scientific journal of orienteering

Official Scientific Publication of the International Orienteering Federation IOF

Volume 16, issued October 2005

Issue date: October 5th, 2005

Editorial

The first online issue of the Scientific Journal of Orienteering

Dear Reader

The Scientific Journal of Orienteering has been an official publication of the International Orienteering Federation (IOF) for more than twenty years now. Founded and for many years published by Roland Seiler, he eventually handed the editorial work over to Toni Held and Torgny Ottosson. Now it is time for another change, and the editorship has passed to me. Torgny Ottosson and I are publishing this issue together in order to provide a straightforward changeover. I would like to thank Torgny very much for all his work.

The Scientific Journal of Orienteering has been published as a printed journal so far. Adapting to modern trends with the intention of making the ScJO available to as many orienteers and scientists as possible, it will from now on be published only in a free accessible online version, linked to the official website of the IOF. In this context I would like to say thank you also to Roland Seiler and Toni Held who have supported me a lot in planning my editorship.

For Torgny and I, it is a great pleasure to publish this issue as it is full of very different and interesting articles, demonstrating the many facets of orienteering and also the high quality of the authors. Furthermore, the journal's topicality is emphasised through two articles that are very closely related to the 2005 World Orienteering Championships in Japan.

The first article, by Zürcher S, Clénin G and Marti B, may give an answer to the success of the Swiss National Team in Japan. In preparing for the special demands of Japanese terrain, the question was posed of how closely aerobic capacity testing meets the special running demands of orienteering. In answering this question Zürcher et al. invented the so called 'Japan-test', in which the Swiss Orienteering National Team ran on a treadmill device with an 'uphill' mat. What they found out is very interesting and, in my opinion, in this instance surprising. It underlines the special demands on running capacity in orienteering.

Pack formation in orienteering cannot be eliminated. Because start intervals in international competitions have been shortened in order to increase the spectators' enjoyment, world class orienteers have got even more used to this phenomenon over the last few years. Yet still, discussions arise after every important competition. And the more important the competition, the bigger the discussion. Ackland JG shows in his article that one can analyse final results very precisely by including pack formation in calculations, and demonstrates these effects for the long-distance final competition in WOC 2005. Maybe in future it will even be possible to consider this formula in course planning and defining the starting intervals, so as to reduce pack formation?

Koukoris K presents a very substantial sociological study on how beginners became involved in orienteering in Greece and what their motivation was. In relation to the IOF's aim of developing orienteering as an Olympic sport, this article is very important in respect of describing strategies on how to get more participants in orienteering.

Pribul RF and Price J analyzed race strategies and running speed of elite and non-elite orienteers in different classes. The result showed no difference between elite and non-elite classes but, surprisingly, perceived and performed strategy vary a lot.

Lyme borreliosis is a bacterial infection with Borrelia burgdorferi transferred by tick bites. Orienteers in regions with endemic Lyme borreliosis – that is large parts of Europe and North America - are at great risk of getting infected. Fahrer H et al. wrote in the Scientific Journal of Orienteering in 1993 that in Switzerland more than 40% of orienteers showed positive serologic testing, but less than 10% had suffered from symptoms. During the last ten years it has been recognized that a chronic clinical form of Lyme borreliosis exists, leading to persistent symptoms – sometimes even after adequate antibiotical therapy. As chronic Lyme borreliosis is not a well known entity, Satz N, rheumatologist and a leading Swiss tick-transferred disease specialist, gives a very good overview of the state of the art of diagnosis and adequate treatment of chronic Lyme borreliosis. Knowing of several cases where diagnosis and adequate treatment or alternative treatment options of rheumatologic symptoms have led to an over-rapid connection to Lyme borreliosis,

this article gives good answers on what is real evidence and what is speculation or humbug. It has to be emphasized that treatment can only be successful if there has been correct diagnosis. And the ‘book on borreliosis’ cannot be closed yet, too many questions remain. Due to some delays in translation of the article, the German version will be published in this issue and the English version in the next issue; we are sorry for this inconvenience caused.

Finally, I would like to motivate every reader to submit his or her own contribution. As you can see, many different aspects of orienteering are worthy of discussion. The success of the Scientific Journal of Orienteering is dependent on the contributions. And the contributions are created by you!

But now: Enjoy your reading!

Kind regards

André Leumann

Uphill running capacity in Swiss elite orienteers.

Zürcher S, Clénin G and Marti B

From the Swiss Federal Institute of Sport, Magglingen, Switzerland

Abstract

PURPOSE: To quantify uphill running capacity in a laboratory treadmill test with Swiss elite and junior orienteers, and to evaluate the differences between flat and uphill running capacity. **METHODS**: 32 elite orienteers (M=18, F= 14) aged 21.8 ± 4.1yr were tested twice to voluntary exhaustion, first in the standard Swiss Olympic lactate threshold test, and second in a graded uphill test at 22% incline. 3-4 hours rest were given between tests. To achieve similar workloads, uphill treadmill speeds were reduced to 40% of the flat test. Stages continued 3 minutes, and increased 0,7 km/h per stage. Heart rate, lactate, and Borg were collected. To enable comparison, maximal uphill speed ($Vmax_{uphill}$) was converted to an "equivalent flat speed". **RESULTS**: Mean $Vmax_{uphill}$ was faster than $Vmax_{flat}$ in both men (+7.2% p <0.001; elite men n= 9: 22.5 km/h ±0.84 uphill vs.20.7 km/h ±0.45 flat; junior men n=9: 20.7 km/h ± 0.60 uphill vs.19.5 km/h ±0.62 flat) and women (+3.6% p <0.05; elite women n= 7: 18.3 km/h ±1.5 uphill vs. 17.7 km/h ±0.77 flat; junior women n= 7: 16.8 km/h ±1.1 uphill vs. 16.1 km/h ±0.84). The positive difference ranged from 0.5% to 12.7% in men, and from -6.4% to 15% in women, 5/14 women were slower uphill than flat; no men were slower. Maximal Borg tended to be higher in $Vmax_{uphill}$ vs. $Vmax_{flat}$ (19.4±0.9 vs. 19.2±1.0 n.s.), but maximal heart rate and end lactate were unexpectedly lower (188.4bpm ±9.1 vs. 192.1bmp ±8.3 p<0.001 and 8.8 mmol/L ±2.0 vs.9.2 mmol/L ±1.9 n.s.) $Vmax_{uphill}$ vs. $Vmax_{flat}$ did not exactly correspond to each other: the better the athlete (i.e. the higher $Vmax_{uphill}$), the greater was the positive difference between $Vmax_{uphill}$ and $Vmax_{flat}$ **CONCLUSION**: Elite orienteers seem to have greater running capacity uphill than flat. $Vmax_{flat}$ may be limited by a neuromuscular fatigue before a true cardiovascular fatigue is achieved, explaining why flat and uphill performances do not exactly correspond. This test gives an alternative in performance testing that is more specific to orienteering performance.

Introduction

In orienteering, uphill running capacity plays a commanding role in the race strategy needed to win. With rough off trail running, and extensive climb involved in the sport, the athlete must be as efficient as possible in these conditions to run a winning time. The energy cost of running is greatly increased when conducted off trail, i.e. in terrain. Oxygen cost can be as high as 26% greater running in the forest than compared to road running (1). This high energy demand naturally gives orienteers a high aerobic power (up to 76 and 63 ml/kg/min in men and women respectively) (1). Jensen et al. (1999) showed that running economy was less impaired in orienteers than track runners when running in terrain. They documented that there was even a difference between elite and sub elite orienteers, where elite orienteers had a better running economy in terrain than sub elite orienteers. This shows the importance of measuring specific parameters in orienteers, which are more applicable to orienteering performance.

An orienteers ability to run uphill will be a deciding factor in the route choice that is made (3, 7). Those athletes who feel confident in their uphill running capacity may take a more direct route, instead of a detour to reduce the climb involved. What ends up being the fastest route depends on the athlete's ability, and the difference between flat and uphill running capacity within the competition field.

There is very little research on differences in uphill running capacity in orienteers. Orienteers typically take part in performance testing, which is often performance on a flat treadmill, to determine a lactate threshold or VO2max. These tests are useful to monitor training and possible fitness improvements, but lack specificity. When an orienteer

performs a flat lactate threshold test, the result shows only a part of this athletes running capacity. Their uphill running capacity is equally if not more important to success in orienteering than their flat running ability. The performance testing that is available today seems to have a gap in assessing the possible differences in oxygen uptake, heart rate, lactic acid, and rating of perceived exertion during uphill versus flat work.

Route choice making in orienteering also depends on determining the difference in work-load between running uphill versus flat. This type of information is critical in deciding whether to go around or over climb, yet there is discrepancy in the literature to how large the work-load difference really is. There is empirical research investigating the equivalent difference between climb and distance. Scarf P (1998) used Fell running records in England to calculate a ratio of 1 to 8, meaning that 125m of climb is equal to 1km distance flat. In a research experiment from Knowlton RG (1988) a ratio from 1 to 10 was investigated using running time on three different course, steep uphill, gradual up hill, and flat. All courses were of "equal" workload according to the 1 to 10 ratio, and consequently different in distance. They concluded that 1 to 10 is much too large, what has been supported by other authors (1, 5) but there finding that the ratio could be as low as 1 to 1.8 is not supported. We have had successful experience in a pilot study (not published) conducted, where we compared workload differences between flat and uphill running. We feel we have successfully targeted a workload difference of 1 to 6.5 that resulted in similar heart rate, lactate, and RPE (using the Borg scale) for each concurring stage of the flat and uphill tests.

The aim of this study was to quantify uphill running capacity in a laboratory treadmill test with Swiss elite and junior orienteers, and to evaluate the differences between flat and uphill running capacity. Moreover, we wanted to evaluate the differences in uphill running capacity within the team itself.

Methods

Participants

Eighteen male and fourteen female orienteers, all of who were members of either the Swiss elite or junior national teams, volunteered to participate in this study. Each participant completed a medical and training status questionnaire. A sports medicine physical examination was completed on the same day as the tests. Physical characteristics are given in Table 1.

Treadmill tests

On arrival to the Swiss Olympic Medical Center, Magglingen, each participant completed a flat standardized lactate threshold test, in accordance with Swiss Olympic guidelines (www.swissolympic.ch). The incremental treadmill test (HP Cosmos Venus, Nussdorf, Germany) began after a warm up period on the treadmill. Stages continued 3 minutes, and increased 1.8km/h per stage. The first stage speed was determined from the pervious years test, or for first year runners, 7.2 km/h for women and 9.0 km/h for men. The athlete continued the test until voluntary exhaustion.

The second graded treadmill test was completed after a 3 to 4 hour rest period, where athletes where supplied with a carbohydrate rich energy gel and sports drink (Sponser Sport Foods, Wollerau, Switzerland) and a lunch packet again rich in carbohydrates to control for lost glycogen stores. The second test was completed at 22% incline. This graded uphill test followed the same protocol as the flat lactate threshold test described above. The speeds were reduced in the uphill test to achieve similar workloads, which was established in pilot testing. A ratio of 1 to 6.5 comparable effort was used to calculate the workload difference of running at 22% incline. Speeds were reduced to 40% of the initial speed in the flat test. Each stage continued for 3 minutes, and increase 0.7km/h per stage (also 40% of the increase in the flat test). The test was completed to voluntary exhaustion.

Table 1. Physical characteristics of subjects (n = 32)

	Age	Height (cm)	Weight (kg)	BMI (kg/m2)
Elite men (n = 9)	25.6	179.6	69.2	21.4
± SD	3.36	7.32	6.65	1.06
Junior men (n = 9)	18.4	179.3	69.5	21.6
± SD	1.01	6.43	5.73	1.86
Elite women (n = 7)	24.4	169	56.2	19.7
± SD	3.15	4.14	4.4	1.17
Junior women (n = 7)	20.6	167.1	57.9	20.7
± SD	2.44	4.11	2.24	1.31

Table 2. Equivalent speed conversion.

Uphill treadmill speed	Equivalent flat speed (Vmaxuphill)
2.9 km/h	7.2 km/h
3.6 km/h	9.0 km/h
4.3 km/h	10.8 km/h
5.0 km/h	12.5 km/h
5.7 km/h	14.3 km/h
6.4 km/h	16.0 km/h
7.1 km/h	17.8 km/h
7.8 km/h	19.5 km/h
8.5 km/h	21.3 km/h
9.2 km/h	23.0 km/h
9.9 km/h	24.8 km/h

Table 2. Treadmill speeds on uphill test were calculated into an Equivalent flat speed ($Vmax_{uphill}$) by taking the actual speed and dividing it by 0.4.

Table 3. Mean Vmaxuphill vs. Vmaxflat

		Uphill test	
	Vmaxflat km/h	max km/h	Vmaxuphill km/h
Elite men (n = 9)	20.7	8.9	22.5***
± SD	0.42	0.34	± 0.84
Junior men (n = 9)	19.5	8.3	20.7***
± SD	0.63	0.24	± 0.6
Elite women (n = 7)	17.7	7.31	18.3 n.s
± SD	0.77	0.59	± 1.47
Junior women (n = 7)	16.1	16.8	16.8 n.s
± SD	0.84	0.44	± 1.09

*** $p<0.001$

n.s Not significant

Measurements

In both tests, rating of perceived exertion using the Borg scale was asked 30 seconds before the end of each stage. Blood lactate concentrations were measured using 10 µl samples of whole blood taken from the ear lobe during a 30 second break between each stage and analyzed using Super GL lactate analyzer (Germany), which was pre-calibrated before each test using 2 standards. Heart rate was monitored with a Polar chest transmitter (Polar Electro, Oy, Finland) for the entire duration of the test. Two minutes after test end, a last blood sample was taken for lactate concentration. Maximal running speed in the grade uphill running test was expressed in equivalent flat running speed to enable comparison of the two tests. This was calculated by dividing the actual maximal speed uphill by 0.4 to achieve an "equivalent flat speed" defined with the term $Vmax_{uphill.}$ All $Vmax_{uphill}$ speeds reported have been calculated in this fashion (see Table 2).

Statistical analysis

The results are represented as the mean ± standard deviations. To detect differences between group means, we used an unpaired t-test. The level of significance was chosen at $p< 0.05$.

Results

Mean $Vmax_{uphill}$ was faster than $Vmax_{flat}$ in both men (+7.2% $p <0.001$) and women (+3.6% $p <0.05$). Elite men (n= 9) had an average $Vmax_{uphill}$ of 22.5 km/h ±0.84 versus 20.7 km/h ±0.45 flat and junior men (n=9) had an average $Vmax_{uphill}$ of 20.7 km/h ± 0.60 versus 19.5 km/h ±0.62 flat. Elite women (n= 7) had an average $Vmax_{uphill}$ of 18.3 km/h ±1.5 versus 17.7 km/h ±0.77 flat and junior women (n= 7) had an average $Vmax_{uphill}$ of 16.8 km/h ±1.1 versus 16.1 km/h ±0.84 flat (see Table 3).

The difference in $Vmax_{uphill}$ versus $Vmax_{flat}$ ranged from +0.5% to +12.7% in men, and from -6.4% to +15% in women. Five out of the fourteen women were slower uphill than flat; none of the men were slower.

Maximal Borg (Table 4) tended to be higher in $Vmax_{uphill}$ vs. $Vmax_{flat}$ when men and women are grouped together; however it was not significant (19.4±0.9 vs. 19.2±1.0 n.s.). Maximal heart rate (Table 5) was unexpectedly lower in men and women at termination of the uphill test (188.4 bpm ±9.1 vs. 192.1 bmp ±8.3 $p<0.001$) and sub maximal heart rate during the uphill test were also lower than during the flat test (-2%±3.2% $p <0.05$). End lactic acid concentrations (Table 6) were also unexpectedly lower (8.8 mmol/L ±2.0 vs.9.2 mmol/L ±1.9 n.s.) but this was not significant.

$Vmax_{uphill}$ versus $Vmax_{flat}$ did not exactly correspond to each other (see figure 1): the better the athlete (i.e. the higher $Vmax_{uphill}$), the greater was the positive difference between $Vmax_{uphill}$ and $Vmax_{flat.}$ This shows that a flat test does not express the full running capacity in some orienteers.

Discussion

The main finding of this study is that elite orienteers seem to have a greater running capacity uphill than flat. We found that there were two ways of judging this ability. We compared their uphill running capacity to their flat

running capacity to give a relative ability. Here we were able to determine that some orienteers in relative terms seemed strong uphill, but actually only lacked the flat speed also necessary in the sport. In addition, there were also orienteers that were so strong flat, that their uphill running capacity seemed weak. Therefore, we reported out finding in absolute terms, without taking into consideration the individual flat running capacity.

The athletes were however given a report on both their absolute and relative uphill running capacities.

The results of the uphill test were compiled into a ranking list of the team members' uphill running capacity. This was done as a reference to the athletes and coaches in order to help them prepare for the upcoming world championships in Japan. The terrain in Japan can be characterized by its steep slopes, where the climb can range up to a grade of 35%, at its extremes. The Swiss National team had immense success at this year's world championship in Japan. The team earned 8 medals, 4 gold, 2 silver, and 2 bronze. The results in Japan tended to correlate with the individual results of the athlete's uphill running capacity. The best within the team in the uphill test tended to also be the best within the team in Japan and very successful at the world championships.

There was an increase in maximal speed in both the flat and uphill running from the junior team to the elite team. This gave us insight to what running improvements might be necessary in order to continue onto the elite national team from a junior age. When taking the men into consideration, this observation is in agreement with Züst et al (2002) who reported that men between the ages of 18 and 21 who continued onto the elite national team increased their Vmax significantly, yet they found no significant increase in women regardless to whether they continued onto the elite national team or not. We found significant changes in both men and women, between the teams, in both flat and uphill Vmax.

The literature has investigated the effects of running uphill versus flat from a physiological standpoint. It has been documented that during uphill work, VO2 max is higher than during flat work (9). Oxygen deficit has been seen to increase with an increase in treadmill grade up to 15% (6), and this O_2 deficit is related to a greater activation of muscle mass during uphill running in comparison to flat (9,10). Schmidt et al (1995) investigated the effect of heart rate, lactic acid concentration, and oxygen uptake during running at different speeds and inclines. He found that with an increase in speed of 2km/h, heart rate raised 2-3 bpm higher than with an increase of 3% incline. He also found that lactic acid production was lower when incline was increased. The test that only increased in speed, but stayed flat had the highest lactic acid concentrations, whereas the test that only increased in inclination had the lowest. This conflicts with Olesen et al (1992), who found that end lactate concentrations were higher at a grade of 10.5% than 1%, but there was no statistical difference between the values obtained at 1 and 15% or between 10.5% and 15%. Our finding support Schmidt et al, we found that heart rate was lower during the uphill running test in comparison to the flat test, and lactic acid concentrations, although not significantly different, were lower during the uphill test. A possible explanation for this occurrence is that during the flat lactate threshold test, the use of fast twitch type II muscle fibres are, naturally due to the high speeds, recruited. Since fast twitch muscle fibres use primarily anaerobic energy sources, it makes sense that lactic acid at these speeds is produced. During the uphill running test, the speeds run at 22% incline are not fast enough to elicit large use of type II muscle fibres, and therefore less anaerobic energy is used, producing less lactate. In orienteers, maximal speed during a flat test could therefore be limited by neuromuscular fatigue due to the high lactate levels, before cardiovascular fatigue can be reached. For this reason, orienteers are able to run for a longer amount of time, resulting in a higher maximal speed in the uphill test versus the flat test. If this is the case, why did we see a lower maximal heart rate in the uphill test? We have two possible explanations; one could be that there was a cardiovascular fatigue due to the two tests completed in one day, and that the 3-4 hours of rest given was not sufficient enough to recover. The other hypothetical mechanism is that a local increase in lactic acid caused enough pain in the lower extremities to terminate the test, before a true maximal heart rate could be achieved. This can be supported by the tendency to have a higher rating of perceived exertion during the uphill test. The local lactate production was however not measured to be greater than the accumulated end lactic acid during the flat test, seen by the lower maximal lactic acid concentrations in the uphill test. It also has to be considered that the uphill test always followed the flat test after

the 3 to 4 hours recovery, and even though we tried to restore lost glycogen stores, lower lactic acid levels in the second test could be a consequence of slight glycogen depletion.

