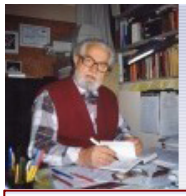

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SPORT STRENGTH TRAINING METHODOLOGY

THE TRAINING SYSTEM IN MIDDLE DISTANCE RUNNING

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THE TRAINING SYSTEM IN MIDDLE DISTANCE RUNNING

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Preface

In no other speciality of Track & Field has the development of a training system gone through such a tortuous process as compared to middle and long distance running. The history of Track & Field is studded with several names of great trainers and the successful evidences of different training systems: Finnish, Polish, English, Czechoslovak, Russian, Hungarian, Swedish, Portuguese and others. It has been an empirical way, full of trials and errors, often not supported by exhaustive physiological concepts about physical training. In this way, success has depended a great deal on chance.

Nowadays, from the top of recent discoveries in the field of applied physiology, some assumptions, on which these systems are based (bibl. 5,6), can be considered incorrect. At the same time, these discoveries open up new prospects to the development of the training system for middle and long distance running. One of these systems is analyzed in this article.

The idea about the training system, described below, is based on recent observations about the nature of endurance: endurance is limited not only by hypoxia in skeletal muscles, by maximum oxygen consumption (VO_2max) and by cardiac capacity, as it was believed once, but also by the capacity of muscles to draw a higher percentage of oxygen out of arterial blood and to oxidize lactate. In other words, the limitation and the development of endurance depend not so much on the capacity of heart to pump blood as on the oxidative capacity of skeletal musculature.

Preliminary scientific remarks

The presented training system for middle distance running is a reworking of the traditional training system. It is based on experimental data which hadn't been adequately evaluated because they didn't conform with the traditional ideas which univocally related endurance to the capacity of respiratory and cardiovascular systems..

The above mentioned reworking is based on the following assumptions:

1. In the sports disciplines of endurance running the competition activity is prevailingly carried out through the involvement of slow twitch fibers. Fast twitch fibers can be involved in the work after the fatigue of slow twitch fibers or when the work intensity is increased. The moment, when the activity of fast twitch fibbers begins, coincides with the moment when the anaerobic threshold is reached; therefore, one is justified in thinking that just the mobilization of fast twitch fibers leads to the increase in blood lactate concentration.

2. Endurance training leads to the decrease in blood lactate accumulation (and, consequently, it increases the anaerobic threshold) mainly thanks to the increase in oxidative capacity both in slow twitch fibres and in fast twitch fibres. This leads to a decrease of anaerobic (glycolytic) mechanism contribution in the energy supplying process of muscle work and to a decrease of lactate production. This situation enables the organism to use glycogen economically, utilising more pyruvic acid and fatty acids..

3. Endurance training causes an increase of the muscles capacity to produce energy thanks to both an increase in number and dimension of mitochondria and an increasing activity of mitochondrial enzymes per muscular mass unity. Therefore, the increase in endurance is correlated more with the increase of the quantity of muscle mitochondria and with the improvement of the muscular oxidative capacity, than it is with the increase of VO_2max. It has been proven that when the endurance level is increased three to five-fold, mitochondrial quantity and oxidative capacity in skeletal muscles is increased two-fold, while VO_2max is only increased 10-14%.

4. The greatest level of intensity that could be reached during prolonged exercise without a considerable blood lactate accumulation (the intensity of Anaerobic Threshold , AT) is a better indicator of endurance capacity than VO_2max. The prolonged exercise at AT intensity level is an effective training method for the development of endurance.

5. In the organism, lactate can be eliminated not only by the liver and by the myocardium but also by the skeletal muscles themselves. In a well trained organism, muscles represent the most important place where the lactate oxygenation takes place. The decrease of blood lactate concentration during the prolonged exercise, is connected not so much to the decrease of the lactate production but rather to the increase in the speed of its "demolition" in working muscles.

