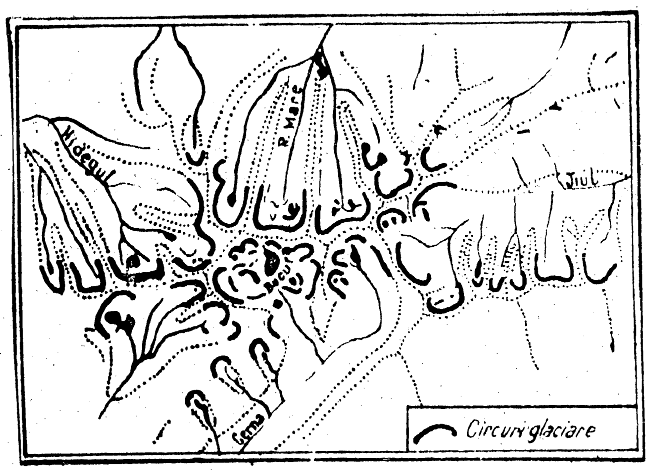

Figure 12. Glacial lakes in the Retezat massif (after Th. Krautner). [within figure] glacial cirques.

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Figure 13. Chains of ponds along rivers in the Jijia depression of the Moldavian plateau (after I. Rick).

Figure 14. Salt and bitter lakes (left of the Danube).

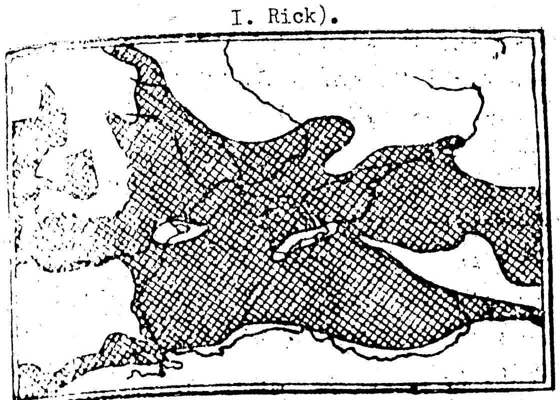

Figure 15. The Black Sea basin in Sarmatian milieu (after M. V. Muratov).

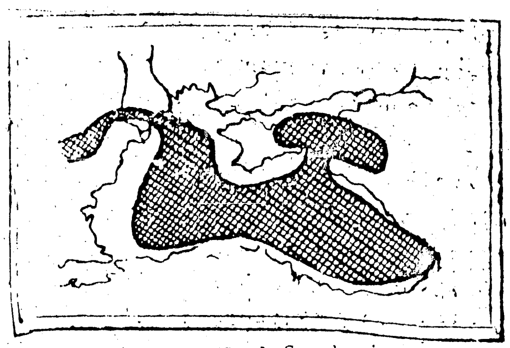

Figure 16. The Black Sea basin in the upper Pontian (after A. G. Eberzin).

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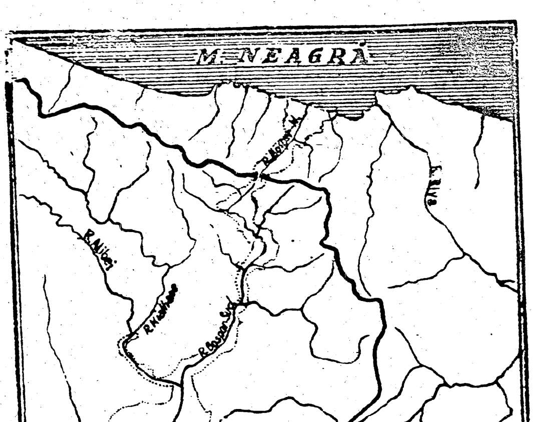

Figure 17. Hydrographic network in the Bosporus area in the Lacustrine period before the passage was cut by the watershed. The watershed separating the Black Sea basin from Lake Marmora (after C. Bratescu).