Table 4. Rating of perceived exertion in Vmaxuphill and Vmaxflat

	Vmaxflat RPE	Vmaxuphill RPE
Elite men (n = 9)	19.2	19.3
± SD	0.67	± 0.71
Junior men (n = 9)	19.8	20
± SD	0.35	± 0
Elite women (n = 7)	18.4	18.4
± SD	1.27	± 1.13
Junior women (n = 7)	19.3	19.6
± SD	1.25	± 0.79

Differences in all groups are not statistically significant.

Table 5. Maximal Heart rate in Vmaxuphill and Vmaxflat

	Vmaxflat HR (bpm)	Vmaxuphill HR (bpm)
Elite men (n = 9)	185	181 n.s
± SD	7.1	± 8.9
Junior men (n = 9)	198	193*
± SD	4.96	± 5.8
Elite women (n = 7)	193	188**
± SD	6.72	± 9.0
Junior women (n = 7)	191	190 n.s
± SD	8.91	± 8.2

** $p<0.01$
* $p<0.05$
n.s. Not statistically significant

Table 6. End Lactic acid concentration in Vmaxuphill and Vmaxflat

	Vmaxflat La (mmol/l)	Vmaxuphill La (mmol/l)
Elite men (n = 9)	9.1	8.16
± SD	2.19	± 2.06
Junior men (n = 9)	10.5	9.9
± SD	2	± 1.68
Elite women (n = 7)	8.3	7.5
± SD	0.88	± 1.31
Junior women (n = 7)	8.4	9.4
± SD	1.86	± 2.24

Differences in all groups are not statistically significant.

production was however not measured to be greater than the accumulated end lactic acid during the flat test, seen by the lower maximal lactic acid concentrations in the uphill test. It also has to be considered that the uphill test always followed the flat test after the 3 to 4 hours recovery, and even though we tried to restore lost glycogen stores, lower lactic acid levels in the second test could be a consequence of slight glycogen depletion.

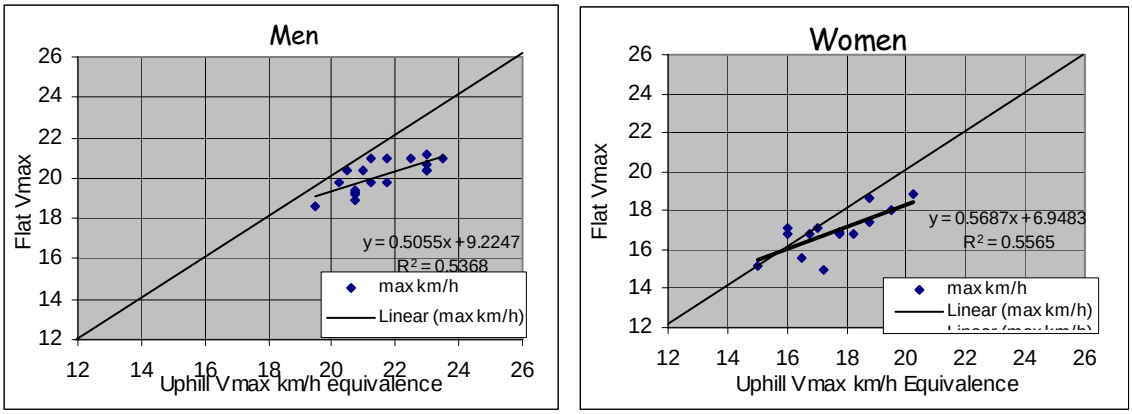

Figure 1. Positive deviation of the equivalent maximal uphill running speed from maximal flat speed, in male and female elite orienteers.

Conclusion

In conclusion, orienteers seem to be having a greater running capacity uphill versus flat, which can have consequences on route choice making during a competition. Their ability to run flat is probably limited by a neuromuscular fatigue due to that fact that they have, by nature of the sport, a better aerobic power than anaerobic. This inability to achieve cardiovascular fatigue during the flat test may explain why flat and uphill performance does not exactly correlate. Consequently, this type of performance testing gives an alternative to the standard lactate threshold test that for orienteers may be more specific to orienteering performance.

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The effect of pack formation at the 2005 world orienteering championships

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Abstract

At the 2005 world championships there was considerable discussion and a formal protest in the long distance race arising from a perceived advantage obtained by some athletes running together. It is shown that a statistical model presented in previous work [1] is applicable to this event, giving predictions of the final times to with 2-3 minutes. Using the model, we show that pack formation was inevitable in this format. The statistical benefit gained at the elite level from running with other competitors appears to derive both from increase speed through the terrain, and the elimination of large navigational errors.

Introduction

The rules of orienteering forbid competitors in individual competitions from following one another, however there is no prescription for what should happen when one competitor catches another. This contrasts with sports such as triathlon where "drafting" (following closely behind another cyclist to obtain reduced aerodynamic resistance) may be forbidden by requiring caught competitors to drop back. There is, however, little doubt that having sight of another orienteer can affect performance, whether through increased chance of spotting a control marker, improved navigation, reduced need to read the map, finding of better routes through terrain, or simply motivation to run faster.

IOF rule 26.1 states, "In an individual interval start race, competitors are expected to navigate and run through the terrain independently." In practice, violations of this rule are commonplace.

The purpose of this paper is to estimate the statistical benefit derived by elite athletes from running together in the recent World Championships. The study is based on a model for pack formation, described below, which has been tested previously on data from public races in the UK.

Methods

In the model, an orienteering race is simulated by assuming that each competitor *i* procedes around the course at a speed u_i determined by their own ability. When another competitor is within a certain range *r* ahead, this speed is increased by a factor *b*, which is referred to as the boost – these quantities are the same for all competitors. A competitor obtains no advantage from a following competitor. We integrate equations of motion in discrete timesteps for interacting competitors moving in one dimension from start to finish. A faster competitor (or pack) can pass a slower one if, despite the effect of the boost, the slower competitor's speed remains below that of the faster competitor. There is no provision the model for one competitor to pass another without seeing each other, e.g. if they are taking different routes. This has some bearing on our results, and will be discussed later.

In previous study, based on a large number of statistically generated artificial races, it was shown that groups would dominate a competition if the fraction of competitors of able to catch another competitor but not get away from them exceeded 13%. Above this threshold the packs will continue to grow in size. Insufficient data from actual events was available for detailed statistical analysis (largely because of lack of start time data), but comparison suggested the model was accurate in the absence of large navigational mistakes.

For application to a specific race, it is necessary to determine the individual speeds u_i and the boost factor b. Because of the correlation with start time, u_i cannot be taken from the qualifying races. The World Rankings list cannot be used as it is compiled in a way that makes it impossible to relate points to relative running speeds, and in any case conflates results from many different terrain types over a long period of time, which may not be relevant to ability in Japanese terrain in August 2005. Consequently, it was decided to use the average speed over the first third of the course, subtracting errors [2] of more than 45s to derive u_i. This has the advantage of being in appropriate terrain and time, and is relatively unaffected by pack formation. By analogy with previous UK work, the boost was set to 8%. Tests with lower boost factors gave poorer fits to the results. With this level of boost, a pair of athletes will move 4% faster than their average, unboosted speed.

The information regarding start times and intermediate lap times was taken from the official website of the 2005 World Championships [2]. These times are not repeated here, but it may be a convenience to the reader to take a copy.

Results

Both men's and women's races were examined, comparing the simulated race with the Good agreement is obtained between the two sets, with packs forming and breaking in the same way for both. It is not the intention of this paper to interfere with the protest in the men's race, so we concentrate our analysis on the women.

In particular, the crucial features of the women's winners are well reproduced: and a discussion of this illustrates most of the salient features of the model. Firstly Jukkola catches 2 mins. on Novikova. In the model these two form a stable pack, however shortly afterwards they are caught by Niggli. Niggli/Jukkola form a stable pack (NJ), but this pack moves too fast for Novikova, who is then dropped. Next two further pairs (Allston/Haapakoski AH and Ryabkina/Jurenkova RJ) are caught by NJ – at one point six of the fastest eight competitors appear to be together – although these groups meet slightly later in the simulation than in the actual race, the model correctly predicts that only Haapakoski from these pairs can stay with NJ, and the boost they provide for her means that Allston will be dropped to finish alone. As can be seen in figure 1, other features of the race are similarly well reproduced, as are details of the men's race.

It is interesting to examine whether effects of packing in the model presented here give it significant additional predictive power over simple extrapolation. In figure 2 the actual results of the race are compared to the model predictions. There is a four minute gap in the results at around 95 minutes, and it can be seen that the model based on the first six controls predicts the finishing times of this group to within three minutes. The agreement with the second group is weaker, because they are more prone to unpredictable navigational errors. Six minutes is the largest deviation. This should be contrasted with naïve extrapolation from the first six controls, which gives errors about 250% greater. It is thus clear that the collective packing behaviour incorporated in the model is important in determining the results.

In the simulated race, the amount of time boosted by being in packs exceeded 40mins for six competitors, five from the leading group (recall that in a pair, only one competitor is boosted at any given time). For a competitor taking 80mins, this level of boost gives a time advantage of around three minutes.

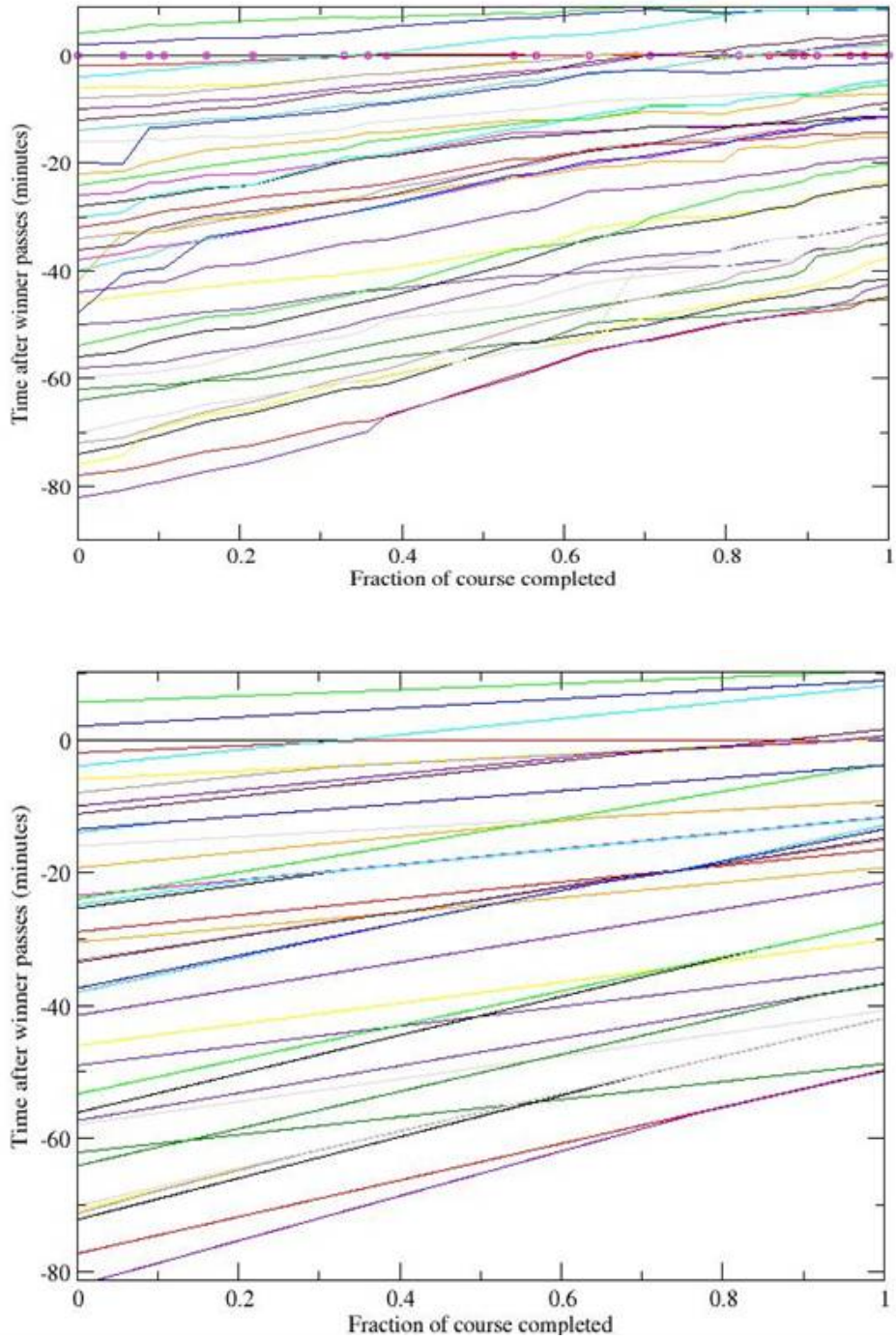

Figure 1. Actual and simulation progression of competitors in the women's classic WOC.

y-axis shows the time relative to the winner at which each competitor is at the location given in the x-axis, hence packs are shown by lines coming together. Colours are consistent between the two figures; competitors named in the text (with start time) are Niggli (black, 0), Jukkola (red, -2), Novikova (blue, -4) Haapakoski (yellow, -6), Allstom (grey, -8), Ryabkina (purple, -10) and Jurenkova (brown, -12). Upper panel shows actual results: circles denote positions of control points where data is recorded. Lower panel shows simulated results, using model described in the text with 8% boost, and minimum time increment of 6sec and range equivalent to 30m. Start times are offset to incorporate errors incurred in the first six legs used to determine u_i.

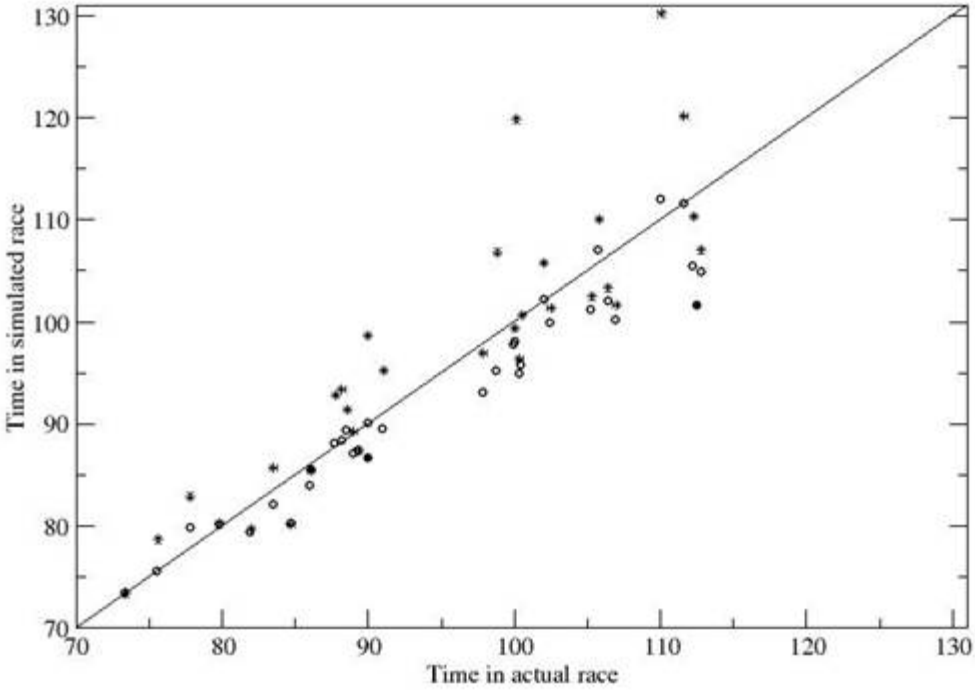

Figure 2. Scatter plot showing correlation between predicted and actual times. Circles are the full models, including packing effects of boost and error suppression, stars represents simple extrapolation from time at the sixth control assuming that independent pace is maintained. Line shows position of perfect agreement. The exact position of control 6 is unknown, so its fractional distance around the course is deduced from the winner's time, which therefore lies exactly on the line. The key point of this figure is that including pack effects gives a significantly better prediction of the final result.

Discussion

It is surprising that a model based on improved speed from following produces such close results, given the importance of navigational errors in orienteering. However figure 1 reveals a remarkable feature – all errors of more than two minutes are made by orienteers running alone. The men's race has only one such incident. By contrast, most of the competitors spend most of their time in packs.

While the benefit of pack formation in avoiding large errors is not explicitly incorporated in the model, it does have a powerful indirect effect in improving the fit. Since we evaluate our speed data from the first section of the race, errors made then are incorporated in the finishing time. The validity of the approximation that no further errors are made in the latter part of the course is helped by the fact that more packs exist then.

As with all statistical models, the uncertainty of its predictions for specific individuals is such that it is inappropriate to apply them rigorously to individual cases. The actual, simulated and extrapolated women's results all have Niggli and Jukkola as clear leaders. The men's result illustrates how unpredictable events cannot be well predicted by the model: As in the real race, Khramov, Lauenstein and Tavernaro forms early and dominates the high positions, however the winner of the simulated race is, in fact Schneider who forms a pack with Stevenson and maintains his early lead, passing a slower moving pair (Schuler and Horacek). In the actual race these packs did indeed form and meet, however Stevenson suffered an injury. If Stevenson is arbitrarily removed from the model at this point, a Schneider/Schuler pair forms (as in reality) but is not as fast as Schneider/Stevenson and Khramov wins.

Thus, according to the model, Stevenson's injury has far-reaching effects: it eliminates him from the medals, it deprives Schneider of the gold, which goes instead to Khramov, it gains several places for Schuler and costs several places for Horacek. It is important to emphasize that these specific outcomes are presented as an example, and cannot be deduced with certainty. However, the more general result is strongly indicated by this work: that a network of strong interactions does exist between competitors, and the actions of one can affect the outcome for numerous others.

Using the model for a race where the distribution of speeds is known it is possible to determine *in advance* whether a particular format with a particular spread of competitor ability through the startlist will be strongly influenced by pack formation. It can also predict at what stage packing will occur, although not which individuals will benefit.