6. Training with continuous prolonged exercise at Anaerobic Threshold intensity level is an effective training method to enhance the oxidative capacity of slow twitch fibers. In addition, interval training at an intensity level greater than or equal to VO_2max is an effective method to enhance the oxidative capacity of fast twitch fibers. When this type of interval training is used after the preliminary preparation of slow twitch fibers (through prolonged exercise at anaerobic threshold level), it also becomes a method for improving the athletes aerobic capacities with the same effectiveness as the continuous prolonged exercises training.

7. Metabolic and morphologic changes in muscles during the endurance training are clearly local. It has been proved that the increase of muscle myoglobin concentration after endurance training is observed only in the muscles involved in the execution of the training exercises. Also the mitochondrial adaptation takes place chiefly in those muscle fibres which are directly involved in muscle contractions specific to these exercises.

8. A high volume of prolonged work is an essential element in endurance training, not only because it leads to the gradual increase in the volume of cardiac cavity, but also because it assures the formation of particular peripheral vascular reactions linked to the optimal distribution of blood flow during the work. These reactions assure the delivery of a greater quantity of oxygen to the muscles involved in the work. The peripheral vascular reactions are local (differentiated), very stable and they demonstrate the organism's adaptation to the prolonged work in a more precise way than the traditional indicators: heart rate and heart systolic throw. It's important that the formation of these peripheral vascular reactions must precedes the high intensity endurance training.

9. The precocious intensification of the endurance training, also if it assures a temporary improvement in the sport result, at the same time, leads to the overworking of the cardiovascular system. This could create conditions which lead to the cardiac dystrophy and could interfere with the normal development of the training process.

In this way the main deduction, to which all this information leads, consists of the fact that endurance is determined not only and not so much by the quantity of oxygen provided by muscles during prolonged and intensive work, as by the adaptation of muscles themselves, (i.e. their capacity to utilize this oxygen).

Just in this, there is the important essence of the organism's morphofunctional specialization during its adaptation to endurance training.

Preliminary methodological remarks

From a physiological point of view, the principle on which the improvement in endurance capacity is based can be defined as the principle of the "antiglycolytic" finality.

To realize this principle the choice and the organization of loads during the whole process of preparation should be done with the aim to minimize the involvement of the glycolytic mechanism in the energy supplying during the competition distance running.

This principle consists in an preliminary organism preparation to intensive regime of competition distance running:

- an increase in heart cavity volume and vascular peripheral reactions;
- the improvement of muscular contraction properties and the improving of oxidative capacity in slow twitch fibres.

Only after this preliminary preparation it should begin the work to increase the specific organism power output:

- the increase in myocardium power;
- the improvement of the organism's buffer systems and
- the improvement of the oxidative capacity of muscles fast twitch fibres.

The following methodological principles of special physical preparation define the formation of this training system.

1. *The principle of concentration of training loads having one primary emphasis as for example (a) , (b) or (c) in different training stages* (the conjugate sequence system of organizing training loads) consists of the consecutive superimposition of training influences brought by more specific loads, which have a more intensive effect,

on the training (the adaptation traces) of the previous loads, which prepare the organism to obtain the best final cumulative effect.
In the training programme every type of load is introduced in such a way that it gradually takes the place of the previous load. The previous load creates the morphofunctional bases to obtain the best effectiveness of the subsequent load. The subsequent load, besides obtaining its specific aims, assures the realization of the training effects of the previous loads at a higher functional level of the organism.

2. *The principle of priority of the special strength preparation* implies a temporal placement of the strength training in the first stage of the preparation period: the special strength preparation, aimed at the Local Muscular Endurance (LME) improvement, must precede the training aimed at the increase in the speed of distance running.
The planning of training in the year's cycle must begin with the definition of the special strength preparation: specific aims, means, methods and the loads volumes; and only after this, can one plan the other training work loads.

The analyzed principles define the general strategic line of the training, which can be summarized in its temporal evolution as follows:

Development of Local Muscular Endurance ⇒ improvement of the organism's capacity to work in a prolonged way at an optimal speed regime ⇒ increase in the utmost speed to cover the competition distance.

