



The Blue Lagoon and Psoriasis



The Blue Lagoon

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The Blue Lagoon and the treatment of psoriasis

Reykjanes is a peninsula in south-western Iceland that is primarily composed of porous lava. The lava is not dense enough to prevent sea water from penetrating it and reservoirs filled with extremely hot geothermal sea water can be found deep in the bowels of the earth. A high-temperature geothermal area is located at Svartsengi and the Suðurnes heating plant was built there in 1976. The Blue Lagoon was created when hot water, formed due to heat exchange, was discharged into the adjacent lava field. It is said that a worker at the plant suffering from psoriasis began to bathe in this new lagoon and improved considerably. This was the beginning of psoriasis cures at the Blue Lagoon.

In the following years, psoriasis patients' interest in the Blue Lagoon grew considerably and many of them claimed that their condition improved by bathing there twice to three times a week. Later, psoriasis patients took the initiative to build a changing facility for themselves at the lagoon. Patients claimed also that their condition improved even more when baths in the lagoon when combined with UVB light treatment, which was later confirmed by research. Strong demands were made for research on the issue.

In 1987, the results from a preliminary study of the Blue Lagoon's healing potential were published in the Icelandic medical journal *Læknablaðið*. The results were encouraging, but it was clear that further research was needed, as these results were solely based on an evaluation of photographs of patients. Shortly thereafter, dermatologists Jón Guðgeirsson and Jón Hjaltalín Ólafsson began another study that unfortunately was not fully completed, due to limited funding. As in the previous study, the results were encouraging.

In 1986, the Icelandic government appointed a committee to explore the multiple ways of exploiting the Blue Lagoon. The committee promoted research on the chemical composition, biology and healing properties of the Blue Lagoon. At the time of writing, three studies on the healing potential of the lagoon have been completed and its biology also has been studied in detail. Doctors Jón Hjaltalín Ólafsson, Rannveig Pálsdóttir and Bárður Sigurgeirsson have carried out the medical research, while biologists Jakob Kristjánsson and Sólveig Pétursdóttir and others have studied the biology of the Blue Lagoon.

Below we shall review the main conclusions of these studies and also give a brief account of the results that have been achieved at the out-patient clinic operated for skin disease patients at the Blue Lagoon.

The Blue Lagoon

Boreholes are located at Svartsengi that reach several hundred meters down into underground reservoirs filled with geothermal sea water. The temperature in the reservoirs is about 240°C. The geothermal sea water is composed of sea water (65%) and fresh water (35%). The chemical composition of the geothermal sea water is changed by the release of chemical substances from adjacent, silicon-rich rock layers. The concentration of silicon in the water thereby increases a hundredfold (430 mg/kg) while the magnesium in the water precipitates, its concentration decreasing approximately a thousandfold. This water is piped up to the surface through the boreholes. The steam that is formed in this process is used to power steam turbines which generate electricity. The water, on the other hand, is used to heat cold fresh water, which is then piped to inhabited areas of Suðurnes



The out-patient clinic at the Blue Lagoon

and used for residential heating. Finally, the geothermal sea water is discharged into the adjacent lava field at a rate of approximately 900 m³ per hour. The geothermal sea water's temperature at this stage is about 37°C. The largest portion of the geothermal sea water leaks through the porous lava, but a significant portion evaporates. When the geothermal sea water cools, it becomes supersaturated with silicon and long chains of silicon molecules are formed. These silicon molecules eventually precipitate out of the water and form the white mud so familiar to visitors to the Blue Lagoon. This white mud seals up cracks in the lava and makes the bottom watertight, further promoting the lagoon's formation. At the time of writing, the lagoon is about 200 m wide and a few kilometers in length. It is one to three meters deep in most places. The silicon concentration of the water is about 140 mg/kg, and it is these silicon molecules that refract the light hitting the lagoon in such a way that a blue color is formed. Hence the name of this natural wonder, the Blue Lagoon (picture 1).