If the simulation is repeated for the same u_i and starting order, with a 4 minute start interval the onset on pack formation is much delayed: only a small number of pairs are formed late in the race. While this may appear to resolve the problem of packing, this work also predicts that longer periods of running as individuals would lead to more significant navigation errors, which could increase packing.

An alternate approach of "forking" the course has been used at previous championships to split pairs of runners from consecutive starts. Typically this fork has been placed late in the course, however this simulation provides a method for determining the optimal location of the fork, which with a 2 minute start interval is closer to the middle of the course..

Conclusions

A pre-existing model for pack formation in orienteering has been analysed in the context of the 2005 World Championships. It has been shown that the formation of packs has a significant outcome on the result. The effect of pack appears to be twofold, a general increase in speed of around 4-8% (less for the faster members of the pack), and the near elimination of navigational errors involving large time loss. At most, the benefit derived from the former effect is up to 3-4 minutes, while the benefit from the latter is unquantifiable.

References

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Appendix – Mathematical and implementation details

The progress of the athletes is modelled by their average velocity v_i over a discrete timestep *dt*. Acceleration is assumed instantaneous on the timescale of *dt*. The position x_i is evaluated by a simple forward difference algorithm, i.e.:

$x_i(t+dt) = x_i(t) + v_i(t)H(t-t_{si})H(1-x_i(t))\,dt$

$v_i(t)$ is discontinuous, being given by

$$v_i(t) = u_i(t) + bu_i(t)H\left(\sum_j H[x_j(t) - x_i(t)]\,H[x_i(t) - x_j(t) + r]\right)$$

where H(x) is a Heaviside step function (H(x)=1 for x>0;H(x)=0 otherwise), u_i, b, r being the velocity, boost and range as defined in the text, t_{si} being the start time for the *i*th competitor,

To implement the simulated race, units of "race length" and "winners time" were used, with other quantities being scaled appropriately. The discrete timestep (6 sec) has the effect of allowing a pack of competitors to leapfrog one another, since the leader is always unboosted. Formally integrating the equations of motion causes the pack to become localised at one point in space, and makes determination of who is boosted impossible. The pack velocity v of some model packs of size N is as follows:

N=2, u_i = a, a : $v_{1,2}$ =1.04a.

N=4, u_i = a, a, a, a : $v_{1,2,3,4}$ =1.06a.

N=2, u_i = a, 1.08a : $v_{1,2}$ =1.08a.

N=3, u_i = a, 1.02a, 1.08a : $v_{2,3}$ =1.091a, v_1=a.

Beginners' Perspectives of Getting Involved in Orienteering in Greece

Koukouris K, Ph.D.

Abstract

Orienteering has only recently been introduced as a sport in Greece, and it is not known what motivates people to decide to participate in a previously unknown and rather complex sport. The present study looks at the first ever experience of the sport of 355 participants. Participant observation and questionnaire were used as methodological tools. Male participants constituted 61.7% of the sample (N=219) with female participants 38.3% (N=135). The vast majority (83.5%) were between 19 and 44 years old. Analysis of the participants' responses showed that the main reasons for taking part in orienteering events are curiosity/desire for a new experience, love of forests and nature in general, love of sports, walking and exercising in a natural environment, social reasons, to learn a new multi-dimensional sport, to acquire compass and map-reading skills, the sense of adventure or nature exploration, and recreation. The main sources of satisfaction for the participants include the natural beauty of the course locations, the sense of adventure and challenge of being in an unknown area, the excitement involved in the discovery of control points, learning orientation using map and compass, running and walking in difficult forested areas, cooperation with friends and co-athletes, and finally the multi-dimensional nature of the sport. The main sources of dissatisfaction include the following: tiring ascents on rough areas, inaccurate maps, and poor weather conditions. In addition in some events the feeling of exasperation due to the time limitation (score events). Problems resulting from poor management, inadequate information, and the location of some events in the burnt forest outside the city were also sources of dissatisfaction. The lack of experience of many beginners leads to difficulties in using a compass, poor understanding of the rules orienteering and difficulty selecting an appropriate course. Others mentioned dislike of certain plants or animals they came in contact with. In general the results of this study showed that participants in Greece are very satisfied with the sport and therefore further efforts to promote the sport would appear worthwhile.

Keywords: orienteering, participation, motivation

Beginners' Perspectives of Getting Involved in Orienteering in Greece

Orienteering has only recently been introduced in Greece (1997), and as such little is known why some people decide to participate in this unknown and rather complex sport. Until 2002 about 20 races were organized in the whole of the country. There are few opportunities to get involved, but it is an ideal sport to get people out of cities. Possibly it is not promoted enough. This is the first attempt at gathering some descriptive data about Greek orienteering participants' reasons for taking part as well as the sources of satisfaction and dissatisfaction from the initial experience of the sport.

Hogg (1995) confirmed through his research that orienteers on the whole are well educated, they are devoted to an active life style, and are interested in travelling and outdoor activities. Long distance travelling in Australia is part of the orienteering culture. Regarding mountain bike orienteering, Hollenhorst, Schuett, Olson, and Chavez (1995) found that mountain bikers in national parks tend to be young, very educated, rich, and from an urban background. A large number of mountain bikers participate in races, organized courses, and festivals.

In contrast to many other European cities where 14% on average of the ground coverage area consists of parks and sport facilities and 39% are open spaces (Sinadinos, 1993), it is well known that in the two major Greek cities, Athens and Thessaloniki, there are relatively few parks or open spaces and citizens have to travel great distances in order to reach suburban green spaces. According to Sinadinos, the lack of green spaces in Greek cities results from

greedy exploitation of land for profit with cementing of land, lack of planning, lack of normative rules, non implementation of approved studies, and so on. Although at present relatively unknown in Greece, orienteering is one of the outdoor sport activities that could transcend this stifling urban context and provide a healthy outlet for people living in urban areas. Orienteering events allow participants to visit some beautiful areas which might otherwise remain unknown and unexplored. Below arguments will be presented in two parts. Firstly evidence for taking part in orienteering from other studies, and secondly evidence for taking part in new sports in general.

Studies have shown that people take part in events for different reasons, and since they have varying abilities, orienteering courses are classified by degree of difficulty. McNeil, Ramsden, and Renfrew (1987) mentioned the following reasons why young children should get involved in the sport: (a) it requires that competitors analyze information continually as well as the ground formation and to connect the map with the ground, (b) it improves fitness and cardiovascular capacity, (c) it is both mentally and physically challenging, motivating children to run further, (d) self-confidence and self-reliance are developed as children are required to take full responsibility for their actions, (e) young people often start the sport in groups and in this way they learn to cooperate with others, (f) young people are encouraged to set targets and work hard and creatively in order to achieve them, and (g) young people learn to appreciate the importance of the environment and develop an environmental protection ethic. Another characteristic of the sport is that it could be adjusted according to each participant's needs. The participant chooses the length and difficulty of the course as well as the speed by which he or she would like to run or walk. Claesson, Gawelin, Jägerström, and Nordström (1981) believe elite orienteers are motivated by the desire to win, A class orienteers participate because they want to improve their performance, B class orienteers because competition motivates them more than non competitive events, and beginners take part because they want to enjoy themselves, to exercise, and learn more about the countryside. In another study (Hogg, 1995), two thirds of Australian orienteers initially decided to get involved in the sport after being motivated by friends or family. Influence by mass media was shown to be the next most important method of getting people involved in the sport. Strangel (1996) classifies Norwegian orienteers into five categories: (1) A large number of participants regard orienteering as recreation, fun, exercise, and as a good opportunity to be out enjoying nature. (2) The elderly participants regard the sport as the best exercise for their age. (3) Younger people regard orienteering as a tough non-family sport. (4) A further small group of older members regard the sport as an ego trip and disregard recruitment; they ignore beginners, sponsors, and spectators. The only thing that they want is to take part in their sport. (5) The last group is comprised of elite orienteers who are primarily interested in contests, mass media, financial support, and sponsors.

It will come as no surprise if authorities of track and field people in Greece will hold a negative attitude towards the sport. What makes orienteering so dissimilar to endurance running? It is hard to answer. We assume that the multi-dimensional aspect of orienteering, the learning of compass and orientation skills, the adventure and exploration of nature, and the recreational aspects of the new sport appear to be the main differences at a first glance. Evidence of differences between athletics and orienteering beyond the technical aspects is lacking. Little has been said about the clash between new sports and the established athletic order. This will be clarified later on. The participants can take part outside competition, or try their skills in permanent courses at any time. Although the participants run against the clock, no participant knows his or her exact position immediately after the finish. Because orienteering in Greece is not so well established as in other countries in Europe, it may be considered to be an alternative sport. And since it is an alternative sport, result lists are not displayed on site, but rather sent two weeks later. Although orienteering is an individual sport, most participants in Greece run in pairs or groups. The club "officials" are participants themselves. They all take part in the event except the course-setter. There is only one active club operating in the whole of the country which sends results lists. There is no official federation. Although the club is recognized by IOF, it is not yet recognized by the Greek sporting authorities. The club has no connection with the State.

The decision to become involved with a particular sport is influenced by several factors. For instance sporting opportunities are very different in urban and rural environments, and consequently the choice of sport depends on the area in which one is brought up. The choice of sport depends on whether someone lives in an urban or rural environment (Knopp, 1972; McPherson, 1982). The family and the educational system are regarded as the main

socializing agents during the formative years in childhood, whereas friends and acquaintances play an important role during adolescence (Brennan & Bleakley, 1997). It has been observed however that despite the existence of many sport opportunities outside the school, young people are not so willing to participate in extra-curricular sport.

Many outdoor people compete in events during activity holidays. According to Eerola (1999), despite its social and financial importance, sport tourism has not attracted the interest of many scholars. In addition, misinformation by mass media regarding activity holidays as being open only to trained people, and the profile of participants as being risk-takers has frightened many potential customers from recreation companies, and created false expectations for those taking part (Kouthouris, Katsimani, Tzetzis, & Kosta, 1999).

Since some of the participants in Greece were mountain bikers it is appropriate here to mention some important points. The fast endorsement of mountain bike by the outdoor enthusiasts shows that mountain biking fulfils many needs including entertainment, physical exercise, and contact with nature (Hollenhorst et. al, 1995). According to the authors nearly a third of mountain bikers (30.5%) are involved in mountain biking simply because they like exercising, 23% are involved for fitness reasons, and 10.8% because they exercise in a natural environment.

In Greece, orienteering is practiced, not as a mainstream sport, but as an alternative sport. The main characteristics of an alternative sport should be clarified before we proceed any further. Beal (1999) identifies three main differences between traditional sport and alternative sport like skateboard, alternative sport having the following characteristics: (1) The participants control alternative sport whereas the authorities are absent. (2) The participants define the limits of the sport that permits them to create an activity that suits their needs. The participants decide to promote individuality, creativity, and self-expression. (3) The participants are against competition and in favour of cooperation. From other alternative sports it is known that the appearance of a new sport always upsets the established athletic order (Heino, 2000). As Heino points out, “the rise of snowboard offered resistance to the dominant culture of skiing and sports as a whole; it made transparent the meaning and capital involved in skiing as well as the commodification and legitimating of sports in general. This is where the animosity began” (p. 176). Important issues such as legitimatization and resistance, social class, and gender are important in the athletic milieu just as in society as a whole. As Rinehart (1998) points out, the philosophy of alternative sport is related to the life-style and the artistic expression of oneself, not to media or competition.

The aim of this study is to analyze the reasons why people participate in orienteering events for the first time in Greece. One of the aims of the analysis was the creation of categories of reasons given by participants as to why they took part in orienteering, their sources of satisfaction and dissatisfaction. It is hoped that the conclusions reached may help in deciding how to promote the sport, improve the quality of orienteering event organization, and increase the participants’ enjoyment, and so on.

Methodology

The Sample

The sample consisted of 355 participants who took part in an orienteering event for the first time ever. Of these participants 61.7% (N=219) were male, and 38.3% (N=136) were female. As regards the age distribution, the vast majority were between 19 and 34 years of age (60.5%), 12.7% were 35-44 years old (2.4% were 45 years or older), with 5.6% aged 12 years of younger (primary school pupils), and 10% aged 13 to 18 years (secondary school children). Most of the participants were still in the educational system (53.5%), while 39.2% had completed their education. Professional and intermediate classes were overrepresented (26.5%), whereas manual social classes were correspondingly underrepresented (5%).

The participants took part in events organized in the outskirts of Thessaloniki, Serres, and Ptolemaida in Northern Greece over a period of four years (1997-2000). Overall, 13 open O events have been organized, as well as numerous other events specially designed for schools, ex-commandos, mountain-bikers, and others. The sample includes nearly all the participants in these events in Greece; in other words it is nearly the total population of participants during these years. A few events (four) were conducted in Athens by another organizer, and these people were not included in the sample. The sample was regarded as representative for beginners in Greece and met the selection criteria.

Method

The categorization of data into sentence-forms (Jones, 1985) and the constant comparative method (Glaser & Strauss, 1967) were used. The concentration of units of meanings which accrue from "properties" and, in the final analysis, "categories", were used in the largest part of the study. Without the usual statistical analysis, reasons for taking part in a competitive sport were examined through interpretative sociology, specifically by applying the phenomenological approach (Whitson, 1976). For the collection of data, an ethnographic method was used. Ethnographic work is generally based upon the active participation of the researcher in the production of knowledge, demands the full-time involvement of the researcher over a lengthy period of time, and consists of ongoing interaction with the people studied (Mitchell, 1968; Pedersen, 1998). Highly personalized accounts that draw upon the experiences of the author/researcher for the purposes of extending sociological understanding were also used (Sparkes, 2000).

Selection of Data

A questionnaire was distributed to all participants at the end of each O event. The questionnaire consisted of 32 questions (7 of which referred to the reasons for participation). Most questions were in multiple choice format, but there were also open-ended questions allowing the participants to make their own comments. In this paper only the open-ended questions (three) are analyzed. There was an introduction explaining the aim of the research. There were further questions (not examined here) focusing on the social and sport background of the subject. The participants were allowed ample time to clarify their thoughts. Because there was an opportunity for multiple answers, the frequency of responses was quantified for each question. The response rate was 100%, with no one refusing to complete the questionnaire. A few small children were helped by their parents to answer the questionnaire.

Results

Reasons for Taking Part

Many people who tried orienteering also practice other sports or physical activities as their first sport, like jogging (11.4%), hiking (9.1%), swimming (7.8%), weight training (7.8%), cycling (7.5%), and others. Participants were asked what prompted them to take part in the event. Participants took part in events for the following reasons, which are described in order of decreasing importance by frequency.

(1) Curiosity/New experience (n=111). The two concepts are sometimes mentioned separately by respondents but together by others. Participants decide to participate in order to have a new experience. They were often influenced by the positive impression given by significant others as well as the advertisement of the event beforehand. A few participants were curious about the way the event was organized. One participant mentioned that he was influenced by

foreign television programmes to try orienteering. The following extracts from the open-ended questions are characteristic:

"I have never participated in an event before, and I wanted to try this experience." "Thirst for something new and unknown." "Information received from a friend and the good experiences and memories that he had from this sport. I wanted to have these experiences too". "I have always wanted to take part in these games because I had seen orienteering events abroad on television." "Curiosity was the reason I travelled to the venue."

(2) Love of forests and nature in general (n=89). Some participants decided to take part in order to get acquainted with the mountain or to see the mountain from another perspective, being already mountaineers. Many participants had already had experience of mountains through hiking clubs, cycling clubs, campsites for children, and so on. The participants gave the following comments:

"I have been involved for more than 10 years with children's campsites and I love every activity connected with nature". "It's another contact with mountains and I have been learning about mountains through my hiking club." "I was persuaded by a friend to come, but the basic reason was my love of nature, mountains, and mountain biking".

(3) Learning a new multi-dimensional sport, map-reading, compass and orienteering skills (n=62). Some participants decided to take part in order to exercise in a different way and coordinate mental and physical exercise. These participants believe that orienteering is a multi-dimensional sport where participants set achievement targets for themselves and mix fun, recreation, and sport. They believe that orienteering is significantly different from cross country running, and demands good map-reading skills within an adventure context. The sport has already attained good fame in Northern Greece and continually attracts new participants. The above mentioned points are illustrated in the following quotes: "I was curious to get to know this sport about which most people talk with enthusiasm." "It is a new sport that brings people, regardless of their age, close to nature. It encompasses fun, recreation, and sport all in one." "The reason was the differentiation of orienteering from normal cross country running."

Some participants were motivated by their desire to learn to use the map and compass, and finally to get to know the area, testing simultaneously their fitness. The similarity with hiking attracts some hikers although the sport demands more skills than hiking or cross country running. Some excerpts illustrate these points: "I wanted to learn map-reading and use a compass and get to know the forest around the city." "I have been involved in mountain hiking for the last 20 years. I am interested in orienteering because it demands additional effort and skills." "It was a chance to get to know our endurance and how well we could orientate." "I saw it as a game. It was an opportunity to get to know the beautiful paths of mountain Hortiatis and learn to orientate using a compass."

(4) Love of sports, walking, and exercising in natural environments (n=58). Another reason for participating was in order to exercise in a beautiful natural environment, to improve fitness, to release energy, and to seek activity outside the big cities. In this study, women regard orienteering as a relatively safe sport due to the large number of runners in the forest. However, it should be mentioned that there were some incidents where female participants were confronted by male exhibitionists in the past in Greece. Some extracts are as follows: "The combination of exercise and contest in a very beautiful environment." "I was always interested in cross country running." "I love sport and nature. I am an athlete despite being old. I will continue exercising till the end of my life" a veteran athlete said. "The need to exercise with security in a natural environment" said a female participant.

(5) *Social reasons, being informed by a relative/friend, being motivated by a coach* (n= 42). This major category mixes several reasons: (a) one person motivates someone else, (b) motivation to do something together as a family, and (c) meeting others. Orienteering is one of the few sporting activities where the whole family can take part. Some participants decided to take part after they were motivated by friends, partners, neighbours, and so on. They regarded orienteering as a good opportunity for fun and solidarity with friends. "Having the opportunity to see their parents playing a sport is a very positive factor which influences children's final involvement in sport" (Brendan & Bleakley,

1997, p. 81). Orienteering can also be the place where friendships as well as characters are tested. A few mountain bikers were motivated by their coaches. The above mentioned points are illustrated below:

"The insistence of my friend who is hooked on extreme sport." "I came to accompany a good friend of mine who wanted to come because he liked the sport." "All the family walked together, having the same target within a beautiful environment." In the first mountain bike orienteering race ever in Greece, a coach motivated many bikers to participate. "The coach told me about it and I liked the sound of it, so I decided to take part in the race." "Solidarity with my friends was the most significant reason, and I ended up gaining a true impression of their character."