General model of the training system

The training system model (fig. 1) expresses the essential strategic idea of the training formation and it consists of the following essential components:

1. a model of the dynamics of the top speed reached during the competition distance (V);
2. the highest level of the top speed that is reached in the competition distance during in the previous stage of training (V_0);
3. the planned increase in the top speed of the competition distance running (ΔV) in the current stage;
4. the dynamics model of essential functional parameters or criteria (**f**), mainly characterizing the level of the specific work capacity[1];
5. the maximal values of functional parameters, reached during the previous season (f_0);
6. the planned increase in functional parameters (Δf);
7. the model of the loads system (blocks A,B,C);
8. the organization model of training actions on the cardiovascular system and the neuromuscular system of the athlete's organism;
9. the system of the distance training means, organized in relation to the principle of the superimposition of loads with different training aims.

[1] The parameter *f* represents the most important parameter of athlete's functional state. In the strength-speed sport disciplines it can be the Maximal Strength and Explosive Strength verified by special dynamometer tests. In the endurance sport disciplines the parameter *f* represents the most important **physiological power** parameter, verified by standard physiological test procedures used in laboratory or in field.

Block A (basic stage) – targets the activation (starting up) of the adaptation processes and the formation of the morphofunctional preconditions that are necessary to the subsequent intensification of the organism work in the specific speed regime.

Block B (special stage) – it is preferably aimed at the gradual increase of the organism's work power in the specific regime similar to that of a competition.

Block C (competition stage) – targets the final part of the organism's adaptation cycle to the maximal level of work power in the specific speed regime under the influence of competition loads.

Here, it's useful to point out that the curves A, B and C in figure 1 don't symbolize the volume of relative loads but the preferential direction of their training action on the athlete's organism at every stage.

The actual sequence of the actions direction in the block training is as follows.

1. At the cardiovascular system level:

Block A – increase in the cardiac cavities volume and formation of peripheral vascular reactions, which satisfy the distribution of blood flow in the organism so that the working muscular groups and the physiological systems, preferably satisfying its specific work capacity, receive a great deal of oxygen.
Block B – increase in the cardiac capacity resulting from the increase in the power of the myocardium.
Block C – increase in the cardiac capacity resulting from the increase in the frequency of cardiac contractions

2. At the neuromuscular system level:

Block A – increase in muscles contractile capacity and improvement of the oxidative capacity in slow twitch fibres.
Block B – increase in the muscular contraction capacity and simultaneous increase in their oxidative capacity.
Block C – increase in the work power of the muscular system in specific cyclic regime.

In block A, the distance work is executed preferably at the anaerobic threshold level intensity. In relation with the AT intensity level increasing during this stage, one should increase the execution intensity of the distance running exercises.
At the same time (concurrently) with distance training, overload training is used and aimed at the increase of muscular explosive strength and Local Muscular Endurance.
In block B, the distance work is carried out with a gradual increase in speed up to the maximal (relative to the competition distance) level and with a gradual increase in distance length, covered at the competition speed. Resistance exercises are used mainly to increase the explosive strength and the reactive capacity of legs muscles.
In block C, the majority of work that is carried out is focused on distance and preparation for competitions.