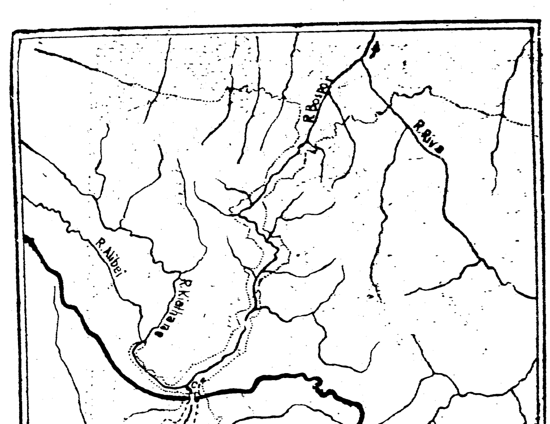

Figure 18. Hydrographic network in the Bosporus area in Wurm II. The shelf is furrowed by river valleys which are now submerged. The watershed at the passage between Istambul and Scutari. The future seashores in Alluvium. Approximate shoreline of the Sea of Marmora in Wurm I. The probable diversion of the river from the Golden Horn to Marmora at the end of Wurm II (after C. Bratescu).

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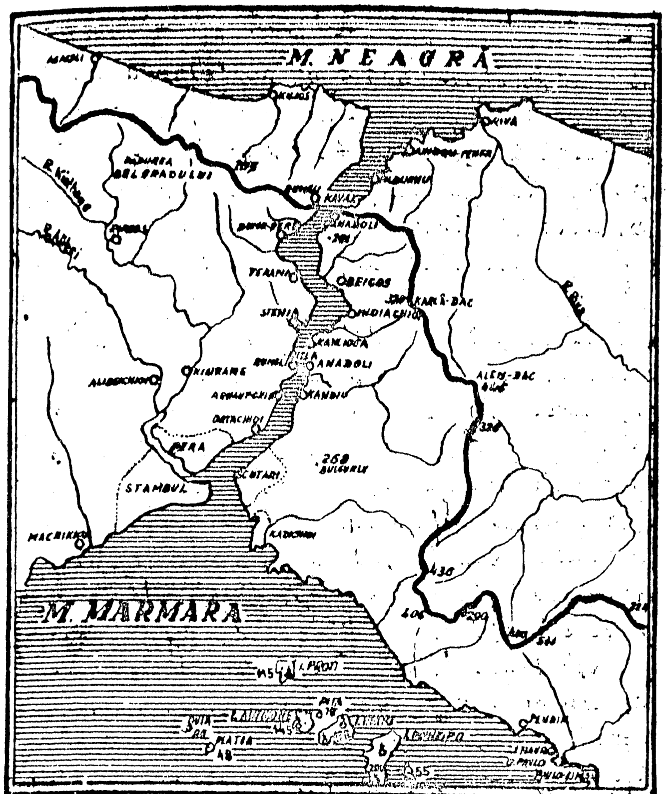

Figure 19. The Bosporus and the hydrographic network at present (after C. Bratescu).

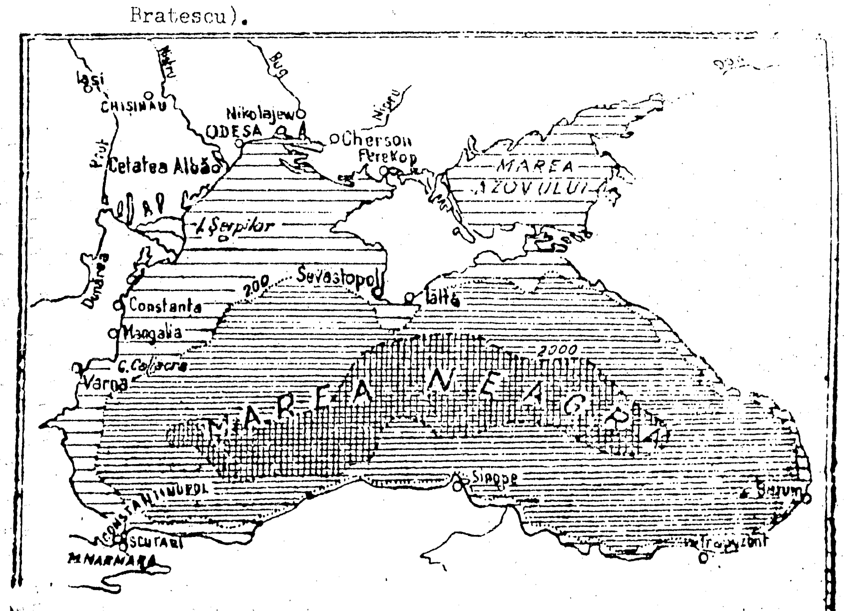

Figure 20. Balck Sea depths.