(6) Recreation and an escape from everyday life (n=26). Some participants decided to take part for recreational reasons and because they regard orienteering as an alternative form of hiking. For these participants, it is a game rather than a sport, where they refresh themselves mentally. They are not interested in competition. These points are illustrated in the following: "Orienteering is a form of recreation and I like it very much." "You recharge your batteries and become strong. And you have something beautiful to remember." For others it was a release from stress. Physical exercise as catharsis characterizes those physical activities which provide a release from accumulated everyday frustrations (Kenyon, 1968). "It was a chance to escape from the city and learn more about nature." "It was a challenge in order to feel the consequences of smoking."

(7) Adventure and exploration of nature (n=24). Some participants decided to take part for the adventure and to explore nature. For example: "There was an internal motivation for something different, original, and adventurous." "I like nature and I wanted to explore the mountain." Perhaps this adventure element presupposes some risk taking. Adventure and exploration of nature were regarded as a relatively serious reason for taking part.

(8) For competitive reasons (n=6). It is well known that competition increases the motivation of people who regard themselves as competitive (Coakley, 1986). Apart from competition against other people, Petrie (1971) mentions another attitude towards physical exercise, that of competition against the natural environment. "I wanted to know the whole procedure and how good I am at trekking."

(9) Miscellaneous reasons (n=17). Some people of the P.E. Department participated as part of their studies without having any internal motive, or simply because they were interested in improving their marks in the course examinations. Some participants decided to take part because they felt bored generally, motivation by significant others (they knew the organizer or the course setter personally), for professional reasons (they own recreation companies), or they were journalists who wanted to write an article in the newspaper, and so on. Some examples include: "I had nothing more interesting to do." "I wanted to prove to myself that I not a lazy person." "I am interested in developing the sport professionally." "I came to this area completely by chance and because I heard about it I took part."

Sources of Satisfaction with the Sport

Participants were asked what made them feel satisfied with their participation in the event. Most spare time activities are multi-dimensional, in that many personal needs are satisfied by each recreation activity (Tokarski, 1985). The following text is about the affective component of attitudes (is it bad or good? Is it harmful or beneficial?), rather than the cognitive dimension of attitudes (is it wrong or true? Is it likely or unlikely?) (Fishbein, 1967; Osgood, 1963). There is usually an interrelationship between various sources of satisfaction and it is very difficult to differentiate between them. However, for analytical reasons these sources of satisfaction will be classified:

(1) Courses in beautiful natural surroundings (n=141). Most participants of an urban origin are attracted to orienteering by the beauty of nature, as racing areas tend to be selected due to their natural beauty. Simple things like the fruits in the fields, the birds and animals in the forest, the discovery of springs, and so on, which are far removed

from everyday life in the cities, attract new participants. Sources of satisfaction include: “The natural environment and the beauty which I saw while searching for the control points.” “I enjoyed the beauty of the forest.” “The fruits that we picked.” “The rabbit and the partridge that I saw.”

(2) Orienteering as a multi-dimensional sport, space conception, and learning orienteering skills (n=66). Familiarization with the use of the map constitutes a basic component of the sport (McNeil et al., 1987). As hiker Westacott (1991) points out “orienteering has a considerable influence on the development of map-reading skills, and many of its concepts such as ‘aiming off’ and ‘attack points’ are now in everyday use by walkers” (p. 108). Some participants felt satisfaction from learning to orientate using map and compass and finally getting to know the area. For example: “The discovery of the forest (as much as we could see) and the effort you made to find the target” (orienteering improvement) was a source of satisfaction for one participant.

Some participants liked the fact that orienteering is a multi-dimensional sport and combines mental and physical exercise with a natural environment, has a lot of variety, demands self-concentration and observation, produces a thrill or a feeling of excitement, and has a great range of applications, and so forth. For example: “I liked its philosophy, nature, timing, self-concentration, and observation.” “The relationship between hiking, orienteering, and sport.” “The burning of body calories and brain substances.” “The well designed map which was very analytical.” “The capacity of the sport for wide applications.” “You were motivated to find the control points whereas simultaneously you exercise and breathe fresh air.”

(3) Exploration, adventure, and challenge in an unknown area (n=40). The planning of orienteering courses obliges the participants to wander in natural environments where they would only rarely decide to go on their own. According to respondents in all races there is a continuous investigation that keeps the interest of participants at a very high level. As is well known, there are various obstacles during the course which enhance the excitement and difficulty, as is illustrated by the following comments: “The steep descents and the river crossing.” “I saw some areas in the forest that I would not have seen otherwise.” “The continuous investigation kept the interest unimpaired until the last minute. It was a race which, the further you went, the more enthusiastic you became.” “It was adventurous, and you were under stress until you found the control points. Afterwards, you felt relieved and carried on.” “I liked the sense of play and exploration in the familiar environment of my home city.” “We found a spring.”

(4) Competitive stress regarding the discovery of control points (n=36). Many participants felt anxious about finding control points but felt satisfied when they found them. According to Hastie (1995), the participants in orienteering are more satisfied when they complete the course rather than when they compete. This point is illustrated in the following: “The agony of searching for the control points, as well as the natural beauty spots.” “The continuous stress about whether you will be able to reach the finish line having discovered all the control points.” “You were under stress until you found the control points. Afterwards, you felt relieved and carried on.” An experienced mountain-biker liked “the stress of finding the control points as well as the two very beautiful descents which were technically for the very advanced.” A small girl who took part in a string course said she liked “the forest and searching for the tapes”.

(5) Action-exercise in difficult areas (n=32). Some participants particularly enjoyed running in the forest off the paths. The choice of race appropriate for the individual enhances satisfaction. For example: “The combination of physical endurance and path finding.” “The opportunity we had for climbing and canoeing.” “The selection of a difficult course by the organizers which helped improve my fitness.”

(6) Social reasons, cooperation with friends and co-athletes (n=29). Although orienteering is an individual sport, in Greece, because of participants’ lack of experience, groups of athletes are allowed to compete together and cooperate. For many parents, an important characteristic of orienteering is that it allows families to take part together. During weekends, evening entertainment is organized for participants, which creates a friendly atmosphere. Being with friends or with the family could both be a reason for taking part as well as a source of satisfaction. The following were mentioned as sources of satisfaction: “Being with my friends before and after the race.” “I wanted to be with my

family." "The joint effort and the positive attitude of organizers and participants." "The night entertainment and the race."

(7) The poor weather conditions (n=9). In contrast to many participants who were dissatisfied because of poor weather conditions (see later), there were a few participants who liked the stress created by poor weather conditions. For example: "I liked the weather conditions which created a lot of stress."

(8) The good management of the event (n=8). A few participants were impressed by the efforts of the organizers. For example: "The organizers were friendly and cheerful." "The effort to spread the sport." "The sensitivity of the organizers who invited me" said a blind man.

(9) Development of self-confidence, confrontation of challenges (n=7). Several participants felt proud because they managed to confront the challenges of the game and achieve the targets. The demands (very difficult course) can have positive outcomes (being proud). Some extracts appear here: "The sense that I could test my abilities without being able to find all the control points within the one hour time limit." "I liked the challenge because there was a lot of fog and mud, it was a very difficult situation but now I am proud of myself." "I managed to finish the race by checking all the control points."

(10) The friendly and fair competition (n=5). Competition might reduce the motivation of potential participants who would describe themselves as non competitive to take part in sport (Coakley, 1986, pp. 205-228). On the contrary non competitive people are more likely to be motivated by non competitive sports (although orienteering could also be done in a non competitive manner), or by sports where competition is hidden and where comradeship is first. The results of the O events organized so far were not announced immediately but sent by post two weeks later. That means that participants do not learn who the winner is on the day of the event, and so they cannot celebrate in front of others, but rather they get feedback at a later date. "I liked the fact that I was alone and I wasn't competing against anybody." "There was no obvious competition."

(11) Miscellaneous sources of satisfaction (n=15). Some participants liked the fact that they had the opportunity to see the burnt forest. Others mentioned they needed to set themselves a target, to get rid of stress, to teach their children, and so on. For example: "I liked the whole idea because you had a target." "Beside the fact that I felt great, the courses were beautiful and it was an opportunity to get out of the daily routine." "Teaching orienteering to my children."

Sources of Dissatisfaction with the Sport

Participants were asked what prompted him or her to feel dissatisfied with the event. Nearly half of the participants (45%) mentioned no sources of dissatisfaction. But others mentioned the following sources:

(1) Tiring ascents on rough areas (n=30). As is well known in countries where the sport is developed, orienteering takes place in rough forested areas, where there might be some relatively steep ascents. Crossing streams might be especially difficult for children. Many participants take part in events without first attending some introductory speeches. Many young mountain bikers participated in the first ever MB orienteering event without prior knowledge of the sport, apart from a single training session. As a result of their lack of experience and being poorly informed of the rules, they were apprehended by difficult ascents. For example: "I didn't like the fact that I had to ascend a steep hill." "Crossing the stream was too difficult for children." "I didn't like the ascents and the fact that we were running here and there", said a twelve-year-old mountain biker.

(2) Inaccurate maps (n=24). Many participants mentioned that the maps used were inaccurate. Indeed one of the main obstacles for the development of the sport in Greece is the lack of maps. The only maps available (after application at the Military Geographical Service in Athens) were military ones dating back to 1970. This presents mountaineers, as well as other interested people, with the task of finding their way around a mountainous country without the help of accurate maps. This presents any organizers of orienteering events with the task of drawing their own sketchy maps, which might lead to some inaccuracies. The participants' comments were as follows: "I didn't like the poorly drawn map. More details like houses, paths, and fences are needed." "Maps could have been better."

(3) Poor weather conditions (including very cold or hot weather, or rain) (n=25). The majority of those who complained about the weather had taken part in a single event under very bad weather conditions (fog, muddy dirt roads) on a mountain. Most of the events were held under ideal weather conditions. Comments: "I didn't like the muddy dirt tracks." "Unfortunately there was fog and rain. However, we should not forget that when we are talking about orienteering, these conditions are absolutely normal."

(4) Responsibility of the participant himself or herself. Lack of experience with the compass/orienteering and too easy or too difficult control points (n=25). Orienteering skills are best taught at an early age and then developed with experience. Otherwise it is difficult for older children or adults to master the compass skills. Also due to the selection of inappropriate courses in certain cases, some control points appeared too easy, and others too difficult. As an 11-year-old mountain biker said: "It was very difficult to use the compass. We got confused and sometimes we fell." "We were cycling in all different directions."

(5) Limited time for running resulting in disappointment (n=18). Some participants in score orienteering events expressed dissatisfaction because of the time limit: "Time puts you under pressure and doesn't allow you to enjoy the beauty and serenity of the mountain." "I expected the game to last longer."

*(6) Poor management/inadequate informat*ion (n=18). As mentioned earlier, many participants take part in events without first attending some introductory talks which are organized prior to the event. Instead they expect to be instructed just before the start of the event, when the organizers are very busy. Variations between courses are not by colour-coded standards, but by the particularities of the terrain. Also there are no predefined time starts, but participants are able to start at any time, usually within a four hour period. As participants mentioned:

"The members of the organizing committee should coordinate the race better. They should give information about the use of compass and maps; they should tell us where exactly the first control point is." "There should be an intermediate race between the one for beginners and the one for advanced runners that wouldn't give my nine-year-old son a rough time. My son was very enthusiastic with the beginners' race, but he wanted something more. The intermediate race was beyond his capacity." "There should be a large interval between the starting times, so that those who follow do not cheat. Otherwise, fair play in the competitive part of the race is spoilt."

(7) Organizing some races in the burnt forest and ugly scenery (n=17). Some participants disliked the fact that the event had been organized in a burnt area of the forest. For example: "I felt dissatisfied because of the burnt forest, the ruined and abandoned cars; some had criminal aims against the forest." So, the reason for their dissatisfaction was not the race per se, but the organizing of the race in the burnt forest.

Despite the course planners' efforts to choose the most scenic areas, forests in the outskirts of the city present a realistic rather than ideal choice. An experienced mountain biker did not like "the fact that there was no variation in the morphology of the terrain and the scenery".

(8) Fear of injury and lack of contact with the organizing committee and remote start (n=10). This fear is justified because the race covers a large area. This is risk inherent in orienteering and participants are aware of it abroad. Besides, the start is indeed sometimes remote from the finish line, inhabited areas, or the bus stop, this being

determined occasionally because this is required by the needs of the course. Whereas abroad this seems to be the norm (for example it is not unusual for the start to be 3 km away from the finish line), it is disturbing for some participants in Greece.

(9) Aspects of the natural environment (n=9). Within the depressive urban conditions children become alienated from nature. As a result of this a few children are upset by nettles, thorns, lizards, caterpillars, and insects. Nearly all of those who mentioned problems with the flora and fauna were children. They mentioned: "I didn't like the insects and the reptiles on the grass." "I didn't like the remote and dangerous places with high grass." Needless to say, there were no particularly dangerous places or snakes in the orienteering area.

(10) Litter along the course (n=5). In the forests surrounding the city, the litter, including cans, plastic plates, debris, mattresses, and even burnt and abandoned cars, is obvious. Many participants were dissatisfied with the presence of litter. "I didn't like the litter" in the running area. However, one participant saw the problem in a different way: "It is a good thing that there is litter so that we can become conscious of their filthiness."

(11) Miscellaneous sources of dissatisfaction (n=21). Other reasons for dissatisfaction included problems with co-athletes, the disturbance by the participation of ex-commandos in the races, disturbance by the simultaneous cycling race in one particular event, poor quality compasses, too friendly competition, helping other teams, not finding the control flags because of their removal by third persons, and so on. It is usual for beginners in Greece to run in pairs. Only one of them carries the map and compass. If the partners separate for some reason during the course, the one left without compass and map is in trouble. A major problem for the organizers is the removal (possibly theft) of control flags, which creates unnecessary stress and frustration for the participants. Some of these problems are illustrated by the following quotes: "There was a simultaneous cycling race and we had to pass through the lines of the cyclists." "I lost my team-mate who had the compass and map during the race. I got lost in the forest." "The compass was of poor quality, it was dangerous when I was climbing the rocks, but it was my responsibility." "Someone took the control flags." "The visitors and the participants were very noisy."

Discussion of Results and Conclusion

The results of this study do not agree with the arguments presented by Vanrusel (1995) and Humberstone (1999). However, the values and actions of those who are involved in outdoor activities have changed. Instead of love of nature, (traditionally regarded as a feminine quality), those who are involved in outdoor activities usually have aggressive, destructive, and male chauvinistic characteristics in a Rambo-like fashion (Humberstone, 1999; Vanrusel, 1995). Instead of being concerned exclusively with their own personal interests, participants in outdoor activities should realize that these activities might harm the interests of society as a whole (Vanrusel, 1995). The environment must remain intact for future generations. Some people with modern un-conventional values oppose the macho competitive ideology (the mountain conquering syndrome) (Humberstone, 1999). These characteristics are far from the reasons listed in the results of this study. First of all those involved in this sport are more nature friendly than those who are involved in consumptive, for example, hunting or motorized outdoor activities, snowmobiles, jet ski, motorcycling, and other (Jackson, 1986). Secondly, newly-established sports cannot exhibit these characteristics. According to Hammit and Brown (1984), whereas in the urban environment we pay superficial attention to other people, in the wilderness we pay deep attention to familiar persons. Solitude in the wilderness liberates the mind from the daily routine and offers serenity.

The main reasons for taking part in O events are curiosity/new experience, love for nature, forests or mountains, learning a new multi-dimensional sport and compass and map-reading skills, love for sports, walking and exercising in natural environments, social reasons, being informed by a relative/friend, being motivated by a coach, adventure and nature exploration, and recreation.

The curiosity/new experience dimension was the most important reason for taking part in the sport. As Donnelly and Young (1999) pointed out, nothing can prepare an aspiring rock-climber for the first climb, because it is something that he or she should try himself or herself first. Similarly no written or oral account of orienteering can be compared to first hand experience. If the experience is positive, the participant will be eager to try again.

Love for forests and nature in general is the second major reason for taking part in the sport. It is well known that some of the reasons for young people's involvement in outdoor activities is their desire for experiences in the natural environment and their willingness to protect it and show commitment to green idealism, which is widespread among young people (Putnam, 1989). In contrast to those people who are involved in consuming (fishing, hunting) or mechanized outdoor activities (sea and snow scooters), those who participate in sports which appreciate nature (hiking, kayaking, orienteering) have stronger attitudes towards the environment (Jackson, 1986). The results of this study are consistent with young people's trend to protect the environment by taking part in outdoor activities.

The third factor, love of sports and walking in natural environments, could be combined with the previous factor. The social reasons factor (including being informed by a relative/friend, being motivated by a coach), is a serious factor frequently mentioned in research about attitudes towards physical education and sports. The attitude of participants toward physical activity as a social dimension was documented three decades ago (Alderman, 1970; Apgar, 1976; Dotson & Stanley, 1972; Petrie, 1971). Schutz, Smoll, Carre, and Mosher (1985) divided this into two dimensions: (a) social continuation, and (b) social growth.

The learning a new multi-dimensional sport reason and the learning map-reading reason were combined. These are frequently mentioned in popular literature of the sport. The adventure element follows. Perhaps the adventure element presupposes some risk taking. As Albert (1999) concluded, "far from being merely an inconvenient – even peripheral – element in sport, danger and risk taking might be better understood as constitutive of participation in the first place" (p. 169). Although orienteering is much less dangerous than other outdoor activities, there is some risk of injury. According to research the risk of injury during participation in orienteering is comparable to other sports. Among 15,000 participants in the international O-Ringen games of 1977, 658 were injured. Ekstrand, Roos, and Tropp (1990) estimated that there are 8.4 accidents for every 10,000 hours of running in orienteering. These results are comparable with most other sports.

Another quite important reason for taking part is recreation. For some beginners orienteering is a recreational sport which could make them feel happier or stronger. The increase in free time as a result of the industrialization multiplied the need for sport and games (Stamiris, 1991). Unfortunately, free time is often filled with activities that do not necessarily make people happy or strong. As Czikszentmihalyi and Lefevre (1989) pointed out, if people could realize how negative their feelings are when their experiences are not challenging or strong enough, they would improve their life quality with a more conscious and active use of their leisure.

Participants are satisfied because they enjoy the beautiful courses in nature, they face an adventure, and challenge themselves in unknown areas, they enjoy the stress regarding the discovery of control points, they learn to use map and compass, they enjoy running and walking in difficult forested areas, they are happy because they cooperate with friends and co-athletes. They feel dissatisfied when they have to face tiring ascents on rough areas, inaccurate maps, and poor weather conditions. The limited time for running resulting in a state of exasperation was a source of dissatisfaction when score events were organized in the past. Some management problems, inadequate information, and the organizing of some races in the burnt forest next to the city were also sources of dissatisfaction. Many beginners have to face problems with the compass and the sport rules because of their inexperience. Also they cannot choose a course appropriate for them. Some are alienated from the natural environment, and they are upset by some plants and animals. Last, fear of injury because of lack of contact with the organizing committee is a possible threat. In general it would appear that participants in Greece are very satisfied with the sport. Efforts should be made to promote the sport further.