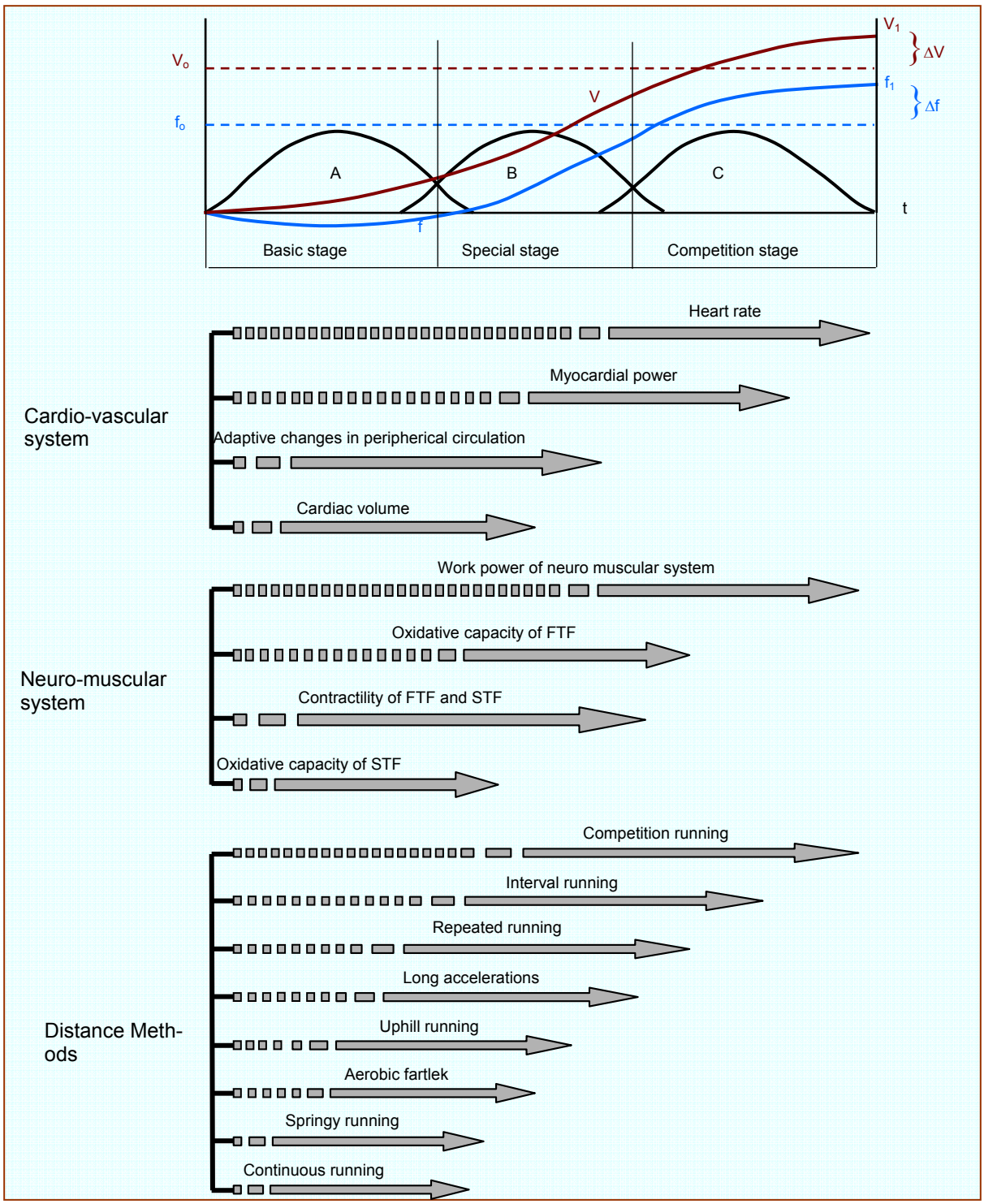

FIGURE 1 - GENERAL MODEL OF THE TRAINING SYSTEM IN MIDDLE DISTANCE RUNNING AND LONG DISTANCE RUNNING

The system of running loads is composed by means and methods in the temporal sequence as described below:

1. *Uniform prolonged running* – consists of continuous running, at a steady speed corresponding to that of the athlete's anaerobic threshold (AT). The carrying out of this exercise prescribes the maintenance of a correct breathing and of the optimal stride length (during the running, the push-off should be rather reactive)

2. *Springy running* – consists of an uniform, not prolonged, running in the aerobic regime (the blood lactate level doesn't increase beyond 2 mM/lt). Unlike the usual running, this exercise execution technique includes push-offs, which are more accentuated, more springy and directed more upward. Stride length is shorter: the forward movement at the hip of the swinging leg should be of a lesser amplitude.

