The Altitudinal Variations of the Main Climatic Elements in Romania and Their Pretability for Performances – Case Study: the Southern Carpathians

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Introduction

Trainings at altitude play an important role in obtaining performances in sports. Therefore, our study tries to point out the climatic factors characteristic for the training areas situated in the Southern Carpathians, especially in the Bucegi Mountains. Also, we want to see how they influence the training sessions that take place at higher altitudes.

Since the beginning of the world, man has lived in the middle of nature. His life was dependent on the climatic elements, therefore, his daily activities were organized according to the manifestations of the weather.

The climate, with its elements such as temperature, air humidity, solar radiation, air movements, influences the human physiology, playing an important role in the development of the motric skills. The climatic factors influences both horizontally and vertically the natality, the geographical distribution of the races, the evolution of the society, the ethnic customs, the psychic state, health etc.

The selection and the training of the talented elements is very important in achieving performant results. The specialists in this field have chosen as a selective criterion, among others, the native region of the performers. Investigations were made on different geographical areas, from where the performers came. The effects of the climatic and bioclimatic elements, of the relief, of the vegetation, of the soil and of the social environment on the organisms were studied.

Looking back, we could say that in every historical epoch, the concrete social, historical and geographical conditions have highly influenced the development of the motric skills.

The researches made in different domains have scientifically proved that sportive performance is determined by a multitude of factors.

Among the factors that are responsible for the sportive performance is the geographic environment. This is due to the fact that man's adaptation to the environment, in order to preserve itself and to further develop (N. Margineanu, 1973), is both biophysical and biochemical, not only psycho-social and biophysical.

Man is adapting himself to the relief, but also to the temperature, humidity, pressure etc. We work in a certain way in winter and in another way in summer. If we look at the problem in this way, it is clear that our activities are taking place in a certain way if we live in plain areas and differently if we live at higher altitudes. The variation of the influence of the physical environment it is simultaneously dependent both on the environment's nature and on the individual.

The differences that appear between geographical areas situated at different altitudes can be seen in the group's behavior or in the nutrition or in a certain psychology and philosophy of life.

When naming the factors that are responsible for the sportive performance we must not forget about the altitudinal influence, as it is the one to determine the environmental conditions.

Altitude is one of the factors that contributed to the existence of the Romanian sportive success at the world and Olympic competitions. Due to its features, it compensates what would be offered by modern training conditions.

Our study is generally focused on the Southern Carpathians, but especially on the Bucegi Mountains. The Southern Carpathians, also known as the Transylvanian Alps, have as limits the Danube Defile, the Danube-Cerna Scar and the Moldavia Valley. They dominate to the north the Transylvanian Depression and to the south the Getic Subcarpathians. They are very massive. The highest altitude is the Moldoveanu Peak-2544 m. Their average altitude is of 1200 m.

The Bucegi Mountains are situated in the eastern part of the Southern Carpathians. They are formed of highly individualized and strongly denivelated massifs: Bucegi, Leaota and Piatra Craiului, which dominate with more than 1000 m the surrounding depressions (the Prahova Valley and the Rucar-Bran Scar). Due to their massiveness and their altitude, which frequently surpasses 2000 m, the crossing ridges and the Rucar-Bran Scar have most of what is characteristic to the Southern Carpathians (Valeria Micalevich-Velcea, 1961).

The sportsmen that participate in those events with a aerobian-anaerobian predominance, have their general physical training mostly at high altitudes. Training at high altitudes is a sine qua non condition for success. Due to the spreading of this new training method, at various altitudes and under different climatic conditions, numerous modern Olympic training centers were built.

On the Bucegi plateau, because of the existence of a flat surface, was built, besides the old chalet Piatra Arsa (1950 m), a new hotel, but also a stadium with a synthetic runway, fit for the sportsmen trainings.