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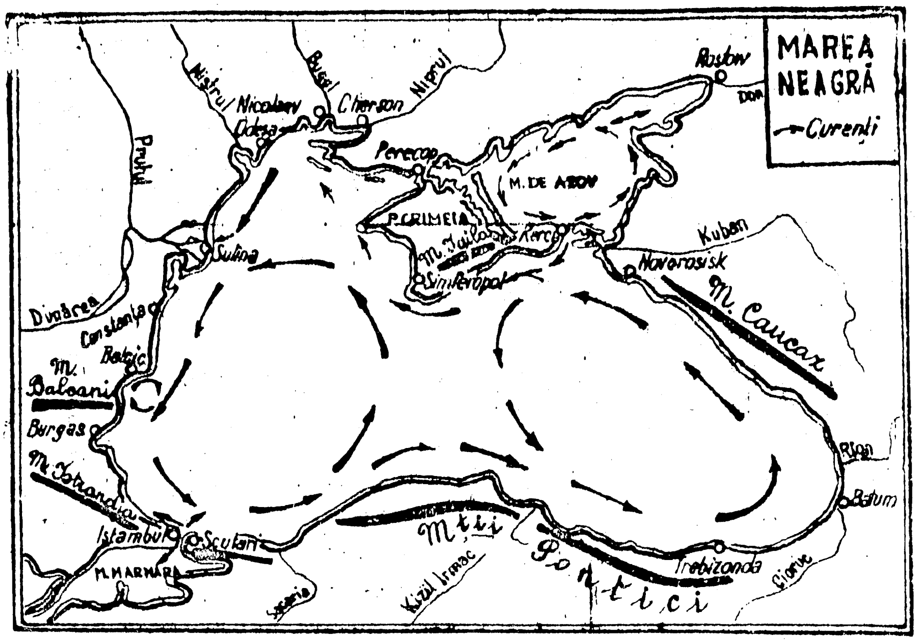

Figure 21. The Black Sea. [within figure] currents.

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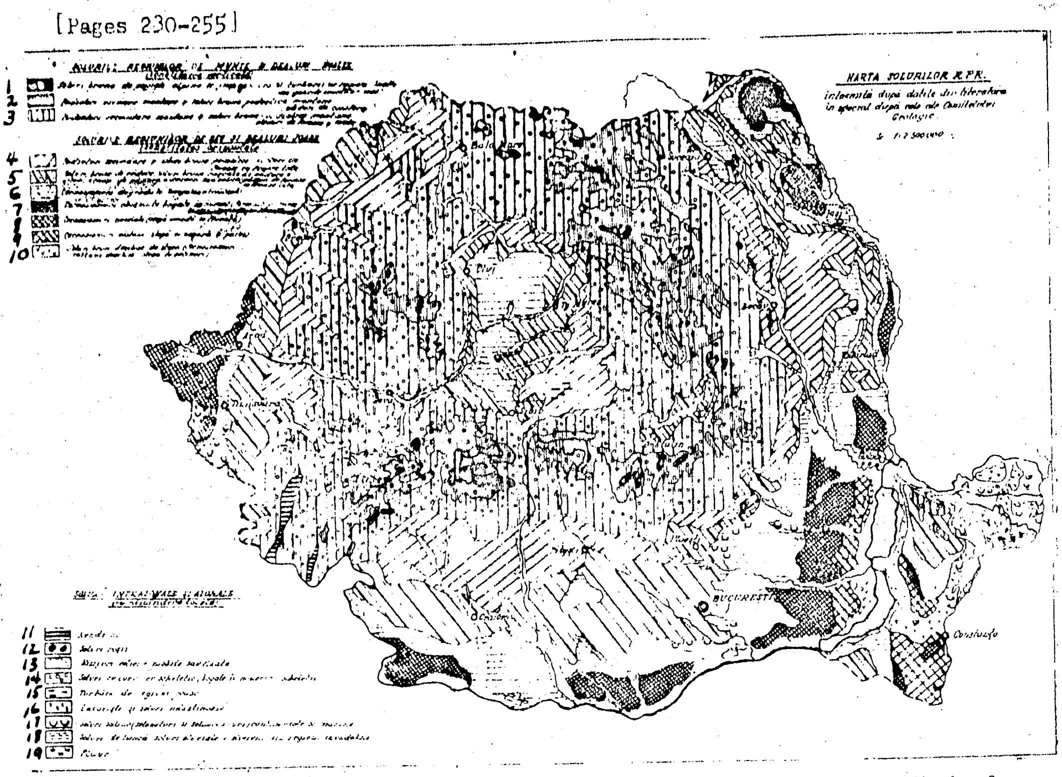

Soil Map of the RPR according to data in the literature, especially that of the Geological Committee. Scale: 1:2,500,000.