The results of this study are culture bound. Considering the huge gap that exists between the initial stage of development of the sport in Greece, and the advanced development of the sport in most European countries, it was expected that the results of this study should be culture bound. Different mechanisms operate both within and between cultures that negate the global application of any model (Fishwick & Greendorfer, 1987). Combinations of methods (open and closed-ended questions as well as participant observation) have been used in this study. However, due to space limitations not all results are mentioned here. Time and monetary limitations did not preclude the single investigator from employing many triangulatory devices. This is a research program, not an isolated research project. Field work preceded the survey by providing information about receptivity frames of reference and span of attention of respondents (Smith, 1975). This helped the triangulation of methodology. The initial results were sent to some regular participants who were given the opportunity to make comments and contribute in this way to the quality of the study (Walker, 1985). The results of the study are peculiar to this sport, and thus are not applicable for other new outdoor sports in Greece.

Suggestions for the Development of the Sport in Greece

The aim of the suggestions is to increase public awareness of orienteering, improve quality of orienteering in this country, and attract more participants to the sport. Several suggestions could be made for the development of the sport in Greece:

(1) Afthinos (1998, p. 168) suggests the organizing of daily trips to the forests in the outskirts of a city in connection with learning the basic techniques of the sport. He also suggests the incorporation of orienteering in the city projects for recreation in nature. By organizing more events in the outskirts of a city the sport could become more accessible and well known to people (Strangel, 1996). The participants in the events mentioned that the days of the event should coincide with public holidays, when many people go out to the countryside, so that a lot of people see the event and get to know the sport. This suggestion is connected with Reasons 4, 5, and 6 for taking part in events. It is also connected with certain sources of satisfaction (1 and 6). Orienteering of course could be organized in urban areas in the form of score orienteering. Some university campuses in Greece have detailed architectural maps. Other outdoor events, games, or parties could be organized as well. As many forms of orienteering as possible should be organized in forests surrounding the cities. The events should be modified according to local terrain, and when one form proves to be popular it should be continued (Palmer, 1994). Permanent orienteering courses should be established in forests surrounding the cities. Score orienteering events were eventually dismissed, because they were not proved to be popular with participants (see 5 in sources of dissatisfaction).

(2) There should be better coordination and recruitment methods in schools (Hogg, 1995; Strangel, 1996). Teachers and parents should be involved in the development efforts. Orienteering skills should be taught along with writing and reading skills in ordinary schools from the age of 9 or 10 years (not just outdoors, but also in the classroom). As these children grow, they regard orienteering skills as natural as writing and reading. The desire for map-reading and use of compass (Reason 3), and the desire for learning a new multi-dimensional sport as reasons for taking part is interrelated with this suggestion. The sport should be an integrated part of children's camps and P.E. university departments in the country. Orienteering is taught only in one of the P.E. education departments, and in a handful of children's camps. The compulsory participation in orienteering because of studies has not led to any real progress of the sport. The sport should be developed through the education for the recreation of adults and the elderly (Hogg, 1995).

(3) In cooperation with hotel managements the sport should be spread in tourist areas where there is an influx of foreign visitors.

(4) The sport should become customer and media oriented. There should be excitement among the audience (Strangel, 1996). Schools, clubs, and others could organize trips to the competition venue.

(5) The maintenance of social contacts with other members of the club and the development of social contacts in general through training sessions constitute an essential element for the recruitment of new athletes to the sport (Hogg, 1995). The social reasons (Reason 5) were indeed a relatively important reason for taking part in the sport.

(6) The development of orienteering in Greece could be facilitated through the creation of active O clubs. There were only two orienteering clubs in Greece, but one of them stopped activities. The creation of ghost clubs with no real orienteering activity and misinformed members only serves private and commercial interests.

(7) Because those who do take part in orienteering events in Greece come from various backgrounds and abilities (hikers, ex-commandos, school children, etc.), there should be plenty of choice in terms of the degree of difficulty for the participants (Palmer, 1994) (see point 4 in sources of dissatisfaction).

(8) Local advertising and promotion of the sport could serve the sport better than national campaigns because the concept of orienteering is not well understood by the people (Palmer, 1994). In Greece the urbanization trends after the War were so extensive that few people were left in the countryside with knowledge of local forests. Also due to fires the forested parts of the country are under severe threat (see point 7 in sources of dissatisfaction). The existence of criminal elements in forests frightens many citizens, especially women. Environmental education could be made through outdoor activities including orienteering. One should get to know nature before one develops ones conscience regarding the environment (see point 7 in sources of dissatisfaction). Had they not taken part in orienteering events, many of the participants would never have seen the rubbish in the forests or realized the extent of forest destruction. And perhaps this is one of the most important but hidden benefits.

In addition to the above, I would add that colour-coded events with more options should be organized. The accuracy of maps should be improved by professional mappers. The management problems could be improved by better and more professional practices. At certain points during the race there should be water and medical stations.

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An Investigation into the Race Strategies of Elite and Non-Elite Orienteers

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Abstract

The introduction of new technology in the form of 'electronic punching' in the sport of orienteering has opened up new areas for investigation, particularly in the field of race strategies. The aim of this study was to compare the race-strategies of elite and non-elite orienteers. A preliminary questionnaire was completed by 119 orienteer runners stating which race strategy they preferred to use in a race situation. The actual race strategies of 15 elite and 15 non-elite orienteers from four different age classes, M21, M50, W21 and W50, were then compared using results from three events. The relative speeds for the first, middle and penultimate legs of the race were determined for each runner in order to discover the runner's actual race strategy. Independent t-tests showed that there were no significant differences ($p>0.05$) between the race strategies of elite and non-elite orienteers in three out of the four classes analysed. The results of this study therefore suggest that the differences in performance between the elite and non-elite orienteers are likely to be due to other factors, such as a difference in overall fitness levels and absolute speeds sustained throughout the race. Results also indicated that whilst significantly more orienteers felt they had used a 'steady throughout' race strategy during a race situation ($p<0.05$), in the majority of cases relative speed actually increased significantly ($p<0.05$) over the course. It is clear that electronic punching allows close analysis of times throughout a race and may, therefore, prove useful as a training and coaching tool for elite orienteers.

Introduction

The ability of runners in long-distance events to develop an effective race strategy is a key element to the winning or losing of races. Research into marathon running has shown that a fast pace in the first 10 to 15 miles is a good predictor of a fast overall marathon time (Hamm, 1996). In the 5,000 m however, it is more desirable to keep a consistent pace, as short bursts of speed will be detrimental to overall performance (Martin & Coe, 1997, p. 344). Some runners however, seem to discount this research and run with their own race strategies, for example, Paula Radcliff runs each race at her own pace, usually preferring to push ahead of the rest of the field. This has often proved effective in her case, but disastrous for others. The bulk of research in the field of race strategy involves marathon running and long-distance track events, whilst other sports such as orienteering, which uses endurance running as its base, have been less well researched.

The very nature of orienteering, with its elements of cross-country and off-road running (Bird, cited in British Orienteering Federation, 2000, p. 16) combined with a hostile environment, has caused problems for research, with only a limited number of studies completed. The majority of studies focus on either the physiological or cognitive aspects of the sport, for example, the study by Creagh and Reilly (1998) into the physiological and biomechanical aspects of orienteering and that by Almeida (1997) into decision-making in orienteering.

Almeida (1997) compared the cognitive differences between the best orienteers and other orienteers of a sample of ten elite Portuguese orienteers. It was found that there were "no significant differences between the two groups [in terms of] the cognitive processes involved in decision-making" (Almeida, 1997, p. 54). There must therefore be alternative reasons as to why some orienteers come first and others come last. A number of different theories have been formulated in an attempt to solve this question.

Eccles, Walsh, and Ingledew (2002) investigated whether the use of different heuristics during route planning affects the level at which an orienteer competes. Their results suggested that novices use a very different heuristic to experts when planning routes to controls in that whilst "novices work forwards from the start to the control … experts work backwards from the control to the start" (Eccles, Walsh, & Ingledew, 2002, p. 327). Although this research shows that there are distinct differences between the cognitive processes of those who win orienteering races and those who come last, it does not explain how these differences affect performance. Murakoshi (1990) suggests that it is experience that leads to the differences between elite and non-elite orienteers: "Subjects were asked to judge conditions of terrain from given maps. … The results implied that experts use not only the meaning of map symbols but also their internal knowledge, and that this knowledge may be gained by experience" (p. 10). This research must be questioned though, as large numbers of orienteers compete for many years and gain a great deal of experience, but are not able to compete at an elite level. Cheshikhina (1993) developed their theory by expanding previous research by Hancock (1987), which "showed that exercising at, or above the anaerobic threshold has a statistically significant inhibiting over-all effect on the ability to perform mental tasks" (Hancock, 1987, p. 43). It was found in Cheshikhina's study that "qualified orienteers [those who had participated at a high level] developed a high psychic stamina against the fatigue caused by running" (Cheshikhina, 1993, p. 49). These participants were, therefore, able to carry out the cognitive tasks asked of them during orienteering to a high standard. Elite orienteers have also been found to be more proficient in certain map reading skills than non-elite participants (Barrell & Cooper, 1986, p. 25).

The development of electronic punching and its introduction at major competitions in the late 1990's (Borg & Rochford, 1999, p. 8) has increased the opportunity for research into orienteering. "Electronic punching is a system that uses an electronic card containing a microchip and electronic punches, replacing the traditional paper or Tyvek cards and needle punches" (United States Orienteering Federation's [USOF] Electronic Punching Program, 14/02/05). According to the USOF, this system not only saves on time and work, and eliminates many mistakes but also provides split times for all competitors at each control. This data allows comparisons to be made between competitors and can also be used to see how the competitors pace themselves over the course, whether they are fast at the beginning or end, or if they run at a steady pace throughout.

The introduction of this new electronic system has provided researchers with brand new data and allow for a greater understanding of orienteering. There would appear, however, a lack of researchers using this data. The purpose of the current study therefore, was to use this data to gain insights into how orienteers pace themselves throughout their races and to determine whether their chosen race strategy has an impact on their performance and final placing.

Method

Subjects

119 orienteers of varying abilities completed a questionnaire investigating their perceived race strategy. Their physical characteristics are shown in Table 1.

Gender	**Age (yrs), mean ± SD**
74 males	47.27 ± 13.80
45 females	40.70 ± 14.84

Table 1 Physical Characteristics of Questionnaire Respondents

The top 5 and bottom five finishers in four different classes: M21L, W21L, M50L, W50L, were used to analyse race strategy. Those who finished in the top 5 are referred to as 'elite' orienteers in this study and those who finished in the bottom 5 are referred to as 'non-elite'. Data was collected over three different weeks in the middle of the orienteering season to ensure high participant numbers, and at three events of different competition level, one national event and two badge events at different venues across England.

Preliminary questionnaire

In order to gain an overview of orienteers' views in the area of race strategy, a questionnaire was designed requiring subjects to state how long they had orienteered, at what level they had competed, the race strategy they felt they used in the race, their age and gender. The questionnaire was handed out to orienteers at random at the finish point of two separate events. 119 questionnaires were completed and returned.

Analysing race strategy

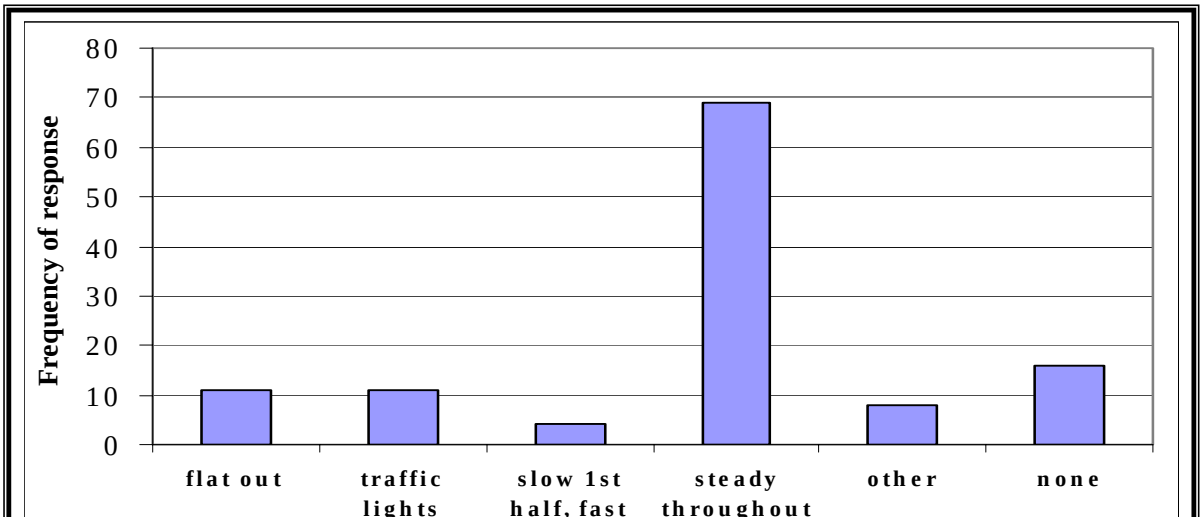
In order to analyse race strategy, speed over three different sections of the race were calculated. The first section analysed was the section between controls 1 and 2 and was named the '1st leg'. The second section analysed was the 'middle leg' and used the two controls at the mid point of the course, their numbers dependent on the course being analysed. The final section analysed was the 'last leg' and used the data collected from the split between the penultimate and last control (not the finish point).

Using the computer programme OCAD (a drawing programme for cartography), the distances between controls 1 and 2, between the middle two controls and between the final two controls were measured in meters. Using the British Orienteering Federation website, results for the four classes from the three events were downloaded using WinSplits software (British Orienteering Results, 11/03/03). Results are posted on a universally accessible database on the Internet and the software provides a breakdown of each competitor's race, providing the time taken between each control as well as the total time taken (WinSplits, 04/05/02). Using the split times (in seconds) and distances (in meters) that had been measured, each competitor's speed was calculated over the beginning, middle and end of the race.

To ensure that comparisons could be made across different events the competitors' absolute speed over separate parts of the course was converted to a relative value, that is, their speed between certain controls as a percentage of their average speed over the whole race. This was calculated using the total distance of the race, again available through the OCAD computer programme, and the competitors' total time taken to complete the race, available through WinSplits. Therefore, for each subject a relative speed was calculated for the beginning, middle and end of the race.

Various statistical tests were used to analyse the data depending on which was most appropriate. Tests used were Chi Squared and t-tests. Significance was accepted at $P<0.05$.

Figure 1: Race strategy choice amongst orienteers



Results

Figure 1 represents the responses of orienteers when asked which race strategy they felt they had used during the previous event. A one-dimensional Chi-squared test showed that significantly more orienteers chose 'steady throughout' as their race strategy than any other ($p<0.05$).

Table 2 shows a comparison between the elite and non-elite group for each of the identified legs of the race. It can be seen that there was no significant difference ($p>0.05$) in the relative speeds for each of the 3 legs for the majority of the race classes. The exception was the W50 group where the non-elite orienteers ran at a higher relative speed compared to the elite runners for the middle and end legs of the race.

Table 3 shows a comparison of the race strategies used by the elite and non-elite orienteers. For both the elite and non-elite groups, comparisons were made between each of the legs, that is, the first leg compared to the middle leg, the first leg compared to the last leg and the middle leg compared to the last leg. It can be seen that in the majority of cases the runners speeded up as the race progressed. It was found that the last leg was significantly faster than the other two legs, and the first leg was usually the slowest. In most cases the increase of speed at the start of the race was less dramatic and resulted in no significant difference ($p>0.05$) being found between the first and middle leg of the race. In all except the M21 class there was a significant increase ($p<0.05$) in pace from the mid point of the race onwards.

Table 2: Comparison between elite and non-elite orienteers of relative speeds for each leg of the race.

Race class	1st leg	Middle leg	End leg
M21	NSD	NSD	NSD
M50	NSD	NSD	NSD
W21	NSD	NSD	NSD
W50	NSD	*	*

* Significant difference found ($p<0.05$) – relative speeds were higher for the non-elite group
NSD = no significant difference found ($p>0.05$) between the elite and non-elite groups

Table 3: Race strategy adopted by elite and non-elite orienteers

Class	Group	1st leg v middle leg	1st leg v last leg	Middle leg v last leg
M21	Elite	NSD	*	NSD
	Non-elite	*	*	NSD
M50	Elite	NSD	*	*
	Non-elite	NSD	NSD	*
W21	Elite	NSD	*	*
	Non-elite	NSD	*	*
W50	Elite	NSD	*	*
	Non-elite	NSD	*	*

* Significant difference found ($p<0.05$) – in all cases the later leg was faster than the earlier leg and shows evidence that runners had speeded up as the race progressed
NSD = no significant difference found ($p>0.05$)

Discussion

Results from the questionnaire showed that significantly more orienteers chose 'steady throughout' as their race strategy. Previous research into endurance type events has shown that the optimum race strategy for both time trial cycling and long distance running is an evenly paced strategy allowing for minimum energy wastage (De-Koning, Bobbert, & Foster, 1999, p. 266; Foster, Snyder, Thompson, Green, Foley, & Schrager, 1993, p. 383; Hawley, 06/98). The orienteers in this study were, therefore, following the suggestions of previous findings in deciding to run at a steady speed throughout the race to ensure optimum performance.

The data collected from this study has shown that for the events analysed, in only one class (W50) was there a statistically significant difference between the race strategies undertaken by the elite and non-elite orienteers ($p<0.05$). This suggests that it is not the race strategy itself that is affecting the orienteers final placing, but that other factors must be influencing their performance and final positioning. Orienteering is a very complex sport with a number of factors affecting performance on the day. According to Bird (1996, p. 10) orienteers need not only "a good aerobic capacity and muscular endurance", but also "good flexibility to move fluently over rough terrain", plus well developed "muscular strength for running up hills over soft ground and through thick undergrowth". They also need high levels of anaerobic fitness for the short bursts of speed that are characteristic of orienteering events (Gjerset, Johansen & Moser, 1997, p. 4; Moser, Gjerset, Johansen, & Vadder, 1995, p. 3). It could therefore be that overall fitness across these different components is the reason for the difference between the elite and non-elite competitors in the events analysed and not the choice of race strategy.

Other theories that could explain the differences between the elite and non-elite orienteers involve the cognitive aspect of the sport. As this study has suggested that there are no differences between the race strategy of elite and non-elite orienteers, differences in levels of expertise could, in part, be due to elite runners developing high psychic stamina that prevents errors being made in terms of navigation through fatigue caused by running (Bird, 1996, p. 10; Cheshikhina, 1993, p. 49).

The results from this study have also suggested that whilst an orienteer may state that they ran using an even paced strategy, as is shown in the analysis of the orienteering questionnaire, this is not always the case in the actual race situation. Data analysis showed that there were significant differences between the relative speed of the first and last legs, and middle and last legs, in a majority of the classes, for both the elite and non-elite competitors. These results suggest that the actual race strategy was not in fact 'steady throughout', the most popular race strategy in the questionnaire, but that the relative speeds of the competitors changed over the course of the race. The results showed that at some point during the race, and mostly from the mid point onwards, competitors increased their speed. There is, therefore, conflict between how the orienteer thinks they are running their race and the actuality. This apparent contradiction could again be due to the complex nature of the sport. Whilst an orienteer may start the race with the aim of keeping an even pace, the terrain and the placement of the controls may prevent this from happening. If a course has a large amount of climb and the competitor does not have high levels of muscular endurance, this may mean that their pace has to be a lot slower, and the competitor may compensate for this loss of time by increasing speed on flatter legs. The increase in relative speed across the course may also be due to the competitor keeping some energy in reserve in case they make mistakes in their navigation and have to run for further distances than was previously thought. When it is realised that they are nearing the end of the race and no more mistakes are likely the competitor may feel that they can push themselves more by increasing their speed.