The characteristics of the mountainous bioclimate depend on the relief microclimate, on the altitude and on the orientation of the mountains. The endocrine neuro-vegetative functions, which coordinate the organisms' acclimatization to a new environment, are highly solicitatEditura

The bioclimate specific to these regions is solicitating and particularly coordinating the acclimatization of the organisms' functions to the environment. Due to the altitude, the Bucegi Mountains' bioclimate is characterized by the effects of the existing climatic factors, especially the low pressure of the air oxygen, which is directly proportional with the decline of the atmospheric pressure. The higher the altitude gets, the more strongly the effects of the climatic factors are felt by the organism. These effects are permanent, no matter the season or the geographic landscape, being independent of the solar radiations.

The mountainous climate in this area is a direct consequence of the relation between the relief (the active subadjacent surface, the orientation of the mountain range, the orientation of the slopes, the configuration of the relief), the climatic and altitudinal elements and it is most of the times benefical for the sportsmen trainings. It is harsh in winter and cold in summer. The air is relatively dry and the cloudiness is high. The sunshine duration is reduced, the precipitations are moderately-abundant, the atmospheric circulation is active and the snow layer is thick and persistent.

When differentiating the climatic processes and phenomena, the most important role is that of the altitude. It determines the climate's main feature, that is a vertical zonality of all the climatic processes and phenomena. As a consequence, important changes of all the latitudinal climatic elements appear as the altitude is getting higher. These changes are emphasized by vertical variable gradients of the climatic elements: the annual average temperature of the air is dropping as the altitude gets higher, corresponding to the vertical thermic gradient of 0.5-0.7°C/100 m. The air temperature is one of the main factors which conditions life development and the activities in mountainous regions. In all the massifs over 2000 m the annual average air temperature is negative (-2.6°C at the Omul Peak meteorological station, 2509 m).

At altitudes higher than 2000 m, the lowest temperatures are in February, while the highest are in August. At altitudes lower than 2000 m, the coldest month is January, and the highest temperature is registered in July. This happens because of the annual regime of the cloudiness (the total annual cloudiness grows with 0.1/100 m). The monthly average figures of the

air temperature of the coldest month-February, at an altitude of 2509 m, is of -11°C (Omul Peak), the thermic gradient being the smallest during the whole year: 0.3-0.4°C/100 m.

The monthly average air temperature of the hottest month-July, at an altitude of 2509 m, is of 5.7°C (Omul Peak). During this period of the year the thermic gradient is the highest of the whole year: 0.7-0.8°C/100 m under 2000 m, and 0.6°C/100m between 2000-2500 m.

The annual average amplitude of the air has the lowest values: 16.8°C. This emphasizes the moderate character of the thermic regime of the Romanian high mountains. This moderate character is a consequence of the geographical latitudinal position of the mountain range-which is situated between 45-46° northern latitude, under the regime of the transitional temperate climate-, but also because the maximum altitude- Moldoveanu Peak, 2544 m - is an average height in comparison with other mountain range situated at the same latitude.

Another important thermic parameter is the daily regime of the air temperature. Knowing this regime makes possible the organization of the activities in the best moment possible in order to avoid the risks of accident (muscular stretches, muscular breakages, chilblains), but also to reach the training's purposes.

Analyzing the daily regime of the temperature points out that the lowest hourly average numbers are registered at sunrise, which differs from month to month. In winter, the lowest hourly values are registered around 4-5 o'clock in the morning.

The highest hourly average figures are registered at noon in July, around 13-14 o'clock. If, at 600 m altitude these numbers are of 13.5-22°C, at 2500 m altitude they are of 4-7°C.

In January, these numbers are negative during the whole day, the maximum being at noon, around -10°C.

During the day, between certain hours, the air temperature can change unexpectedly, and this fact can disturb the training process, while the sportsmen's organisms need to accommodate to the new situation, through thermoregulation mechanisms. These oscillations of the temperature are determined by the local geographical conditions, but also by the general atmospheric circulation.

The daily thermic control is maximum in August, being of 6-7°C at 2000 m, also pointing out the dinamicity of the existing climate.