The biology of the lagoon

The chemical composition of the lagoon is shown in table 1. The average temperature is 37°C, though the temperature decreases somewhat in windy conditions. Rain and snow seem to have little effect on the lagoon's temperature, however. The lagoon's average pH is about 7.5 and its salt content 2.5%. This would appear to be the ideal conditions for the development of faecal bacteria. It was assumed that such bacteria would occur in large amounts in the Blue Lagoon, similar to what happens in unchlorinated swimming pools, especially considering the fact that over 300,000 people visit the lagoon per year. It was thus quite surprising that no trace of bacteria normally associated with humans, like faecal bacteria, was found in the lagoon. Instead, research revealed that bacteria found in humans die when placed in water from the Blue Lagoon. The biology of the lagoon seems in this respect to have a built-in disinfection system. Also worthy of note is the observation of doctors treating patients at the Blue Lagoon that infected wounds heal quickly

when exposed to the lagoon fluid. Research has not revealed any fungal growth in the lagoon, but two types of organisms have been found, blue-green algae and a new, previously unknown type of bacteria.

The blue-green algae that occur in the greatest numbers are *Leptolyngbya erebi* var. *thermalis*, genus Cyanobacteria. They thrive in the lukewarm water and grow readily on the silicon molecules. When these algae occur in great numbers, green concentrations form on the water. Silicon mud that is rich in the algae is also often greenish. Many psoriasis patients think that the greenish mud works the best against their lesions, yet others disagree. The algae in question are not known to occur anywhere else in the world under similar circumstances.

Another microorganism has also been found in the lagoon, a bacillus belonging to the *Roseobacter* genus. These bacteria occur in great numbers in the lagoon and their growth seems to depend little on outside conditions. Further analysis of this organism has recently begun, revealing that it is a new type of bacteria that has not been found anywhere else in the world. It has been given the name *silicibacter lacuscaerulensis*, which can be translated as "the silicon bacterium from the blue lagoon." There is a need for further study of this new organism that has adjusted so well to the unique environment that is the Blue Lagoon. These bacteria do not seem to grow on agar unless water from the Blue Lagoon is mixed with the agar. The question thus arises as to whether the bacteria or the algae that grow in the lagoon are responsible for the lagoon's healing properties. At the Department of Immunology of the National Hospital in Reykjavik, preliminary research has been conducted on supernatant in which bacteria have grown and the results

show that the bacteria can produce a substance that has an influence on the immune system. This research is at such an early stage, however, that is difficult to draw any conclusions at the moment.

The bathing facility

In order to investigate the Blue Lagoon's influence on psoriasis, a special treatment pool was built at the south end of the lagoon, opposite the main bathing facility (picture 2). The treatment pool is 25 x 6 m in size and its bottom is smooth, as opposed to the bottom of the Blue Lagoon itself, which is very rough. Studies have been conducted on the biology of the treatment pool, showing that the conditions there are in all respects comparable to those of the Blue Lagoon. A 200 m² facility built beside the treatment pool currently houses an out-patient clinic for patients with skin ailments. Two dermatologists and three nurses work at the clinic, along with other personnel.

The Blue Lagoon's effect on skin healthy skin

Skin becomes dry after all protracted bathing. Yet bathing in the Blue Lagoon has an even more pronounced drying effect on skin. Bathers commonly rub the silicon mud formed at the bottom of the lagoon on their skin, which causes the shedding of dead skin cells. The skin softens but becomes dry at the same time. Therefore it is necessary to use moisturizing cream copiously after bathing in the lagoon. If hair is immersed in the lagoon, the hair strands become coated with silicon crystals. As a result, the hair stiffens and may be difficult to control for several days afterwards. To prevent this, it is advisable to apply hair nutrients before entering the water.