3. *Aerobic fartlek* – consists of prolonged uniform running at the intensity of the athlete's aerobic threshold (blood lactate 2 mM/lt), with shorter distance speed accelerations (100-200 m for middle-distance runners and 300-400 m for log distance runners) that should provoke the anaerobic metabolism increasing not more than 4-5 mM/lt blood lactate level

4. *Uphill running* with an accentuated push-off and active swinging forward swinging movement of the opposing leg.

5. *Long accelerations* – consists of 100-120 mt distance running exercises executed with a gradual increase in speed and subsequent forward inertial moving.
   The execution of this exercise includes the following phases:
   a. a relaxed start with a gradual increase in speed up to the maximal or sub-maximal level (the maximal speed tract length should be gradually increased from one training session to another in relation with the improvement of the athlete's ability to perform this exercise);
   b. passage to free running through inertia, maintaining the speed that is reached and controlling running technique, amplitude of movements and stride length.

6. *Repeated Running* – consists of distance speed running, the length of which is determined by the length of the competition distance. At first, the running speed is sub-maximal, then (at the end of the stage B) it is maximal.
   The recoveries between the repetitions of fast distances should assure the full re-establishment of the organism work capacity, enough for a good-quality performance in the subsequent repetition.

7. *Interval Running* – consists of running a repeated distance at an optimal speed with incomplete recoveries between repetitions. It represents the traditional well-known method of endurance training in the disciplines of running sports.

8. *Competition running* – performed at the competition distance and, now and then, at longer or shorter distances than the competition distance.

According to the sequence previously explained, it's possible to say that the main idea

of the training system consists of a definite sequence of gradually increasing the intensity of the organism work regime.

This increase begins with training means aimed at developing Local Muscular Endurance (block A) and then it continues with training means aimed at decreasing the time to cover the competition distance (block B) and, finally with competition distance loads (block C).

When resistance exercises are replaced by running exercises (from block A to block B), their role in the training system changes: from the function of means aimed at increasing the organism's work regime to the functions of means aimed at supporting the muscles contractile capacity.

In block B, more important than improving the speed of the competition exercises is the capacity of the athlete's organism to develop and to maintain the power output level in the specific muscle work regime that assures the basic energetic preparation for the maximum power work regime in the competition stage (block C).

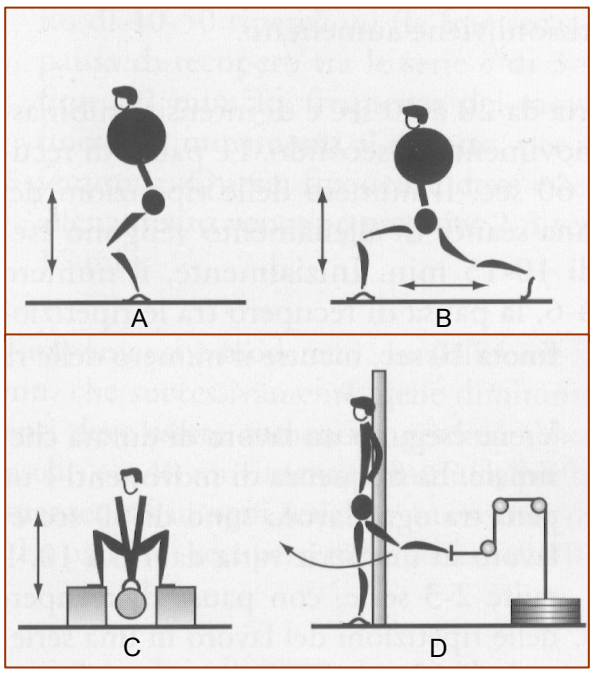

FIGURE 2 - EXERCISES TO IMPROVE LOCAL MUSCULAR ENDURANCE IN LEGS

The organism's power work level (at which running exercises are carried out on the racetrack) should be gradually increased in such a way that it doesn't cause excessive fatigue in the organism. This is why the execution speed of racetrack exercises must correspond with the three intensity (speed) levels (fig. 1):

- *Optimal level* – it corresponds with the level of the uniform running work in block A;
- *Maximal level* – it corresponds with the level reached by the athlete in block B, when he is able to carry out the distance running without inducing excessive organism fatigue;
- *Record maximal level* – it corresponds with the level reached by the athlete in block C, before the main competitions.