We cannot leave aside the data regarding the average number of the days that have characteristic temperature values. At an altitude over 1800 m, the number of frosty days, meaning the days with temperatures below 0°C, is of 220-260 per year. Summer days, with temperatures around 25°C are nonexistent.

The annual average relative moisture is rising with 1.0-1.5 %/100m, being an important characteristic of the climatic environment of the mountainous regions. Although invisible and hard to point out, the water steam are part of all the biological and physical processes of nature, giving the climate the feature of "humid" or "dry". Also water steam are providing the air with the necessary humidity for the formation of the clouds and of the precipitations, they reduce the insolation at the level of the active surface through the absorption and the diffusion of the solar radiations, while during the night they stop the cooling through radiation of the active surface, reducing in this way the excessive thermic contrasts of the microclimate.

On the various altitudinal levels, the relative moisture is increasing indirectly proportional with the temperature, but only in the warm season (April/August). During the rest of the year, they increase until they reach altitudes of 1800-2000 m, and then they decrease while the altitude increases. In this way, at the base of the mountainous massifs, the moisture is of 77 %, while at average altitudes is of 85 % (87.3-91 % at Omul Peak). This is due to the dynamic character of the climate of the high peaks. Moisture's distribution in summer is due to the convective currents which climb the slopes towards the top in a characteristic movement, transforming the water steam provided by the forests through evapotranspiration.

Moisture's variation during the year depends on the altitude, on the slopes' exposition and on the air circulation.

At altitudes over 2000 m, the highest monthly numbers are registered in May-July, as a

consequence of the large quantities of water steam resulted from convection.

The daily regime of the relative humidity is influenced directly by the insolation. During the night, the cold, humid air descends on the slopes, determining an increase in humidity in the valleys until the sunrise. In this way, the cold, humid air from the peaks is replaced by a dryer one. This decrease in humidity in winter also takes place during the day.

In summer, the air on the peaks is dryer before noon in comparison with the second part of the day, when the water steam from the valleys climb the slopes under a convective circulation.

The absolute humidity is the proportion between the quantity of water steam in grams contained by $1m^3$ at a given time and the air temperature. It increases directly with the temperature and it decreases with the latitude and with the distance from oceans and seas. Humid air makes impossible the loss of water through the skin.

Air moisture is directly influencing the organisms, affecting the hidric equilibrium through the skin and the skin folds, but also indirectly through the temperature and air movements.

For a normal life, the air humidity is about 30-70 %. Air humidity regulates the atmospheric factors, wrapping the body with a protecting blanket. At an average altitude, where the water steam is around 85-91%, the organisms which are under an intense effort are characterized by changes of the lateral circulation, while the toxic products resulted from the intense burnings during the trainings are much more harder to be eliminated through the skin. An abnormal humidity favors a pathogen intervention of the extern agents, the respiratory apparatus (respiratory diseases, colds, flu) and the excretory one being the most affectEditura

The annual quantity of precipitations increases with 70-100 mm. These gradients vary according to the exposition of the slopes. On the western slopes, the humidity, the cloudiness and the precipitations will be higher than on the eastern slopes. They are characterized by a large nonuniformity in their distribution in time and space.

The climate of the Romanian high mountains is under the influence of the western circulation in summer, and under a dry, continental one in winter. The slopes with a western and north-western exposition, situation on the main directions of the Atlantic cyclones, are responsible for an intensification of the frontal processes and of the orographical convections, which determine an increase of the precipitations. In the eastern side, the precipitations decrease under the influence of the descendent adiabatic warming. In the Bucegi mountain, which represent the eastern façade of the Southern Carpathians, The annual quantity of precipitations at Omul Peak is of 1346 mm.

Generally, over 2500 m, the annual quantity of precipitations decreases under 1200 mm due to the air masses which climb the slopes and cool adiabatically. Also, the water steam are condensed and they give birth to precipitations. This condensation level reaches the altitude of 1900 m. The cooling of the air when it reaches the top determines a drop in the quantity of water steam and, as a consequence, a decrease in precipitations.