Use of the PASI score in research

In order to appraise the results of psoriasis treatment, an objective evaluation of the patient's condition is necessary. The descriptions of lesions found in traditional clinical histories are not sufficient; neither is asking patients if they note an improvement or not. Therefore the PASI (Psoriasis Area and Severity Index) method was developed. The method is based on the assignment of points, in accordance with a predetermined assessment system, for the spread of lesions and for the degree of redness and thickness of lesions. Points are also assigned for scaling. Separate assessments are made for the head, torso, and upper and lower extremities. The final result is a composite score providing an assessment of the severity of psoriasis for the patient in question at a given time. When the PASI score is higher than 10, the psoriasis is usually quite severe. By regularly calculating the PASI score during treatment, it is possible to follow the progress of the patient. The PASI method was originally developed for research purposes, but is now increasingly used in the conventional monitoring of psoriasis patients' condition. The PASI score is determined on a monthly basis for patients at the Blue Lagoon's out-patient clinic, and on a weekly basis for patients staying at the Blue Lagoon's recuperation residence.

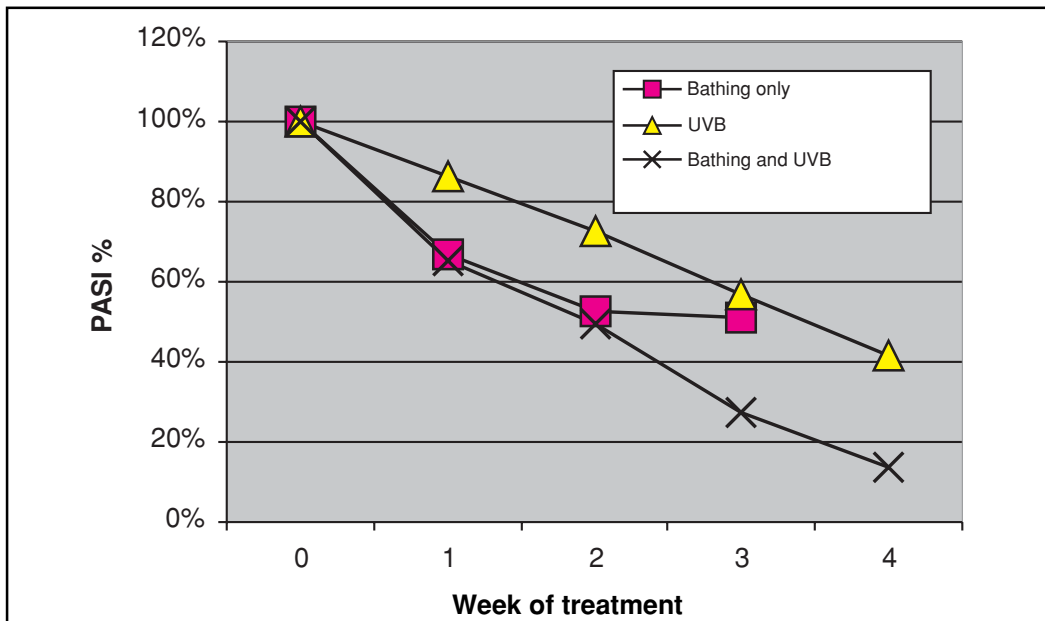
The effect of bathing in the Blue Lagoon on psoriasis – the first study

In 1992, a study was done on 28 German psoriasis patients. All patients received treatment at the same time. No outside treatment was allowed during the study and the patients were instructed to cease all other psoriasis treatment four weeks before coming to Iceland. Another criterion was that patients have