The represented training system (Figure 1) can last a year (in long-distance running) or it can be repeated twice in a year's cycle, if one participates in winter competitions (in middle-distance running).

Training methods for the Local Muscular Endurance improvement

The overload exercises are concentrated in block A.

Their aim, as it is already said, is not only directed towards strength improvement but mainly the intensification of the organism work regime in order to improve Local Muscular Endurance of the muscle groups that are involved in competition distance running.

Special research and the experience in training have confirmed the efficacy of overload exercises, showed in figure 2, to improve Local Muscular Endurance of legs muscles.

In exercises A, B and D the overload weight is about 40% of the maximal level; in exercises C, the overload weight is 24 or 32 kg.

These exercises should be executed using two different versions of LME methods with the 10 sec and 20-30 sec sets duration.

Version 1 – In one training session one should execute 2-3 series of 10 sec sets (10-12 consecutive repetitions of exercise) with the 30 – 60 sec rest intervals between each sets and 8-10 minutes rest interval between each series. The tempo of exercises should be executed at moderate intensity (at a rate of one movement per second).

At the beginning, in each set it should be executed with only the 5-6 repetitions of exercise with 60 sec rest intervals. Then, the rest intervals should be gradually decreased from 60 to 10 sec, the number of repetitions should be gradually increased to 10-12 and the work intensity should be gradually increased until the maximal.

Version 2 – In one training session one should execute 2-3 series of 20-30 sec sets (15-20 consecutive repetitions of exercise) with 30-60 sec rest intervals between each sets and a 10-12 minutes rest interval between each series.

In this version the work should start with 4-6 repetitions in each set with 60 sec of rest, then the rest should be decreased to 30 sec. and the number of repetitions should be increased until to 15-20.

The first version predominantly develops maximal anaerobic power, while the second version develops, more so, the alactacid anaerobic capacity: both of them assure the increase of the organism's energy production with a moderate activation of the glycolytic mechanism. In addition to this, both versions efficaciously allow the increase in the following:

– power and capacity of aerobic production,
– speed of development of aerobic process (factor of recovery processes improvement during and after the work).

In the recovery intervals between the sets and series, one needs to execute the short cyclic work with the same muscular groups at an intensity of about 60-70 % of the maximum level. This facilitates the activation of lactate oxidation in the working muscles. At the beginning of the basic stage the work load should be executed 2-4 times a week (with the control of athlete's mood and his capacity to endure the load).

In the second half of the basic stage (block A) the uphill running with a little slope should be included in the training. These runs should be executed at a speed of 55-60% of the competition speed:

– 10 × 150 m for athletes of middle distance running;
– 10 × 400 m for the athletes of long distance running.

These runs should be executed with an accentuated push-off and with an active oscillating forward movement.

The value of the analyzed training system

Specialized research and experience have confirmed the high effectiveness of the methodological principles in the construction of the training systems for middle distance runners and long distance runners.

1. It has been highlighted, in particular, a strict correlation between the speed of running at the AT level intensity and the ground support time of running at the AT level intensity with the strength parameter F_{max} of legs flexor muscles (the maximal force displayed in maximal explosive strength effort): respectively r = 0,695; r = 0,828 and r = 0,688.
   On the other hand, F_{max} level and the increase of the maximal speed level are strictly correlated with the volume of overload work loads (respectively r = 0,718 and r = 0,686). There is a strict connection between the increase of stride length during maximal speed running and the total volume of overload work (r = 0,597) and the stride length of the running at the AT speed level (r = 0,756).
   The athletes who used this training system attained higher results than the athletes who used the traditional training systems.
   In particular, it's important to point out that the total volume of distance running loads used by these athletes was 50% less (3000-3500 m) than the athletes who used the traditional system training (6000-7000 m).