The richest precipitations are registered in June, when the activity of the cyclones is very intense and the thermic convection inside the unstable air masses which penetrate the back part of the cyclones has high values. In this period, at Omul Peak was registered a quantity of 173 mm. Over 2000 m, the number of days with precipitations is over 170 per year. Precipitations like: rain, drizzle, snow, sleet, hail, in a minimum quantity of 0.1 mm are determined by a complex of processes and conditions such as: the presence of clouds, the shadow on the surface during the day, the modification of the radiative balance and the soil moisture.

During the winter, due to the temperate continental climate, snow is present around 270 days per year, at an altitude of 2500 m, which means that the first snow layer is in September and the latter in the first decade of April.

The atmospheric pressure is one of the most important factors for the trainings at high altitudes. On average, the atmospheric pressure in Romania at the sea level, at 0°C and at 45° northern latitude is of 760 mm Hg, but, as it is influenced by the temperature, humidity, air movements and altitude, it varies a lot.

For every 100 m in altitude, the pressure decreases with 12 mb until 1600 m, and with 10 mb between 1600-2500 m. At 600 m, the annual average numbers are of 948 mb, at 800 m -

925 mb, at 1200 m - 880 mb, at 1800 m – 817 mb, at 2200 m – 770 mb, and at 2500 m the pressure drops to 747 mb.

What is really important in the training at high altitudes is not the dropping of the global atmospheric pressure, but the dropping of the oxygen pressure.

The oxygen represents 20.95 % of the air components, and this percentage is not influenced by altitude.

At an average altitude, the dropping of the atmospheric pressure determines the dropping of the oxygen pressure. At 2000 m, for an atmospheric pressure of 600 mm Hg, the partial oxygen pressure is of 111 mm Hg, which is equivalent with 15.8 % of the air volume.

Air masses and the wind. The air masses play an important part in the trainings as, through their action, they change the mountainous climate. They are specific to the place where they form, as they are characterized by density, temperature, humidity and specific electric charge. While they move from one part to another under the influence of the air currents, the air masses change under the influence of the regions beneath them.

The wind is extremely variable in time and space, influencing very much the organisms. The wind is represented by the air which moves from the regions with high pressure towards the regions with low pressure.

The wind is influenced y the relief, which is, at the same time, an obstacle which decreases its speed, and because of the convergence of the current lines, it increases its speEditura In mountainous regions, the wind controls the entire life. As the altitude is increasing the speed of the wind increases too. Until 1500 m, the annual average speed is of 4.9 m/s, at 2000 m, its speed is of 9.1 m/s.

In summer, at altitudes over 1500 m, the speed of the wind is higher during the night and in the morning. The smallest values are registered at noon, between 13-14 o'clock. In winter, the wind is intense and permanent, dispersing and transporting the snow. The blizzard takes place 90days per year at 2500 m and 60 days per year at 2000 m.

The static or dynamic character of the climate is given by the alternance of the wind with the atmospheric calm. For the Bucegi Mountains, at 2000 m, the climate is dynamic, with the wind present in 96 % of the total annual observations, The atmospheric calm being rarely felt in summer, in a proportion of 4 %. The weak wind, with a speed under 0.5 m/s, is a favorable factor, being a corrector of the thermic contrasts. The powerful winds (100-120 km/h) have a visible mechanic character, dispersing the clouds, the smoke and the dust. Moderate winds favor the evapotranspiration, they cool the human skin, they stimulate the cutaneous functions and the peripheral circulation.

All these climatic factors determine certain functional and biochemical changes in the organism:

The Acclimatization

The acclimatization represents especially the adaptation at the meteorological factors (temperature, humidity, pressure, air movements, solar radiations etc.). It is also influenced by other factors, such as the hygiene conditions of the respective area, the social environment etc.