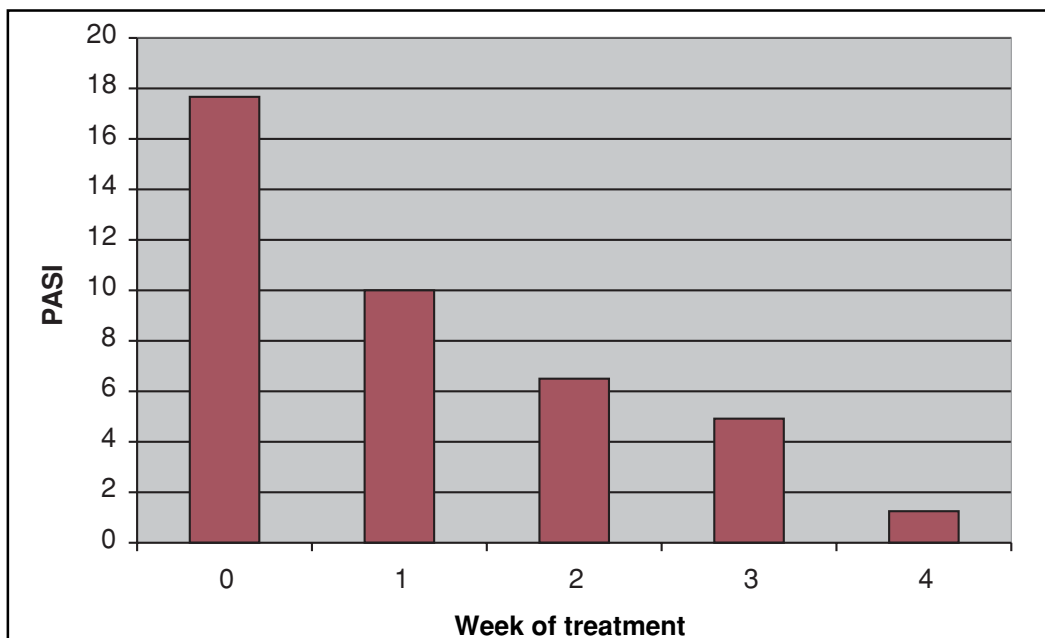
plaque psoriasis affecting over 10% of their body surface. The patients bathed daily in the lagoon and rubbed silicon mud from the lagoon on their lesions while bathing. The patients were examined upon arrival and then weekly during the three-week study. The PASI score was used to evaluate the extension of the psoriasis and photographs were taken of the patients. Twenty-seven patients, 15 men and 12 women, 25 to 62 years old (median age 46.1 years), completed the study. The patients had been afflicted by psoriasis for an average of 25.5 years. The mean PASI score upon arrival was 16.1, signalling that the patients had very severe psoriasis. All of them had been treated for the disease in the previous 12 months. The mean PASI score decreased from 16.1 to 10.8 in just one week, which constitutes a statistically significant difference ($p=0.01$). Changes in PASI score can be seen in table 2 and in graph 1. Side effects were mild, mostly dry skin or itching which were easily eliminated by the use of moisturizing cream. No severe side effects developed.

Bathing in the Blue Lagoon and UVB light treatment – the second study

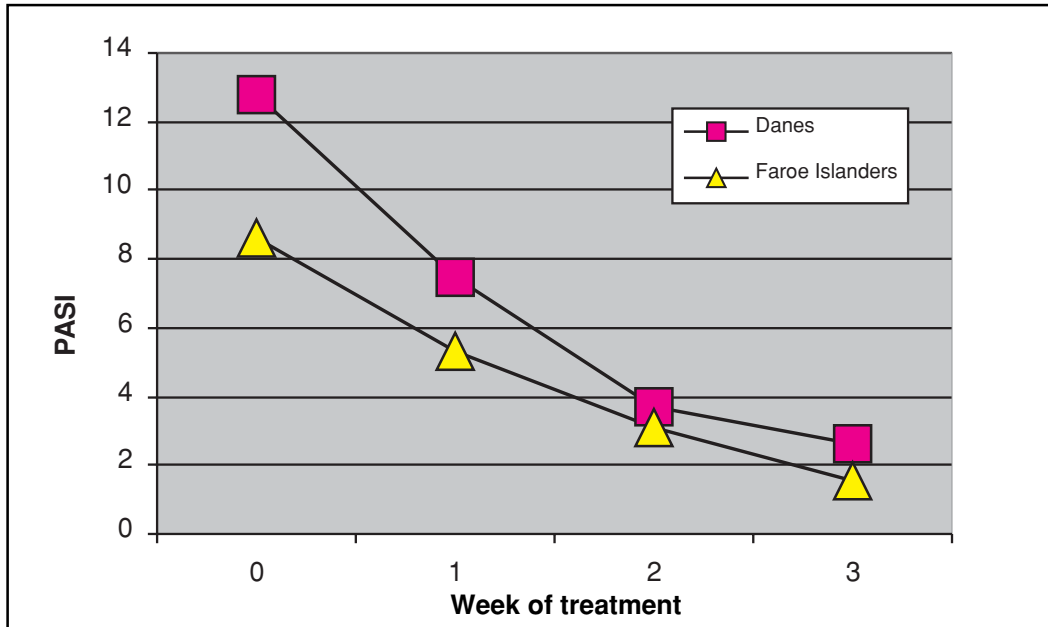
The results from the first study clearly indicated that bathing in the Blue Lagoon was a very effective treatment for psoriasis. Scales disappeared quickly and lesions were greatly reduced in thickness in only two weeks. Achieving even better results was desirable, however, and combining UVB light treatment with bathing in the lagoon seemed to be a logical progression. UVB phototherapy is known to be effective against psoriasis by itself and also to enhance the results of other psoriasis treatments, such as tar, Calcipotriol (Daivonex) and Ditrinol. Some psoriasis pa-