2. From experience one can deduce that if only distance training is used, even if it favours the improvement of the function's organism vegetative system, it is not able to cause such an action in the muscles to increase their oxidative and contractile capacity.
   Therefore, if the athlete's training is carried out with the only means of distance running it can cause an imbalance between the muscular and the vegetative system, which doesn't support the improvement of work capacity.
   In order to eliminate the risk of this imbalance, the whole training should be aimed at the solution of two correlated problems:
   - to provide a higher effectiveness of the cardiovascular system's capacity to provide oxygen to the working muscles;
   - to develop the muscular tissue's capacity to draw out and to use the given oxygen.

   Research and experience have confirmed that the second problem can be solved via the use of specialized methods of overload work, that, among other things, can replace many of the taxing kilometres ran during the distance training.

3. The temporal organization of loads in the block training system solves important methodological problems connected with the preparation of high level athletes.
   In block system, the phase of work aimed at the increasing the organism's functional capacities and the phase of work aimed at increasing the top speed of the competition running takes place in different training stages:
   - the special strength load is concentrated in block A;
   - distance running work for decreasing the time to cover the competition distance is concentrated in block B.

   In this way, the distance running work is not restricted by the athlete's organism functional capacity and at the same time,

loads aimed at increasing his/her functional capacity don't interfere with the distance running work.

4. In the use of block system one should consider that the concentration of strength loads in block A, which assures the training effect on the athlete's organism, can lead to the decrease in the parameters of the athlete's specific work capacity.
   This decrease represents the impact of the strong training effect on the organism, which is objectively necessary to initiate the adaptation process for high level athletes. At the same time, this decrease creates unfavourable conditions to the high intensity distance running work.
   Nevertheless, this phenomenon is temporary.
   After the conclusion of the concentrated strength loads volume, an important and stable increase in the functional indicators is shown up to a level that is higher than the initial one, shows. This is why concentrated strength loads and distance running should take place in different training stages.
   In other words, overload exercises precede the distance running by supporting the work in the subsequent training stages. In fact, overload exercises prepare the organism for the high intensity distance running work and assure that this work is carried out under favourable conditions (when the organism is at a high level of work capacity).

5. It's important to point out that in the block training system described here one won't find the preparation and competition periods, as they exist in the traditional concept, which prescribes the subdivision of the training process into two parts only formally connected: the preparation period with high volume of loads and the competition period with participation in the competitions.
   In actual fact, this has been expressed by traditional conceptions, according to which, during the period of preparation, the athlete "accumulates" while during the period of competition he/she "realizes" physical potential, that should be maintained and revitalized after the competition but it isn't increased. Therefore, in the preparation period the athlete should use the great volume of loads in order to create a reserve of work capacity, which can be maintained as long as the competition period.
   The proposed system is another form of training organization, which foresees an organic and interdependent connection between the steady development of the adaptation process and the competition activity.
   Competitions and the immediate preparation for them "are included" in the uninterrupted process of the organism morpho-functional specialization as a factor of it adaptation to the specific work regime.
   The tasks of this factor consist in the maximum intensification of the organism work regime in the final phase of the adaptation cycle (block C), which leads the athlete to that level of specific work capacity, in which the main aim of his/her preparation is realized.

6. The main innovation in this system is also the fact that it includes a non-traditional training stage (block B), which plays an important role in the training system. In block B, the contribution of the specific

work is increased in the training process; thus assuring a gradual passage from the special physical preparation to the specific speed work and to the participation in the competitions.

To conclude, I'd like to point out that the description of this system never claims to say the last word about the evolution of the theory and the methodology in the preparation for middle and long distances runners and to exclude, in practice, the use of other training systems.

It's certain that the subsequent steps in its improvement require a deep knowledge of the physiological nature and the psychic sphere of human being.

In present day, it is difficult to prepare a champion without this knowledge. Tomorrow it will be impossible.

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