Soils of high hill and mountain areas (Vertical zonality): 1, Brown soils of alpine meadows, juniper forests, and peat bogs of high regions (on high mountain barrens); 2, Mountain primary subsoils and mountain podzolic brown soils (coniferous forests); 3, Mountain secondary subsoils and mountain podzolic brown soils (deciduous and mixed forests).

Soils of low hill and plain areas (horizontal zonality): 4, Secondary subsoils and podzolic brown soils (deciduous broadleaved forests); 5, Forest brown soils, reddish-brown soils of forests and gray soils of forests, often podzolic (deciduous broadleaved forests); 6, Degraded chernozems (levigated) (forest-steppe); 7, Common chernozems rich in humus (formed on [several words illegible]; 8, Chocolate chernozems (humid steppe with [word illegible]; 9, Chestnut chernozems (steppe with feather grass and Deschampsia); 10, Steppe light brown soils (light chestnut chernozems) (steppe with wormwood).

Intrazonal and azonal soils (local distribution): 11, Rendzins; 12, Red soils; 13, Shifting or stable eolian sands; 14, Skeletal soils (rich in skeletal material); 15, Low area peat bogs; 16, Lake and swamp soils; 17, Saline soils (solonetzes and solonchaks), continental and marine; 18, River meadow soils (alluvial soils and alluvia in flood areas); 19, Floating vegetation.

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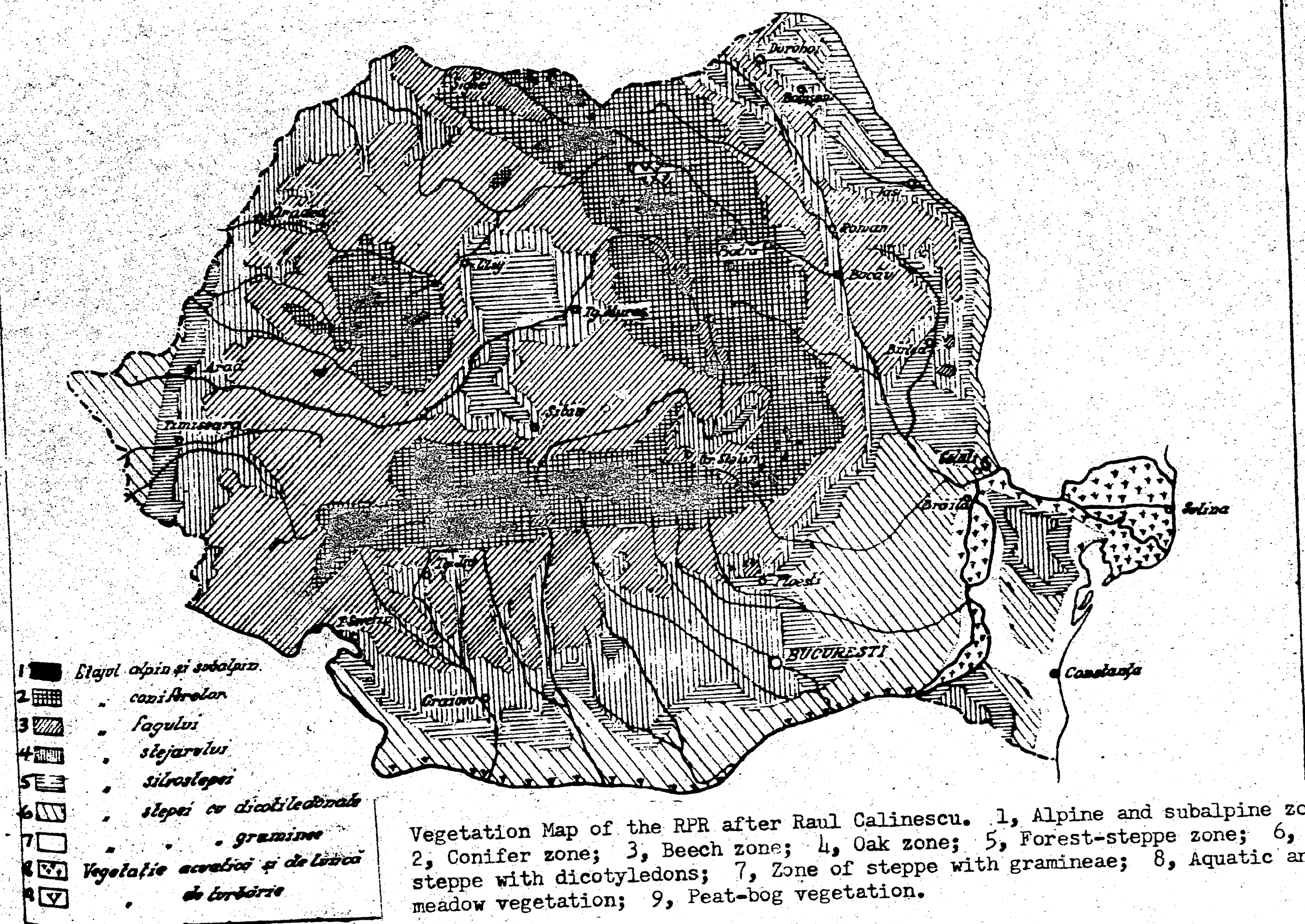