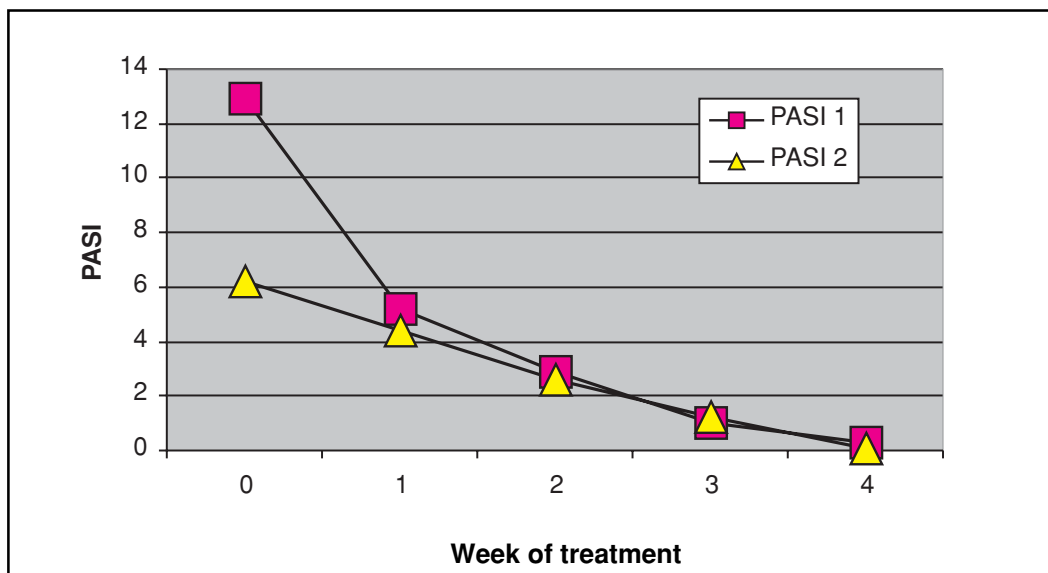
Graph 1. Comparison of PASI scores for psoriasis patients that only bathe in the Blue Lagoon, that bathe in the lagoon and receive UVB light treatment as well, or that only receive UVB phototherapy (UVB). In order to facilitate comparisons, all PASI scores are shown as a percentage of initial scores.



Graph 2. The results for the first nine Icelandic patients treated at the out-patient clinic at the Blue Lagoon.



Graph 3. The results for Faroese and Danish patients treated at the Blue Lagoon's outpatient clinic in autumn 1997.