It was noticed that the persons in the temperate regions are easily adapting to the cold climate than to the tropical one, especially because of the high humidity from there, which disturbs the thermoregulating process, but it is also responsible for an accentuated dehydration, which is due to the abundant perspiration. The persons from the tropical regions hardly adapt to the cold and temperate climate during winter.

It was noticed that the adaptation at the excitant climatic conditions is very difficult, than to the indifferent ones.

Other factors that influence the acclimatization are: age, sex, the organisms' resistance, life conditions etc. Children and old persons are hardly adapting to the tropical climate than men, and

the disordered people (especially those who have nervous disorders and neurovegetative instability) and the convalescents are having problems.

Thermoregulation

During the training process at high altitude, the sportsman is under the influence of some specific bioclimatic factors, which depend on altitude, latitude and season.

These bioclimatic factors, in some "normal" conditions, are indifferent, and act in abiding limits, without determining the organism to adapt to new conditions. Besides these limits of tolerance, they become tonic, stimulative, even "stressing" and in this case the organism needs to adapt himself to the new conditions.

During the training process at altitudes over 1800-1900 m keeping the body temperature quasiconstant in conditions on thermic discomfort - under 16.8 TEE- is one of the most important conditions of the human homeostasis.

In order to maintain the constant temperature of 37° C, the organism has a complex regulating system which contains thermoreception functions, functions of prelucration and integration and physiological effectors.

The meteorological factors are either stressing or stimulating for the organism. In both cases they go hand in hand with the self-defense and adapting mechanisms in order to keep the internal homeostasis.

In thermo genesis, as a consequence of the stimulation of the main physiological functions, the muscular tonus and the organism's vitality increase. We are dealing with a hyper tonic cutaneous stress, which can be calculated with the formula of P.A. Siple (after Elena Teodoreanu and co., 1984):

$$P=(10\sqrt{(v+10.45-v)}\ (33-t°C)$$

Where:

P-the cooling power
v-the wind speed in m/s
t° C-the air temperature inside the conventional meteorological shelter ($33°C \geq t$).

Amplifying this formula gives us the hyper tonic index, which is characteristic for the training process at altitudes over 1800-1900 m.

In order to study the cutaneous stress we can use the formula of W.H.Terjung (after Elena Teodoreanu and co., 1984):

$$S.C.A.=\sum(N2+D2)$$

Where:

S.C.A.- the annual average cutaneous stress;
N-index of monthly stress at night (1o'clock);
D-index of monthly stress at day (13 o'clock);
For S.C.A.=0, there is no need for thermoregulation;
For S.C.A. below"10", we have the less stressing region;
For:>30:0-1300 m,
<20: plains and hills;
100:1500 m altitude;
130:2509 m altitude.

The heat production inside the organism is the result of the chemical reactions that take place inside the cells. This happens with the increase of the metabolism, under the influence of :

- the intensification of the muscular activity;
- the adrenaline and noradrenaline;
- thyroxin;

- the increase over the normal limits of the body temperature;
- eating food and pharmaceutical products.

Having in mind that over 1500 m the thermic comfort is inexistent, to avoid certain negative pathological aspects like local chilblains, muscular cramps, muscular breakages, adequate clothes will be used, the underwear will be comfortable, made of cotton, the head will be covered with a bonnet, the training shoes will be proper, gloves will be used when it is cold, sunglasses etc.

The wind speed is an important factor regarding the state of thermic comfort. When it is over 3.5 m/s it is stressing the organism, and, if the temperature is very low, the wind accentuates the state of discomfort.

Adapting to Hypoxia

Even the sportsmen, which are robust and healthy, when they climb at altitudes over 1800 - 1900 m need to adapt to the new climatic conditions, through certain functional and biochemical modifications, which are the response to the altitudinal stress.

If the atmospheric and oxygen pressure are low, the phenomenon of hypoxia, which is the incapacity of the tissues to receive the necessary quantity of oxygen at a certain moment.