Due to the need for good navigational skills in orienteering, any mistakes can be costly, both in time and in energy expenditure. This study measured the distance between controls directly, with no room for error. In reality however, orienteers often follow line features such as paths, streams, fences and walls to find a control which means greater distances are run (Renfrew, 1997, p. 43). Individual differences in speed between certain controls therefore, may be due to mistakes in navigation rather than the competitor choosing to slow down or speed up to follow their pre-determined race strategy. Hence further study is needed to investigate times in relation to the actual route taken.

In conclusion it was found that there were no significant differences between the race strategies used by elite and non-elite orienteers. This study therefore suggests that it is not the choice of race strategy that determines the race outcome. Research has suggested that differences may instead be due to a combination of fitness levels and psychic stamina. It was also found that a significant majority of the orienteers questioned in this study aim to run races at a steady speed. However, when race strategies were closely analysed relative speed increased as the race progressed in most of the classes. This contradiction between how an orienteer thinks they are running a race and what is actually happening is possibly due to the complex terrain and the ever changing navigational component of the sport. This study has also shown that electronic punching can be used as a valuable tool in the analysis of orienteering events.

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Die chronische Lyme-Borreliose

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Einleitung

Die chronische Lyme-Borreliose ist eine Multisystem-Erkrankung, deren Symptome meistens unspezifisch sind. Ihr Beschwerdebild kann oft nicht von anderen, chronischen Erkrankungen, wie dem chronischen Müdigkeitssyndrom, der Fibromyalgie, dem multiplen, chemischen Hypersensitivitäts-syndrom, aber auch nicht von der rheumatoiden Polyarthritis oder der Multiplen Sklerose unterschieden werden. Diesen Krankheitsbildern gemeinsam ist meistens eine ausgeprägte Müdigkeit, Muskel-, Gelenk- oder Sehnenbeschwerden, sowie neurologische, neurofunktionelle oder neuropsychiatrische Störungen. Entsprechend schwierig ist nachzuweisen, dass diesen unscharfen Beschwerden eine Lyme-Borreliose zugrundeliegt. Erschwerend kommt hinzu, dass häufig auch der serologische Nachweis nicht mehr erbracht werden kann (Donta 2001).

In der nachfolgenden Uebersicht wird versucht, die chronische Lyme-Borreliose nach den klinischen Hauptbeschwerden in einige Krankheitsbilder zu unterteilen, wohlwissend dass vom einem zum anderen Beschwerdebild fliessende Uebergänge bestehen, und Ueberlappungen und Kombinationen üblich sind.

Einteilung der Lyme-Borreliose

Die Lyme-Borreliose wird in verschiedene Stadien eingeteilt.

Als Stadium I bezeichnet werden das Erythema migrans und die Allgemeinsymptome, die einige Tage bis Wochen nach dem Zeckenstich und der Uebertragung von Borrelia burgdorferi auftreten können. Während in Nordamerika 90 Prozent aller Lyme-Borreliose-Erkrankungen mit einem Erythema migrans beginnen, tritt dieses in Europa höchstens bei 30 Prozent der Fälle auf.

Als Stadium II wird die akute Organmanifestation, vor allem der Gelenke, Muskeln, Sehnen, des zentralen und peripheren Nervensystems, der Haut und des Herzens bezeichnet. Sie ist Folge der Erregerdissemination von der Stichstelle via Blut- oder Lymphwege in die verschiedensten Organe.

Das Stadium III bildet die eigentliche chronische Lyme-Borreliose. Die Definition ist aber nicht einheitlich. Amerikanische Autoren verstehen darunter das Spätstadium der Lyme-Borreliose, in die sie alle Formen der Neuroborreliose und auch die Acrodermatitis chronica atrophicans einordnen.

Andere bezeichnen eine Lyme-Borreliose als chronisch, wenn ein Jahr nach Beginn der Krankheit und nach adäquater antibiotischer Therapie weiterhin Beschwerden bestehen. Nach unserer Auffassung liegt eine chronische Lyme-Borreliose dann vor, wenn nach antibiotisch korrekt behandelter Lyme-Borreliose des Stadium I oder II Beschwerden, morphologische Gewebsschäden oder funktionelle Störungen über ein Jahr bestehen bleiben (Tabelle 1).

Die chronische Lyme-Borreliose kann in die verschiedenen Organformen eingeteilt werden: Die chronische Lyme-Borreliose des Bewegungsapparates (Gelenke, Sehnen, Muskeln), des Nervensystems, der Haut und des Herzens. Von diesen chronischen Organerkrankungen ist das Post-Lymesyndrom abzugrenzen.

Verlauf der Lyme-Borreliose und Häufigkeit der chronischen Lyme-Borreliose

In verschiedenen Langzeitstudien konnte gezeigt werden, dass auch nach adäquater antibiotischer Behandlung bei einen grossen Prozentsatz der Betroffenen anhaltende Beschwerden zurückbleiben. Bei der Lyme-

Beschwerdebild	Beschwerden, morphologische Gewebsschäden oder funktionelle Störungen, n die länger als ein Jahr n trotz stadiengerechter, antibiotischer Therapie bestehen, und die n die aktuell typische Hauptsymptome enthalten oder früher enthielten.
Serologie	Aktuell oder früher nachweisbar erhöhter IgG-Antikörpertiter und/oder aktuell oder früher nachweisbar breites Antikörperspektrum im IgG-Western Blot.
Ausschluss	Je nach Beschwerdebild klinisch, laborchemisch, radologisch oder mittels Spezialuntersuchungen Ausschluss aller möglichen Differentialdiagnosen.

Tabelle 1. Diagnostische Kriterien für eine chronische Lyme-Borreliose

Arthritis rechnet man mit einem Uebergang in die Chronizität in circa 10 Prozent der Fälle. Von der Neuroborreliose oder von der Acrodermatitis chronica atrophcans besitzen wir keine zuverlässigen Angaben; sie dürften aber nach eigener Erfahrung auch bei diesem Prozentsatz liegen. Von diesen genau abgrenzbaren chronischen Verlaufsformen einzelner Organe oder Organsysteme sind jene oft diffusen Beschwerden abzugrenzen, die meistens, aber nicht zwingend im Anschluss an eine akute Organmanifestation der Lyme-Borreliose folgen, aber deutlich über die Organgrenzen hgehen und nicht mehr dem ursprünglichen Organbefall entsprechen. Aus ihnen entwickeln sich die Beschwerdebilder wie das Fibromyalgie-syndrom, die Lyme-Enzephalopathie, das chronische Müdigkeitssyndrom oder das Postlyme-Syndrom. Ueber die Häufigkeit solcher Postlyme-Beschwerden bestehen unterschied-lichste Angaben, wobei die Resultate nicht immer auf zuverlässigen Erhebungen basieren (Fragebogen, Telefonbefragung, etc.) (Abbildung 1)

Seltzer et al. (2000) untersuchten den Verlauf der Lyme-Borreliose bei 678 Patienten aus Connecticut (USA), die antibiotisch behandelt wurden, durchschnittlich bis 51 Monate nach Diagnosestellung. Sie konnten keine signifikante Häufung von muskuloskelettalen Beschwerden gegenüber 212 randomisierten Personen feststellen, die keine Lyme-Borreliose durchmachten. Im Unterschied dazu stellten Shadick et al. (1999) bei 186 Patienten 6 Jahre nach durchgemachter Lyme-Borreliose gegenüber 167 Personen ohne Lyme-Borreliose in der Ananmnese signifikant

häufiger Müdigkeit, Palpitationen, Koordinations-störungen, Kopfschmerzen, vermindertes Erinnerungsvermögen, Konzentrations-, Wortfindungs- und Schlafstörungen, Gelenks-schmerzen und –schwellungen, Muskel-schmerzen, Schwäche, Steifheit der Muskulatur und Nackensteifheit sowie Gedächtnisstörungen und allgemeine Reduziertheit fest. Andere Untersucher wie Asch et al. (1993) oder Klempner et al. (1999) fanden in nicht randomisierten Untersuchungen eine auffallende Häufung von muskuloskelettalen, neurologischen oder neurofunktionellen sowie verschiedenste Störungen des Allgemein-befindens fest.

Trotz teils stark unterschiedlichen Untersuchungsergebnissen, wird heute in der Fachwelt am Auftreten chronischer Folgezustände einer Lyme-Borreliose in Form von verschiedenen Krankheitsbildern nicht mehr gezweifelt (Steere 2001, 2002, Donta 2002).

Diagnose der chronischen Lyme-Borreliose

Die Diagnose der chronischen Lyme-Borreliose ist eine Ausschlussdiagnose. Sie besteht erstens, aus dem Nachweis von typischen Hauptsymptomen wie dem Erythema migrans, Arthritiden, Meningoenzephalitiden oder einer Acrodermatitis chronica atrophicans (Tabelle 2). Nebensymptome, die eine lange Liste von Beschwerden umfassen, sind

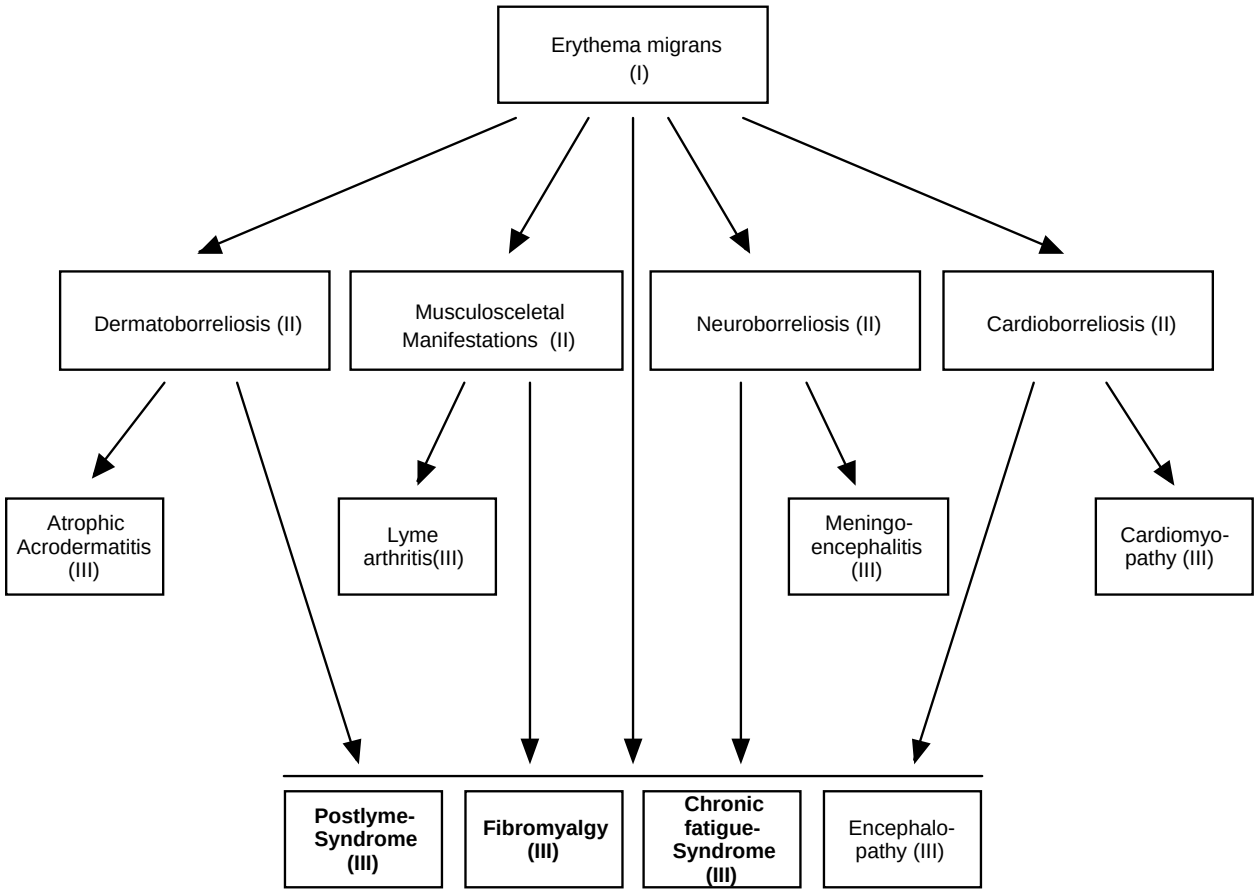

Abbildung 1. Stadien (in Klammern) und Organmanifestationen der Lyme Borreliose

diagnostisch nicht verwertbar, da sie im Rahmen zahlreicher anderer Erkrankungen auch vorkommen können (Tabelle 3). Im Stadium III, also bei den chronischen Formen der Lyme-Borreliose sind die Beschwerden meistens unspezifisch und können nicht von solchen anderer chronischer Krankheiten unterschieden werden. So lassen sich eine chronische Lyme-Arthritis kaum mehr von einer Rheumatoiden Polyarthritis, eine chronische Neuroborreliose kaum mehr von einer Multiplen Sklerose oder eine chronische Acrodermatitis kaum mehr von einer Altershaut unterscheiden. Es ist deshalb wichtig, dass anamnestisch typische Beschwerden der vorausgegangenen, akuten Krankheitsphase eruierbar sind.

Skin	Musculosceletal system	Nervous system	Heart
Erythema migrans Erythema migrans multiforme Borrelial lymphocytoma Acrodermatitis chronica atrophicans Morphaea Lichen sclerosus et atrophicus	Arthritis (mono- or oligoarticular) Arthralgia Myositis Tendinitis	Meningitis Encephalitis Neuritis Myelitis Radiculitis Inflamation of ear Inflamation of eye	Myocarditis Partial or complete heart block

Tabelle 2. Hauptsymptome der Lyme Borreliose.

Zweitens muss die Diagnose serologisch bestätigt werden können. Im Stadium I liegt in der Regel ein normaler IgG- und IgM-Antikörpertiter vor, im Western Blot zeigen sich IgG- und/oder IgM-Antikörperbanden gegen p41 (Flagellin) und gegen das OspC. Im Stadium II sind ein erhöhter IgG-Antikörpertiter und im Western Blot ein breites Antikörperspektrum gefordert. Die entsprechenden Befunde sind auch im Stadium III vorhanden. Die erhöhten Titerwerte oder die Antikörperbanden im Western Blot bleiben zwar über Jahre bis Jahrzehnte erhöht und nachweisbar, nehmen aber doch allmählich ab, so dass sie nach Jahren oder Jahrzehnten bei der späten Abklärung einer chronischen Lyme-Borreliose oft nicht mehr nachweisbar sind. Umso wichtiger wäre es, serologische Daten aus früheren Blutproben zu erhalten. Nach der persönlichen Erfahrung von Donta (2001) finden sich bei chronischer Lyme-Borreliose auffallend häufig spezifische IgM-Antikörper gegen OspC, OspA, OspB, p35, p37, p39 oder gegen p83-93, Befunde, die sich aber in anderen und in unseren Kollektiven nicht bestätigen.

Ein drittes und entscheidendes Kriterium in der Diagnostik der Lyme-Borreliose ist der akribische Ausschluss andere Differentialdiagnosen, die für die vorliegenden Beschwerden in Betracht kommen.

Wie aus den Ausführungen hervorgeht, kann bei einem Teil der Patienten, bei denen keine typischen Hauptbeschwerden und keine positiven Serologien vorliegen oder vorgelegen haben, die chronische Lyme-Borreliose nicht mehr diagnostiziert werden. Medizinisch gesehen ist dies kein Nachteil, weil die Therapie ohnehin symptomatisch ist und Antibiotika höchstens noch probatorisch eingesetzt werden. Der einzige Nachteil ist versicherungstechnisch. Eine Lyme-Borreliose gilt als Unfall oder als Berufskrankheit, was bei entsprechender Anerkennung durch die Versicherungen finanzielle Vorteile haben kann.

Unglücklicherweise ist die chronische Lyme-Borreliose eine Diagnose geworden, die für die verschiedensten chronischen Beschwerden, wie Müdigkeit, Schmerzen oder funktionelle Störungen eingesetzt wird, ohne dass die Diagnosekriterien erfüllt sind, und dadurch wenig Wahrscheinlichkeit besteht, dass diese Diagnose vorliegt. Entsprechend werden vielfach unnötigerweise Antibiotika ohne Erfolg eingesetzt (Steere 2002, bei steere 2002 Sigal 1990, Steere et al. 1993, Reid et al. 1998, Burdge et al. 1993).

- Müdigkeit, Malaise
- Kopfschmerzen
- Fieber
- Nackensteifheit
- Gelenkschmerzen
- Gelenkschwellungen
- Muskelschmerzen
- Geschwollene Lymphdrüsen
- Rücken-, Brust- oder Bauchschmerzen
- Durchfall
- Gewichtsverlust
- Heiserkeit, Halsbeschwerden
- Husten
- Bindehautentzündung der Augen
- Übelkeit
- Erbrechen
- Missempfindungen und Schmerzen an Armen/Beinen
- Herzklopfen, Schweissausbrüche, Schwindel
- Psychische Veränderungen (Nervosität, Reizbarkeit, emotionale Labilität, verminderte Konzentrationsfähigkeit, Schlafstörungen, Depressionen)

Tabelle 3. Häufige Nebensymptome der Lyme Borreliose .

Die chronische Lyme-Borreliose der Haut
Acrodermatitis chronica atrophicans und Morphaea

Zu den häufigsten chronischen Hautformen der Lyme-Borreliose gehört die Acrodermatitis chronica atrophicans in ihrer Spätform, im sogenannten chronisch atrophen Stadium. Wird das akut-entzündliche Stadium (Stadium II der Lyme-Borreliose) mit den typisch lividen Hautschwellungen, vor allem der Extremitäten, nicht rechtzeitig und adäquat antibiotisch behandelt, so entsteht schon nach wenigen Monaten eine Hautatrophie, die histologisch mit einem Schwinden der Epidermis einhergeht. Die Haut runzelt sich zunehmend, wird dünn und seidenweich. Die Anhangsgebilde der Haut, wie die Schweiss- und Talgdrüsen oder die Musculi arrectores pilorum degenerieren und erfüllen ihre Funktion nicht mehr. Die Venenzeichnung wird deutlich sichtbar, die Haare lichten sich

und Verschiebungen der Braunpigmentierung entstehen. Prätibial und ulnar können knotig fibrosierende oder verkalkende Infiltrationen entstehen, die zu den sogenannten ulnaren oder prätibialen Banden führen. Die Haut ist brüchig und oft entstehen Risse und Ulcera an atypischen Stellen mit ausgesprochen schlechter Heilungstendenz und oft mit präkanzerösen Veränderungen an ihren Rändern.