Graph 4. Nine Faroese patients underwent treatment two separate times, at an interval of a year, at the Blue Lagoon's outpatient clinic. The results of the first treatment (PASI 1) are shown next to the results from a year later (PASI 2).

tients had already used UVB phototherapy on their own in combination with bathing in the lagoon and claimed to have achieved good results. Therefore, a second study was undertaken, in order to compare bathing in the Blue Lagoon and UVB light treatment on the one hand with UVB treatment only on the other. This was necessary in order to show that the treatment results were not solely caused by light therapy.

Twenty-three psoriasis patients from Germany, 10 women and 13 men, participated initially in the study (age 17-46, median age 24). The patients had suffered from psoriasis for an average of 23 years (4-43). All of them had been treated for the disease in the previous 12 months. The baths in the Blue Lagoon were carried out in the manner described above. The treatment lasted 4 weeks as opposed to the previous study's three weeks. Patients received light therapy 5 times a week.

The control group was treated with UVB light therapy only, instead of bathing in the lagoon. The same type of UVB lights (Philips TL 100W/01) was used on the control group and the group with combination therapy. All patients were allowed to use moisturizing cream. PASI assessments were made weekly as in the previous study. Both groups' PASI scores, shown in table 2 and in graph 1, fell week by week; this decrease was statistically significant. Patients who bathed in the Blue Lagoon and received UVB light therapy recovered considerably faster, however. There was already a statistically significant difference between the two groups' PASI scores a week into the study and this difference lasted all four weeks. At the end of the study, 20 out of 21 patients had experienced at least a 75% recovery. The side effects were mild, mostly

dryness of the skin that was easily remedied by moisturizing cream.

Discussion

The first study indicated without a doubt that bathing in the Blue Lagoon constitutes an effective treatment for psoriasis. The second study showed that the results from the first study could be enhanced by using UVB phototherapy in combination with bathing in the lagoon. After only one week this combined method had proved to be considerably more effective than light therapy by itself; this difference in effectivity lasted 4 weeks. Graph 1 shows that almost 90% of the psoriasis symptoms had disappeared from the experimental group as a whole after four weeks. The mean PASI score was 20.3 at the beginning of the treatment and had decreased to 2.8 at the end, which is a very good result. Actually, this means that most of the patients had totally recovered.

From these results one can draw the conclusion that bathing in the Blue Lagoon combined with UVB phototherapy is a very good treatment for psoriasis. The psoriasis treatment program at the Blue Lagoon's out-patient clinic is currently based on these results. It is still not known what causes patients to recover, but there are various possible explanations. Analysis of the chemical composition of the water in the Blue Lagoon has revealed that the water contains no substances that are known to cure psoriasis. The silicon mud is of course significant and doubtlessly the reason for the rapid disappearance of patients' scales that has been observed. We believe that the mud is the best option possible for descaling treatment. What makes the Blue Lagoon special, however, is the organisms that grow in it. It is thus tempting to



conclude that these organisms may produce some sort of substance that is effective against psoriasis, thereby explaining patients' recovery. Obviously, more research is required on this matter.

The out-patient clinic at the Blue Lagoon and the opening of the recuperation residence

An out-patient clinic for skin disease patients was opened at the Blue Lagoon on January 1st, 1994. Since then, hundreds of Icelandic patients have undergone treatment there for skin ailments, primarily psoriasis. Increasing number of foreign patients have also been treated and an agreement was newly reached with Faroese and Danish health authorities on the treatment of Faroese psoriasis patients at the Blue Lagoon. An agreement with Icelandic health authorities on the treatment of psoriasis and eczema patients at the Blue Lagoon was recently renewed. The contract contains an innovative provision for the operation of a recuperation residence for these patients at the Blue Lagoon Hotel. Four rooms there will normally be at the disposal of psoriasis and eczema patients. This agreement makes access to the facilities of the Blue Lagoon equal for patients from the Reykjavík area and from other parts of the country. Plus, the agreement makes more intensive treatment possible for severely afflicted psoriasis patients from the Reykjavík area. Staying at the Blue Lagoon's recuperation residence gives them the opportunity to receive treatment twice a day, six days a week.