The situations in which hypoxia is encountered are (Bratucu, L., 1996):

- low oxygenation of the lungs(anoxia);
- reduced oxygen capacity in the blood (anemia);
- the slow movement of the blood in the sanguine vases;
- the blocking of the oxidative processes of the tissues.

Among the first symptoms of the life at high altitudes is the “sick of height”, which is characterized by headaches, nauseas, tiredness, nausea, unconsciousness, bleedings of the retina, lung or cerebral edema. The more people climb, the more these symptoms are getting obvious.

Training at altitude is producing a supplementary hypoxic stress, which needs a new adaptation, which is similar to the changes that appeared after a severe training at the sea level.

During the adapting process, the following changes appear.

Modifications of the Enzymes

The active muscles produce more enzymes for the oxidative metabolism. These are found especially in the skeletal muscles, and they increase in size and number. Fat acids are largely used by the skeletal muscles, therefore, the concentration of lactic acid in the blood is reduced during the sub maximal effort. (David E. Martin, 1996)

Modifications of the Cardio-Vascular Apparatus

The most important modifications of the cardio-vascular apparatus are (Dragan I., 1977):

- the increase of the cardiac flow;
- the increase of the circulant sanguine volume;
- the increase of the sanguine flow on the cardiac beat;
- the increase of the percentage of the hemoglobin and of the red cells;
- the increase of the cardiac and respiratory frequency;
- slow recovery after intense effort and exaggerated reactions;
- deregulations in the ortostatic event.

At altitude, the maximum cardiac frequency which can exist appears, in these conditions, at a slower rhythm than at the sea level. The blood that is pumped by the heart is lesser. So, even at

a perfect accommodation, the maximum capacity encountered at the sea level will not be equalized at altitude. This explains the dropping of the VO2 max at altitude.(D.Martin, 1996).

The volume of the plasma from the blood decreases and it recovers only after weeks of accommodation.

The hypoxia is stimulating the secretion of eritropoetina (EPO) from the kidneys, which determines the increase of the production of the red cells (which contain Hb) in the bone marrow.

If the plasma and the red cells increase equally, the total blood volume will increase too, without any other modifications.

Modifications of the Metabolism

The intensification of the metabolism, of the catabolically processes is an adaptative reaction through the decrease of the xeric proteins, of the hemoglobin etc. They indicate the need to consume more proteins (meat, eggs, cheese, milk) and mineral salts.

Modifications of the Respiratory Apparatus

During the training process at altitude, the following modifications appear:

- the oxygen saturation at the alveolar level is decreasing (only 92-94‰, the oxygenation of the tissues is reduced;
- the Vo2 max is decreasing, but after the adaptative period it will be higher than that at the sea level;
- the alkaline reserve is decreasing, but it will get back to normal after a month.

There is an abnormal variation of the lung dimensions, which is influence by height, age and sex. The persons whose lungs operate normally will adapt faster.

At altitude, a tonic climate prevails, which is an impediment for the sportives whose respiratory apparatus is hyper-reactive and susceptible to reflexive contraction in contact with cold dry air. They are predisposed to bronhospasms or to asthma imposed by physical exercises.

The dynamic character of the climate from the high regions determines the appearance of the lung bioclimatic stress.

The bioclimatic stress is calculated with the formula:

$$S.P.A.=\sum(N2+D2)$$

The index is situated between 7.5-11.6 mb, this being equivalent to a relaxed, unstressed index. Below the referential indexes we have a state of discomfort through dehydration, when the air is poorer in water steam. Over 11.5 mb the skin folds are hydrated, the atmosphere is hard to bear, is of embolient type. We have in this case a hydrating index of discomfort.

In the Romanian high mountainous regions the months with a dehydrating index are specific around 8-9 months per year, from September till May. The months with a hydrating index are inexistent, being replaced by unstressed months. The unstressed interval is at 2000 m, between May and August, while at 2500 m the interval is reduced to three months.