In circa 50 Prozent der Fälle ist die Acrodermatitis chronica atrophicans mit Komplikationen des Nervensystems, vor allem mit Polyneuropathien verbunden. Andere Patienten leiden gleichzeitig an Arthritiden, welche die Gelenke unter der betroffenen Haut befallen.

Die Morphaea als zirkumskripte Sklerodermie kann einzeln oder vergesellschaftet mit der Acrodermatitis chronica atrophicans auftreten und gehört teilweise in ihrer chronisch- atrophen Form auch zu den Manifestationen der chronischen Lyme-Borreliose. Der Mehrheit der Morphaea lässt sich aber keine Aetiologie zuordnen. In der Regel beschränkt sich die Morphaea auf wenige und begrenzte Herde, die allerdings auch ausgedehnt sein können. In ihrer generalisierten Form kann sie fleckig das ganze Integument erfassen.

Die Diagnose der Acrodermatitis chronica atrophicans kann einerseits in den meisten Fällen schon klinisch gestellt werden, andererseits laborchemisch durch den Nachweis stark erhöhter IgG-Antikörpertiter und eines breiten Antikörperspektrums im Western Blot. Bei der Morphaea sind die serologischen Resultate meistens nicht aussagekräftig. Normale Antikörpertiter und ein schmales Antikörperspektrum sind die Regel. Die Zuordnung zur Lyme-Borreliose kann meistens nur histologisch, respektiv durch Bakterienkulturen oder durch einen PCR-Test in der Biopsie des betroffenen Hautgewebes gesichert werden.

Sofern die Acrodermatitis chronica atrophicans oder die Morphaea noch nicht adäquat therapiert sind, ist eine Antibiose mit Rocephin 2 gr pro die per infusionem an 28 aufeinanderfolgenden Tagen durchzuführen. Die Atrophien bleiben aber bestehen.

Die chronische Lyme-Borreliose des Bewegungsapparates

Die chronische Lyme-Arthritis

Nach amerikanischen Statistiken münden etwa 10 Prozent der Lyme-Arthritiden in einer chronischen Form. Europäische Statistiken über die Häufigkeit bestehen nicht; der Prozentsatz dürfte aber in der amerikanischen Grössenordnung liegen. Ein Uebergang in die chronische Form kann auch bei antibiotisch adäquat und rechtzeitig behandelten Patienten geschehen. Wie schon Herzer (1990) nachweisen konnte, kann bei einer chronischen Lyme-Arthritis nur bei einer Minderheit eine vorangegangen akute Entzündung nachgewiesen werden. Der Pathomechanismus ist nicht bekannt. Wie bei anderen chronischen Arthritiden, prädestinieren auch hier wahrscheinlich genetische Faktoren. Bei Patienten mit chronischer Lyme-Arthritis konnten gehäuft die Alloantigene DR2, DR3 und DR4 nachgewiesen werden (Steere et al. 1979, Kristoferitsch et al. 1986). Weitere Untersuchungen ergaben, dass bei Vorliegen von HLA-B27, von HLA-DR4 oder von Antikörpern gegen OspA die Lyme-Arthritis schlechter auf Antibiotika anspricht (Sigal 1998, Steere et al. 1990c, 1994, Kalisch et al. 1993, Lengl-Janssen et al. 1994, Akin et al. 1999, Widhe et al. 2004).

Klinisch kann die chronische Lyme-Arthritis nicht von einer chronischen Arthritis anderer Provenienz unterschieden werden. Die Gelenksentzündung verläuft in der Regel in Schüben, wobei eine Restitutio ad integrum auch in dieser Phase noch möglich ist. Bestehen aber schon Verdickungen und Schrumpfungen der Gelenkskapseln, Deformitäten, destruktive Veränderungen wie Usuren, subchondrale Zysten, Arthrosen oder eine gelenksnahe Osteoporose, so gelten diese Schäden als definitiv.

Die Diagnose einer chronischen Lyme-Arthritis wird in jenen Fällen schwierig, bei denen keine akute Phase nachgewiesen werden kann. Serologisch findet sich in über 80 Prozent der Fälle ein erhöhter IgG-Antikörpertiter und

ein Western Blot-Befund mit einem breiten IgG-Antikörperspektrum. Da im Verlauf der Jahre die serologischen Spuren verwischen, entgehen wahrscheinlich eine nicht unbedeutende Anzahl von chronischen Lyme-Arthritiden der Diagnose.

Die Behandlung der chronischen Lyme-Arthritis erfolgt nach rheumatologischen Kriterien. Zum Einsatz kommen vor allem nicht steroidale Antirheumatica, Steroide, aber auch Methotrexat, wobei das Ansprechen auf letzteres Substanz bei der Lyme-Borreliose unbefriedigend ist. Eine antibiotische Behandlung mit Cefrtriaxon oder Cefotaxim während mindestens 4 Wochen ist in jenen Fällen angezeigt, bei denen bisher noch keine stadiengerechte Antibiose durchgeführt wurde.

Das Fibromyalgiesyndrom

Es liegen entzündliche Veränderungen der Sehnen und der Gelenkskapseln vor, die zu Schrumpfungen der Gelenkskapseln und zu Tendomyosen vor allem in der Schulter-, Nacken- und Lendenregion führen. Betroffen können aber auch weitere Gelenke wie Ellbogen- oder Kniegelenke sein. Typisch sind die zahlreichen Druckdolenzen an den Sehnenansätzen (Tender points).

Das Fibromyalgiesyndrom ist nach bestimmten amerikanischen Kriterien genau definiert. Das Entstehen des sekundären Fibromyalgiesyndroms als Folge einer Lyme-Borreliose ist bekannt und gilt als seltene, aber schwerwiegende Komplikation. Es setzt nicht eine Lyme-Borreliose des Bewegungsapparates voraus und kann ebenso gut nach einem Erythema migrans oder nach einer Neuroborreliose auftreten. Dinerman et al. (1992) fanden im Verlauf von 287 Patienten mit Lyme-Borreliose bei 22 (8 Prozent) ein Fibromyalgiesyndrom. Nebst den oben erwähnten Beschwerden konnten sie zusätzlich zu den muskuloskelettalen Symptomen oft Dysästhesien, neurofunktionelle Störungen und eine invalidisierende Müdigkeit feststellen.

Die Existenz des Fibromyalgiesyndroms als Folge einer Lyme-Borrelisoe blieb lange Zeit umstritten und der Zusammenhang mit der Lyme-Borreliose wurde in vielen Fällen überstrapaziert und fälschlicherweise postuliert. Borrelia burgdorferi-Baktieren konnten aber im Sehnengewebe bei Fibromyalgie-Patienten nachgewiesen werden (Häuptl et. Al 1993). Der Zusammenhang mit der Lyme-Borreliose kann nur festgestellt werden, wenn eine entsprechende Serologie mit deutlich erhöhten IgG-Antikörpertitern und eine Western Blot-Befund mit einem breiten Antikörperspektrum vorliegen, und wenn alle anderen möglichen Ursachen ausgeschlossen sind. In allen anderen Fällen ist der Zusammenhang nicht gegeben, respektiv bleibt Spekulation.

Eine antibiotische Therapie macht dann Sinn, wenn bisher noch keine adäquate Behandlung mit Ceftriaxon 2 gr pro die per infusionem an 28 aufeinanderfolgenden Tagen durchgeführt wurde. Dinerman et al. (1992) behandelten 15 ihrer 22 Fälle mit Ceftriaxon. Bei allen Patienten heilten die übrigen Beschwerden, bei 14 der 15 Behandelten persistierenden die fibromyalgischen Symptome.

Myotendinosen

In Teilaspekten sind die Myotendinosen den Beschwerden beim Fibromyalgiesyndrom ähnlich. Aeusserst hartnäckig können tendinotische Beschwerden einzelner oder verschiedener Sehnen sein, die als Folge der Entzündung entstanden sind. Sie können Jahre über das Abheilen der akuten Lyme-Borreliose-Symptomatik persistieren. Sie entstehen vor allem im Nacken-Schulterbereich und ergeben das Bild des Cervikalsyndroms. Myotendinotische Beschwerden können aber auch im Bereich der vormals arthritischen Gelenke auftreten, so besonders häufig an Knie- und Schultergelenken.

Die Behandlung erfolgt symptomatisch nach rheumatologischen Kriterien. Von Antibiotika, auch hochdosiert verabreicht, kann keine Besserung erwartet werden.

Die chronische Lyme-Borreliose des Nervensystems

Chronische Meningoencephalitis

Die chronische Meningoencephalitis (Stadium III) ist von ihrer akuten Form (Stadium II) abzugrenzen. Sie ist seltener als die akute Meningoencephalitis und zeichnet sich durch ihren oft schleichenden Beginn und langsamen, progredienten Verlauf aus. Es wird eine Krankheitsdauer von 12 Monaten gefordert (Ackermann et al. 1985, 1988, Hansen et al. 1992, Kohlhepp et al. 1997).

Die häufigsten Symptome aus einem weitläufigen Spektrum sind Hirnnervenausfälle, unter anderem mit Schädigungen des Gehörs, des Sehnerven, des Gleichgewichts, mit Schluckstörungen, Schwindelzuständen, Dysarthrien, spastische Tetraparesen, schlaffe Paresen, Sensibilitätsstörungen, Blasen-funktionsstörungen, Ataxien, Wesensverän-derungen oder Krampfanfälle.

Für die Diagnose sind die Liquorbefunde entscheidend, die eine autochthone Antikörperproduktion und in der Regel eine geringe Erhöhung der Zellzahl ergeben. Mittels Computertomographie oder MRI lassen sich hypodense, respektiv hyperintense Herde nachweisen, die meistens periventrikulär liegen und die sich nicht von Entzündungsherden der Multiplen Sklerose unterscheiden lassen (Wokke et al. 1987a, Weder et al. 1987).

Therapeutisch sollte, sofern diese nicht schon durchgeführt wurde, eine hochdosierte antibiotische Therapie mit Ceftriaxon 2 gr oder mit Cefotaxim 4 x 2 gr während 28 Tagen durchgeführt werden. Bisherige Erfahrungen zeigten, dass damit oft eine partielle Besserung der Beschwerden erreicht werden kann (Wokke et al. 1987a, Weder et al. 1987).

Lyme-Enzephalopathie

Die Lyme-Enzephalopathie ist eine Form der chronischen Lyme-Neuroborreliose, bei der die neurofunktionellen Defizite im Vordergrund stehen. Sie kann Folge einer Meningoencephalitis sein, wobei das akute Stadium auch leicht oder allenfalls unbemerkt verlaufen kann. Bei einem Teil der Patienten lässt sich keine vorangegangene Beteiligung des Nervensystems nachweisen.

Typisch sind noch Jahre nach der akuten Lyme-Borreliose II anhaltende neurofunktionelle Defizite. Die Patienten klagen hauptsächlich über Störungen des Frischgedächtnisses, über einen verminderten Redefluss, eine verminderte Aufmerksamkeit, ein reduziertes Konzentrationsvermögen sowie eine verminderte geistige Reaktionsfähigkeit. Weitere typische Symptome sind Vergesslichkeit, Schwierigkeiten im Umgang mit Zahlen, falsche Wortbildungen oder Verwechslung von ganzen Satzteilen. Zahlreiche weitere Begleitsymptome können hinzukommen: Oft eine ausgeprägte Ermüdbarkeit und Antriebslosigkeit, eine Verlangsamung im Denken, eine Photophobie, Hyperakusis, eine Ueberempfindlichkeit auf Berührung, für Gerüche und für den Geschmack, örtliche und zeitliche Orientierungsschwierigkeiten, Gemüts-schwankungen mit Gereiztheit bis zur Aggressivität. Auch Schlafstörungen liegen häufig vor (Fallon et al. 1998). Die neurofunktionellen Defizite können das Ausmass einer Demenz erreichen. Die häufig begleitende depressive Entwicklung erreicht hingegen nach amerikanischen Kriterien den Schweregrad einer eigentlichen Depression nicht.

Neuropsychologische Untersuchungen zeigen Defizite hauptsächlich beim Lernen und Wiedergeben von Wortlisten, eine verminderte mentale Flexibilität, Störungen beim Lesen oder bei der Artikulation. Aufmerksamkeit und die Psychomotorik bleiben normal, wodurch sich die Lyme-Enzephalopathie von subkortikalen Demenzen, die auch im Rahmen von Neuroborreliosen auftreten können, deutlich unterscheiden. Bei letzteren finden sich im MRI des Neurocraniums subkortikale Läsionen (Benke et al. 1995). Auffallend ist eine Diskrepanz zwischen dem vom Patienten empfundenen Schweregrad der Störungen und den nur leichten Veränderungen, die bei der neuropsychologischen Untersuchung objektiviert werden können.

Bei der Lyme-Enzephalopathie liegt nicht eine generalisierte, sondern eine fokale, auf wenige und hauptsächlich mnestische Störungen begrenzte Pathologie vor, die ihren Schwerpunkt im kognitiven Bereich hat, vor

allem mit einer Schwäche des Lernens und des Gedächtnisses. Pathologisch-anatomisch sind die Störungen im Bereich der Fronto-Temporallappen zu lokalisieren.

Im Rahmen dieser Enzephalopathie müssen auch die zahlreichen, psychiatrischen Krankheitsbilder gesehen werden, die bisher in diesem Zusammenhang beschrieben wurden: Am häufigsten werden Depressionen beobachtet, aber auch Schizophrenien, Wahnhaftigkeit, Verwirrtheit, Delirien, Panikzustände, Halluzinationen (Gehör, Sehen, Geruch), Stereotypien, Zwangsneurosen, Katatonien, Manien und Anorexien (Omatsis et al. 1990, Fallon et al. 1990, Rachmann et al. 1998, Lopker 1996, 1999).

Eine Korreliation zum Schweregrad des voraussgegangenen Krankheitsstadium II, zu Liquorbefunden oder zu den Antikörpertitern und zum Bandenmuster im Western Blot finden sich nicht.

Der Pathomechanisums ist unklar. Bei etwa der Hälfte der Patienten finden sich im Liquor Veränderungen in Form von Eiweisserhöhungen, Pleozytosen oder einer autochthonen Antikörperproduktion. Da die Lyme-Enzephalopathie auch ohne vorgängige Meningoencephalitis entstehen kann, ist eine Erregerinvasion in die Fronto-Temporallappen nicht Bedingung. Es wird angenommen, dass bakterielle Toxine, Zytokine, neuroaktive Kynurenine oder die Quinolonsäure wichtige pathogenetische Faktoren sind (Logigian et al. 1999, Halperin et al. 1996, Fallon et al. 1994, Schmutzhard et al. 1995, Garcia-Monco 1995 b).

Die Diagnose der Lyme-Enzephalopathie kann nur gestellt werden, wenn ein akutes Krankheitsstadium I oder II eruierbar ist, oder wenn serologisch oder im Liquor der Nachweis einer durchgemachten Lyme-Borreliose erbracht werden kann. In den meisten Fällen fallen die Liquorbefunde aber normal aus oder ergeben lediglich unspezifische Befunde, wie erhöhte Albumin- oder Eiweisswerte.

Nicht etabliert ist die Therapie der Lyme-Enzephalopathie. Die meisten Autoren empfehlen eine 3- bis 4wöchige intravenöse Therapie mit Ceftriaxon 2 gr pro die. Damit konnten bei einem Teil der Patienten Besserungen oder sogar Heilungen erreicht werden, wobei die untersuchten Kollektive klein waren, und die Erfolgsquoten entsprechend stark schwankten (Logigian et al. 1990, Fallon et al. 1999). Kaplan et al. (2003), die 129 Patienten mit kognitiven Funktionsstörungen radomisiert mit 2 gr Ceftriaxon pro die während 30 Tagen und anschliessend mit 200 mg Doxyclin pro die während 60 Tagen oder mit Plazebo behandelten, konnten bei den Behandelten keine signifikante Besserung der kognitiven Störungen erreichen.

Nach persönlicher Erfahrung sollte bei Patienten, bei denen bisher noch keine stadiengerechte antibiotische Therapie durchgeführt wurde, diese nachgeholt, das heisst während 28 Tagen 2 gr Ceftriaxon verabreicht werden. Ob gleichzeitig auch noch die vor allem von Laienkreisen geforderten Tetracycline in einer täglichen Dosis von 200 mg eingenommen werden sollen, bleibt ermessenssache, da Beweise für ihre Nützlichkeit bisher nicht erbracht wurden.

Das chronische Müdigkeitssyndrom

Ueber die Häufigkeit des chronischen Müdigkeitssyndrom als Folge einer Lyme-Borreliose bestehen keine genauen Daten. Es beschränkt sich wahrscheinlich auf Einzelfälle (Pollak et al. 1995). Bei verschiedenen Kollektiven von chronischem Müdigkeitssyndrom konnten nicht gehäuft erhöhte Antikörpertiter bezüglich Borrelia burgdorferi gefunden werden (Wright et al. 1988, Pollak et al. 1995, Schmutzer et al. 1999). Einzig Treib et al. (2000) konnten bei 1156 Rekruten im Saarland (D) bei denjenigen signifikant häufiger erhöhte Antikörpertiter bezüglich Borrelia burgdorferi feststellen, die über eine ausgeprägte Müdigkeit und über eine Malaise klagten.

Das chronische Müdigkeitssyndrom wird nach Holmes et al. (1988) definiert. Dazu gehören eine neu aufgetretene persistierende oder rezidivierende Müdigkeit während mindestens 6 Monaten, die durch Bettruhe und Erholung nicht zu bessern ist, und welche die tägliche Leistungsfähigkeit um mindestens 50 Prozent einschränkt. Eine fassbare Ursache muss ausgeschlossen werden können. Zum chronischen Müdigkeitssyndrom gehören eine Reihe

weiterer Beschwerden, wie Arthralgien, Morgensteifheit, Konzentrationsstörungen, Vergesslichkeit, Schwindelzustände, Parästhesien, Schlafstörungen, Reizbarkeit und depressive Zustände. Häufig finden sich Veränderungen des weissen Blutbildes und bei 45 Prozent zeigt der Liquor eine mononukleäre Pleozytose. Um ein chronisches Müdigkeitssyndrom der Lyme-Borreliose zuordnen zu können, müssen klinisch oder serologisch die entsprechenden Nachweise erbracht werden. Auffallend bei der Lyme-Borreliose ist, dass ein chronisches Müdigkeitssyndrom schon nach einem antibiotisch adäquat behandelten Erythema migrans auftreten kann. Das oft invalidisierende Beschwerdemass des chronischen Müdigkeitssyndrom steht in keinem Verhältnis zu den verhältnismässig geringen Beschwerden des Erythema migrans oder zu den Be-schwerden im Rahmen der Lyme-Borreliose II.

Das chronische Müdigkeitssyndrom bei der Lyme-Borreliose kann sich auch nach jahrelangem Bestehen spontan auflösen. In den meisten Fällen müssen therapeutisch antriebssteigernde Psychopharmaka, Lamotrigin, etc. eingesetzt werden. Sofern bisher keine adäquate antibiotische Behandlung der Lyme-Borreliose erfolgte, ist diese nachzuholen Zusätzliche oder wiederholte antibiotische Therapien bringen keine Verbesserung.