Vegetation Map of the RPR after Raul Calinescu. 1, Alpine and subalpine zone; 2, Conifer zone; 3, Beech zone; 4, Oak zone; 5, Forest-steppe zone; 6, zone of steppe with dicotyledons; 7, Zone of steppe with gramineae; 8, Aquatic and river-meadow vegetation; 9, Peat-bog vegetation.

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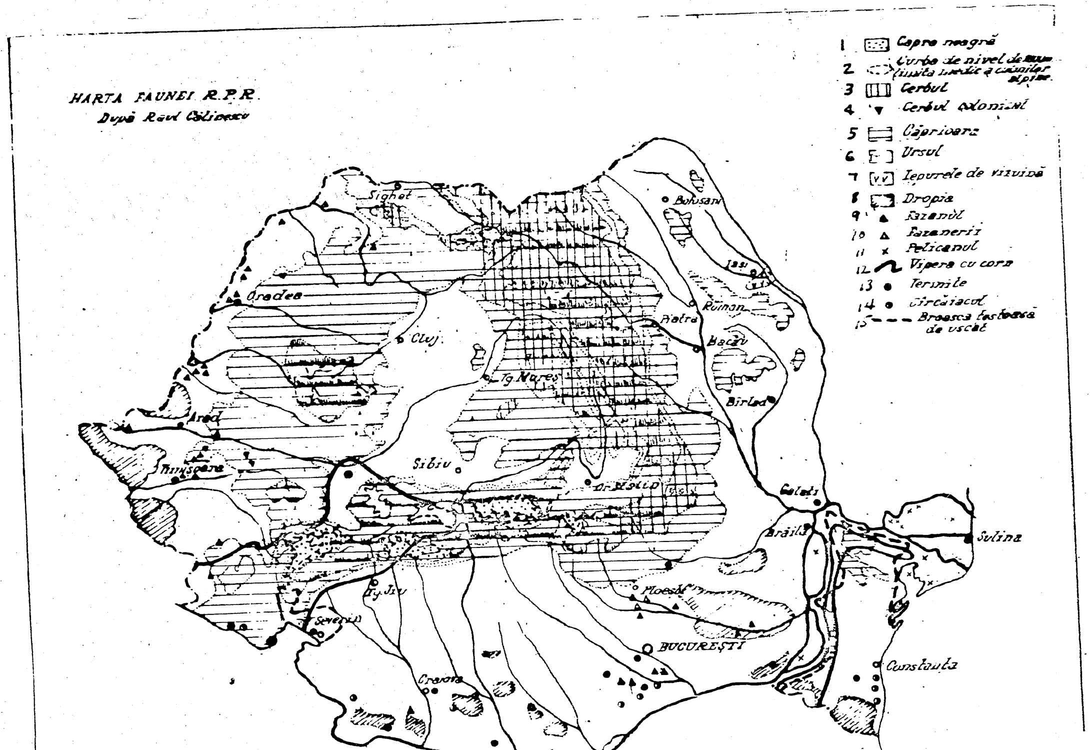

Map of the Fauna of the RPR after Raul Calinescu. 1, Black goat; 2, 1,800-m line, average limit of alpine peaks; 3, deer; 4, domestic deer; 5, roebuck; 6, bear; 7, hare [word illegible]; 8, bustard; 9, phesant; 11, pelican; 12, horned viper; 13, termites; 14, centipede; 15, continental tortoise.

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