The Effects of the Solar Radiation on the Organism

The inclination and the orientation of the slopes are determinant factors in the distribution of the biogeographic world. The differentiated repartition of light modifies the temperature of the air, of the soil and of the humidity, having a direct influence on the training process. The main effects of the solar radiation are:

- the stimulation of the C.N.S. through the optic analyzer;

- it influences the functioning of the endocrine glands and the excretion through perspiration;
- it catalyses the metabolism of the mineral salts;
- it plays an important role in the synthesis of the vitamins;
- it activates the thermolysis;
- modifications of the blood chemical composition;
- the rapid cicatrisation of the wounds and imunological resistance.

The hypoxia conditions, under which the sportsman lives are a burden for his internal organs. Therefore, we must keep in mind that even when resting the organism is stressEditura

The success of the training at altitude depends on an impeccable recovery.

The reduced pressure of water steam determines an increased secretion of water, through the skin and to the respiratory apparatus, which can be irritated through dehydration. This can be preventing by a supplementary ration of liquids, about 3-4l/day.

The diet will be rich in carbohydrates (60-70 %) and the meals will be taken at certain fixed hours.

The solicitations of the mountainous climate intensifies the catalytical phenomena. Therefore, one needs 60-70 cal/kg body/24 hours. The nutritious ration will consist of 65-70 % glucides, 20-22 % fats and 10-12 % proteins.

During winter the caloric needs increase with 10 %, a surplus which will be completed with fats and proteins.

A special attention will be given to the sleeping time (8-10 hours/day), but also to hydrotherapy, and massage.

The geographical factors that influence the human organism act on the physiological plan but also on the motorical skills.

Usually, the passing from plain to mountain is done in a few hours. In the first 48 hours the motric skills are constant, but from the third day on, under the influence of the bioclimatic factors influence the organism and the indexes of the motric skills decrease.

Speed and strength are coming back to normal after about seven days, and after this period the performances achieved in plain regions are easily equaled and even surpassEditura

Sleeping disorders, as well as those of the appetite, of the behavior, great tiredness after effort, slow recovery, all these have negative effects on skill, but after the seventh day, everything gets back to normal.

But this is not the case with resistance. This motric quality has low indexes the whole period passed in a mountainous area. In comparison with speed and strength, resistance is indirectly proportional with the increase in altitude.

Hypoxia is considered to be the main cause for a reduced aerobian capacity. After Iliev I., The key problem of the developing of the resistance is keeping the intensity of the training from the sea level, which depends on the duration of the recovery time. For the control of the intensity, Iliev offers an adaptation of Morton's formula, which is based on the cardiac frequency:

$$WTU=Wt*e$$

Where:

WTU-the training session at altitude;
Wt-the solicitation time (in minutes);
e-natural logarithm;
x=F.C.effort-F.C.repaos/F.C.maximum-F.C.repaos
b=factor:1.92(men), 1.62(women)

Also, this formula can be used in the case of the inevitable decrease of performance, caused by unfit accommodation and reaccomodation.

Conclusions

The geographical environment, with all its characteristics, seals the fenotype. The living, forming and working conditions makes man to seek for the solutions to face successfully the challenges of life. In his struggle, man has modified nature in his favor.

Besides the purely sportive factors, the altitude-climate factor plays an essential role in the sportive training for the obtaining of performances.

It is very important the choosing of the site and of the training period, which has to be in concordance with the aim of the training process, with the individual lifestyle and with the necessary facilities.

The success of the training is influenced by the altitude, by the latitude and by the season.

The effects of the training can be seen individually, taking into account the followings:

- the psychical state;
- health;
- the accommodation capacity to working conditions at altitude (altitudinal stress);
- the training level;
- the competitional value;
- the training duration;
- the experience in the training at altitude;
- the skill of approaching the training's phases.

The training effect at altitude is the result of the interaction of the bioclimatic factors with bio-morphological qualities, with the individual physiological modifications and with the training level at a certain point. Combining the altitude-climate factor with the purpose of the improving the efficiency of the training process is a very important problem for the competitors at an international level, representing the key of success for the majority of the sports fields.

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