Die chronische Lyme-Borreliose des Herzens

Bisher sind erst Einzelfälle von chronische Lyme-Borreliose des Herzens bekannt geworden, die sich in Form von dilatativen Kardiomyopathien äussern (Stanek et al. 1990). Auch persistierende höhergradige atrioventriculäre Blockieren könnten erwartet werden. Bisher fehlen aber Kasuistiken, welche die Implantation eines Schrittmachers benötigten und bei denen zweifelsfrei eine Lyme-Borreliose vorlag.

Das Post-Lymesyndrom

Die Existenz eines Post-Lymesyndroms blieb lange Zeit umstritten. Erst Lanzeitverläufe der Lyme-Borreliose brachten die notwendigen Beweise, so dass dieses Syndrom heute weltweit anerkannt ist (Asch et al. 1993, Klempner et al. 1999, Shadick et al. 1999, Seltzer et al. 2000, Kalish et al. 2001).

Das Post-Lymesyndrom ist ein Beschwerdebild, das in der zeitlichen Folge einer antibiotisch korrekt behandelten Lyme-Borreliose im Stadium I, II oder III auftreten kann. Ein nicht unerheblicher Teil der Patienten klagen auch noch Monate bis Jahre nach durchgemachter und stadiengerecht behandelter Lyme-Borreliose über einen reduzierten Allgemeinzustand, über Müdigkeit oder über eine vermehrte Anfälligkeit auf Infekte der oberen Luftwege. Weitere Hauptbeschwerden sind unter anderen Müdigkeit, Arthralgien, Myalgien, neurologische Beschwerden, Kopfschmerzen, Schlafstörungen, sowie Gedächtnis- und Konzentrationsstörungen. Das Beschwerdemuster des Postlyme-Syndroms entspricht nicht dem ursprünglichen Beschwerdebild. Allerdings sind Patienten, die schon während der akuten Phase der Lyme-Borreliose an Myalgien, Arthralgien, Arthritiden und Müdigkeit litten signifikant häufiger von einem Post-Lymesyndrom betroffen als Patienten mit anderer Symptomatik (Bujak et al. 1996).

Weil das Beschwerdebild des Post-Lymesyndroms unspezifisch ist und auch andere Ursachen dafür verantwortlich sein könnten, darf die Diagnose nur gestellt werden, wenn eine akute Krankheitsphase eruiert werden kann, wenn eine entsprechend pathologische Serologie vorliegt, wenn eine stadiengerechte antibiotische Therapie erfolgte, und wenn andere Ursachen der Beschwerden ausgeschlossen werden konnten (Bujak et al. 1996).

Auch die Pathogenese des Post-Lymesyndroms ist unklar. Das fehlende Ansprechen auf Antbiotika spricht gegen eine bakterielle Genese. Wahrscheinlicher sind Bakterientoxine, die noch über lange Zeit im Körper verweilen können.

Die Therapie des Post-Lymesyndroms ist eine symptomatische, Antibiotika bringen keine Besserung. So behandelten auch Krupp et al. (2003) 55 Patienten mit Postlyme-Syndrom entweder während 4 Wochen täglich mit 2 gr Ceftriaxon oder mit Plazebo. Sie konnten zwar in der Verumgruppe eine signifikante Besserung der Müdigkeit um circa

20 Prozent finden (FSS-11 Score). Die kognitiven Störungen blieben unbeeinflusst. Die Untersucher selbst betrachteten die Besserung der Müdigkeit als unspezifisch und empfahlen die Behandlung des Post-Lymesyndroms mit Ceftriaxon nicht.

Therapie der chronischen Lyme-Borreliose

Die Therapie der chronischen Lyme-Borreliose ist nicht etabliert und die Empfehlungen aller Autoren beruhen auf Erfahrungswerten, die wissenschaftlich nicht regelmässig belegt sind. Wurde bisher noch keine stadiengerechte, antibiotische Therapie gemäss Tabelle 4 durchgeführt, so sollte diese auch im chronischen Stadium noch nachgeholt werden. Als Basis gilt die Infusionstherapie mit Ceftriaxon 2 gr pro die während 4 Wochen. Der Nutzen einer gleichzeitigen oder anschliessenden Behandlung mit Tetracyclinen 200 mg pro die während 4 bis 12 Wochen zur Behandlung der postulierten intrazellulären Borrelien ist wissenschaftlich nicht bewiesen und daher fraglich (Steere et al. 2003, Donta 2001). Dasselbe gilt auch für die zusätzliche Gabe von Nitroimidazolen, die der Behandlung der postulierten, zystischen Bakterienformen dienen soll.

Hypothetisches Ziel dieser Behandlung einer chronischen Lyme-Borreliose ist, die noch vermuteten Borrelia burgdorferi-Bakterien zu reduzieren, die weitere Immunstimulation und damit die Progression der Krankheit zu stoppen. Es ist nicht zu erwarten, dass bestehende morphologische oder funktionelle Schäden behoben werden können. Eine antibiotische Therapie im Stadium III ist dann gerechtfertigt, wenn sie im bisherigen Krankheitsverlauf noch nicht adäquat durchgeführt wurde. Das gleiche therapeutische Vorgehen gilt auch für das Postlyme-Syndrom.

Es bestehen aber keine wissenschaftlichen Grundlagen, dass die Antibiotikatherapien im chronischen Stadium den Verlauf der Krankheit begünstigen, was nicht ausschliesst, dass in Einzelfällen eine Besserung der Beschwerden erreicht werden kann. Auch weitere empfohlene Therapieschemata, wie die Langzeittherapie mit Tetracyclinen, Penicillinen, Makroliden oder Gyrasehemmern während Monaten bis Jahren, die sogenannte Puls-Therapie oder die repetitive Gabe verschiedenster Antibiotika unter anderen auch von Rocephin, konnten bis heute ihren Nutzen nicht belegen.

Die Behandlung der chronischen Lyme-Borreliose beschränkt sich in erster Linie auf die symptomatische Therapie der Beschwerden, die individuell und meistens nach rheumatologischen oder schmerzthera-peutischen Richtlinien zu erfolgen hat. Sowohl für die Behandlung von Schmerzen als auch für die Behandlung von funktionellen und neurofunktionellen Störungen haben Psycho-pharamaca wie die Antidepressiva und Sedativa, nichtsteroidale Antirheumatica, Muskelrelaxantien, einfache Schmerzmittel bis zu den Opiaten, Lamotrigin, etc. einen wichtigen Stellenwert. Bestehen noch Entzündungszeichen, vor allem bei Beteiligungen des Bewegungsapparates und des Nervensystems, so können auch Steroide eingesetzt werden. Die Erfahrungen mit Salicylaten, Antimalariamittel oder mit Methotrexat sind bei der chronischen Lyme-Arthritis, im Unterschied zu der rheumatoiden Arthritis, unbefriedigend.

Tabelle 4. Therapie der Lyme-Borreliose im Stadium I und II (Satz 2002).

Erythema migrans

Amoxicillin	3 x 500 mg	per os	14 - 21 Tage
Doxycycline	2 x 100 mg	per os	14 - 21 Tage
Penicillin	3 x 1000 mg	per os	14 – 21 Tage
Cefuroxim Axetil	2 x 500 mg	per os	14 – 21 Tage

Erythema migrans multiloculare

Probatorische Behandlung wie ein Erythema migrans. Liegen weitere Komplikationen vor, so richtet sich die Therapie nach den anderen Organmanifestaionen.

Borrelien-Lymphozytom

Amoxicillin	3 x 500 mg	per os	21 - 28 Tage
Doxycycline	2 x 100 mg	per os	21 - 28 Tage
Penicillin	3 x 1000 mg	per os	21 - 28 Tage
Cefuroxim Axetil	2 x 500 mg	per os	21 - 28 Tage

Acrodermatitis chronica atrophicans

- (akut-entzündliche Form ohne weiteren Organmanifestationen)

Amoxicillin	3 – 4 x 500 mg	per os	28 Tage
Doxycycline	2 x 100 mg	per os	28 Tage

- (chronisch-atrophe Form und/oder weitere Organmanifestationen)

Ceftriaxon	1 x 2 (4) g	intravenös	28 Tage
Cefotaxime	3 (4) x 2 g	intravenös	28 Tage
Penicillin	4 x 5 Mio E	intravenös	28 Tage

Morphaea

Penicillin	2 x 10 Mio E	intravenös	14 – 28 Tage	Empfehlung
Ceftriaxone	1 x 2 g	intravenös	14 – 28 Tage	Empfehlung

Lichen sclerosus et atrophicus

Penicillin	2 x 10 Mio E	intravenös	14 – 28 Tage	Empfehlung
Ceftriaxon	1 x 2 g	intravenös	14 - 28 Tage	Empfehlung

Arthritis

Ceftriaxon	1 x 2 (4) g	intravenös	21 – 28 Tage	
Cefotaxim	3 (4) x 2 g	intravenös	21 – 28 Tage	
Penicillin	4 x 5 Mio E	intravenös	21 – 28 Tage	
Amoxicillin	4 x 500 mg	per os	21 – 28 Tage	hohe Versagerquote
Doxycycline	2 x 100 mg	per os	21 – 28 Tage	hohe Versagerquo.

Myositis und Fibromyalgie-Syndrom

Ceftriaxon	1 x 2 g	intravenös	28 Tage	Empfehlung

Neurologische Manifestationen

Ceftriaxon	1 x 2 (4) g	intravenös	21 – 28 Tage	
Cefotaxim	3 (4) x 2 g	intravenös	21 – 28 Tage	
Penicillin	4 x 5 Mio E	intravenös	21 – 28 Tage	
Doxycycline	2 x 100 mg	per os	21 – 28 Tage	Nur bei Neuritis cran.u. Radikulitis

Karditis

Ceftriaxon	1 x 2 g	intravenös	14 Tage
Cefotaxim	3 (4) x 2 g	intravenös	14 Tage
Penicillin	4 x 5 Mio E	intravenös	14 Tage

Mögliche Ursachen von chronischen Verlaufsformen

Immunologische und chemische Vorgänge

Der Pathomechanismus über die Entstehung einer chronischen Verlaufsform einer Lyme-Borreliose ist weitgehend unbekannt, was umsomehr zu Spekulationen und zu kuriosen Vorstellungen, vor allem in der Laienliteratur und im Internet führt.

Histologisch auffallend ist, dass verhältnismässig wenige Bakterien zu einer ausgedehnten Entzündung führen können, dass bei einer chronischen Lyme-Borreliose die Erreger in der Regel im Gewebe nicht mehr nachweisbar sind, und dass eine chronische Lyme-Borreliose entstehen kann trotz adäquater und zeitgerechter antibiotischer Therapie. Umgekehrt führt die Anwesenheit von Borrelia burgdorferi im Gewebe nicht zwangsläufig zu einer Erkrankung. Daraus kann grundsätzlich geschlossen werden, dass die Borrelien Mediatoren aktivieren, welche die eigentliche Entzündung induzieren und verstärken. Borrelia burgdorferi hätte somit in der Pathogenese der Lyme-Borreliose lediglich eine Triggerfunktion. Auch zeigt sich, dass individuelle Gewebseigenschaften, wie die Alloantigen bei der chronischen Lyme-Arthritis, und deren Reaktion auf die eindringenden Bakterien entscheidend sind. Daraus wird postuliert, dass die Lyme-Borreliose und speziell deren chronische Verlaufsformen wahrscheinlich entscheidend durch immunologische Vorgänge geprägt sind.

So werden zum Beispiel die entzündlichen Vorgänge der chronischen Lyme-Arthritis durch die OspA-Antigene unterhalten, die auch nach antibiotischer Therapie in den dentritischen Zellen der Synovia persistieren. Die Reaktion bestimmter, hochimmunogener Oberflächenepitope von OspA mit den T-Zellen, sowie die Bildung des autoantigen wirkenden Adhäsionsfaktors hLFA-1alfa perpetuieren die entzündliche Autoimmunreaktion (Gross et al. 1998, Trollmo et al. 2001). In diesem Zusammenhang gehört auch die in den USA gemachte Erfahrung mit der Impfung gegen die Lyme-Borreliose, welche auf der Applikation von OspA und der Induktion von Antikörpern gegen OspA beruht, gemacht wurden. In zahlreichen Fällen kam es zu Autoimmunarthritiden, die zur Rücknahme des Impfstoffes führten.

Bei der chronischen Neuroborreliose sind ausser den schon erwähnten Toxinen und Zytokonen wahrscheinlich auch immunologische Vorgänge entscheidend. So konnten tierexperimentell gezeigt werden, dass die Antikörper gegen das Flagellin, welche mit dem Hitzeschockprotein (HSP60) reagieren, sich an peripheres Nervengewebe binden. Auch führt der Kontakt von Borrelia burgdorferi mit dem Nervengewebe zur Bildung von Antikörpern gegen Ganglioside und die Antikörper gegen bestimmte homologe OspA-Epitope führten zu Kreuzreaktionen mit dem Nervengewebe im Cortex, mit den Axonen und Motoneuronen des Rückenmarkes und mit den Nervenwurzeln (Alaedini et al. 2005, Dai et al. 1993, Garcia-Monco et al. 1995). Auch konnten bei Lyme-Borreliose Geimpften in den USA schwere demyelinisierende Neuropathien und kognitive Störungen beobachtet werden (Latov et al. 2004).

Es ist anzunehmen, dass ähnliche autoimmune Vorgänge bei den anderen Formen der chronischen Lyme-Borreliose eine entscheidende Rolle spielen.

Intrazellulär gelegene Borrelien und zystische Borrelienformen

Intrazellulär gelegene Borrelien und zystische Borrelienformen werden immer wieder als Ursache einer chronischen Lyme-Borreliose angeführt.

Vor allem tierexperimentel und vereinzelt in humanem Gewebe konnten intrazelulär gelegene Borrelien nachgewiesen werden. Es handelt sich bis heute aber um Einzelbefunde, so dass anzunehmen ist, dass intrazellulär gelegene Bakterien seltene Ereignisse sind und dass sie kaum für die Persistenz oder für die Reaktivierung einer Lyme-Borreliose in Frage kommen. Insofern entbehrt die antibiotische Therapie von angeblich intrazellulär gelegenen Borrelion mit Tetrazyklinen jeglicher wissenschaftlicher Grundlage. Auch Cadavid et al. (2000) konnten tierexperimentell zwar in zahlreichen Strukturen des Nervensystem Borrelien finden, nie lagen sie aber intrazellulär.

Brorson et al. (1997) züchteten normale Borrelia burgdorferi-Bakterien, die sie aus pathologischen Hautgewebe von Patienten mit Acrodermatitis chronica atrophicans gewonnen hatten auf einem BSK-Medium, das kein Rattenserum enthielt. Sie stellten fest, dass sich die Bakterien nur langsam teilten und schlussentlich in ihrem Teilungsvorgang stecken blieben und Zysten bildeten. Wurde dem Kulturmedium Rattenserum zugefügt, so entwickelten sich diese Zysten wieder zu normalen, mobilen Borrelien. Aus diesem Befunden wurde geschlossen, dass

diese zystischen Bakterienformen unter schlechten Umgebungsbedingungen (mangelnde Nährstoffe, mangelndes Sauerstoffangebot, nicht optimale Temperatur) quasi als schlafende Bakterien verharren bis bessere Bedingungen zur Weiterteilung vorliegen. Treten günstigere Bedingungen, so wurde weiter spekuliert, können die sich normalisierenden Bakterien zu Krankheitsrezidiven oder zu Krankheitsschüben führen. Im zystischen Zustand sind die Bakterien mit den üblichen Antibiotika nicht eradifizierbar und auch vom Immunsystem können sie nicht detektiert werden, so dass die Serologien negativ ausfallen sollen.

Diese interessanten Schluss-folgerungen sind bis heute Spekulation geblieben. Erstens konnten die zystischen Formen in vivo nie nachgewiesen werden und zweitens, haben bisher alle Therapieversuche mit Substanzen gegen Bakterienzysten (Nitroimidazole) in praxi nie wissenschaftlich belegte Erfolge oder Besserungen gebracht. Auch müsste bei zystischen Borrelienformen die Serologie positiv ausfallen, denn bevor die Borrelien in zystischer Form vorliegen können, müssen sie als normale Bakterien während einer gewissen Zeit das Immunsystem stimuliert haben.

Doppelinfektionen

Doppelinfektionen von Borrelia burgdorferi mit Anaplasma phagocytophila (Ehrlichia) und Babesia microti werden als Ursache für einen chronischen Verlauf der Lyme-Borreliose angeführt. 1 bis 2 Prozent der Borrelien tragende Zecken in Europa sind auch mit Anaplasma phagocytophila infestiert. 19 Prozent von amerikanischen Zecken auf Nantucket Island waren Träger von Babesia microti. Auch bei Patienten mit Lyme-Borreliose konnten in amerikanischen und europäischen Statistiken teils bis zu 20 Prozent Doppelinfektionen, vor allem mit Anaplasma phatocytophila, aber auch mit Babesia microti gefunden werden (Satz 2002, Piesman et al. 1986, 1986a, 1987, Mather et al. 1990, Baumgarten et al. 1999, Leutenegger et al. 1999). Wurde bei Patienten mit Doppelinfektionen der Krankheitsverlauf der Lyme-Borreliose untersucht und mit Patienten ohne Doppelinfektion verglichen, so zeigte sich, dass Doppelinfektionen zu einem erweiterten Beschwerdebild mit mehr Symptomen (Fieber, grippeartige Beschwerden) und zu verstärkten und länger anhaltenden Beschwerden führten (Nadelman et al. 1997, Strle et al. 1999). Es zeigte sich aber in allen Studien, dass daraus nicht häufiger chronische Verlaufsformen der Lyme-Borreliose resultierten. Da eine Lyme-Borreliose häufig mit Tetracyclinen behandelt wird, ist eine allfällige Doppelinfektion mit Anaplasma phagocytophila oder mit Babesia microti mitbehandelt.

Obwohl Doppelinfektionen bekannt sind und in verschiedenen Gebieten Europas und Nordamerikas häufig vorkommen, bestehen bis heute trotz zahlreichen wissenschaftlichen Untersuchungen keine Beweise, dass Doppelinfektionen zu einer chronischen Lyme-Borreliose führen.

Zusammenfassend spielen sich nach heutigem Wissen bei der chronischen Lyme-Borreliose hauptsächlich, immunologische und chemische Vorgänge ab. Dass intrazelluläre gelegene Bakterien, zystische Bakterienformen oder Doppelinfektionen mit anderen durch Zecken übertragenene Bakterien eine entscheidende Rolle in der Entstehung einer chronischen Lyme-Borreliose spielen, konnte bis heute wisschenschaftlich nicht belegt werden.

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Publication Notes

The Scientific Journal of Orienteering is an official publication of the International Orienteering Federation (IOF). It is published in a freely accessible online version at the following address:
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The Sci J Orienteering is registered officially: ISSN 1012-0602

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