Treatment at the out-patient clinic

The psoriasis treatment in question is based on patients bathing in the treatment pool at the Blue Lagoon for an hour at a time, during which they apply silicon mud to their lesions.

Following this, patients undergo UVB treatment in a phototherapy cabinet. It is also possible to receive Helarium light treatment on a tanning bed and UVB treatment for the scalp with combing. Treatment at the Blue Lagoon is primarily intended for psoriasis patients, though eczema patients may also receive care. It is also possible to undergo other, less complicated skin treatments at the same time. At the beginning of treatment, patients are not examined by doctors at the Blue Lagoon. Rather, treatment is based on the referring dermatologist's instructions. The doctors at the Blue Lagoon then follow the patient's progress. Patients treated at the out-patient clinic are examined on a monthly basis while those staying at the recuperation residence are examined on a weekly basis. PASI scores are always determined during these examinations. When treatment has been completed, a report on the patient's visit and the treatment results is sent to the referring doctor. Patients who stay at the recuperation residence receive the same treatment as those who visit the out-patient clinic, except that the former are treated six days a week while the latter are generally treated three times a week. Patients who stay at the recuperation residence also have the possibility of bathing twice a day in the lagoon.

The results of treatment at the recuperation residence

At the end of 1995, records of clinical histories at the Blue Lagoon were computerized. The purpose was to improve the quality of care and to facilitate quality control and research. Statistics from this data base show that treatment was given 3,611 times at the Blue Lagoon in 1996. This figure includes both Icelandic and foreign patients; see table

Chemical	Content
SiSo	137
Na	9.280
K	1.560
Ca	1.450
Mg	1,41
CO ₂	16,5
SO ₄	38,6
H ₂ S	0,0
Cl	18.500
F	0,14
Total Soluble Chemicals	31.900 mg / kg Lagoon Fluid

Table 1. Chemical composition of the Blue Lagoon (mg/kg lagoon fluid)

Week	Baths	Baths + UVB	UVB only
0	16,1	20,3	16,7
1	10,8	13,3	14,4
2	8,5	10,0	12,1
3	8,2	5,6	9,5
4	none	2,8	6,9

Table 2. PASI scores for patients treated only with baths (study 1), with baths and UVB phototherapy (study 2, experimental group), or - in comparison to the experimental group - with UVB phototherapy only (study 2, control group).

Year	Icelanders (%)	Foreigners (%)	Total
1996	3.133 (87)	478 (13)	3611
1997 *	3.994 (82)	898 (18)	4.892

Table 3. The number of treatments given at the out-patient clinic at the Blue Lagoon. *Statistics were only available for the first 11 months of 1997, so the number of visitors for December 1997 was estimated.



Picture 3. Before and after treatment in the Blue Lagoon. In the photo to the left, treatment has just begun and much descaling has clearly been achieved. In the photo to the right, taken at the end of treatment, lesions have completely disappeared.

3 for more details. We have noted with satisfaction an increase in treatment from 1996 to 1997; the treatment of Icelandic patients increased by 27% and the treatment of foreign patients by 87%.

The recuperation residence at the Blue Lagoon began operations on October 1st, 1997 and at the time of writing - the beginning of December 1997 - nine Icelandic patients have received treatment there. Results have been very good, as can be seen in graph 2, which shows the treatment results for these first nine Icelandic patients. Four out of them recovered completely (all lesions gone), and the group's PASI score decreased by an average of 93%. These patients all had severe psoriasis at the beginning of treatment, as indicated by an average initial PASI score of 17.7.

Similar results have been attained for foreign patients that have travelled to Iceland in order to be treated for psoriasis. As mentioned before, Faroese patients have come to Iceland, at a rate of one to two groups per year. Graph 3 shows the results for Danish and Faroese patients who were treated at the Blue Lagoon in the autumn of 1997. Both groups stayed for 4 weeks. The patients' last examination took place less than a week before departure, so the actual recovery may have been better than the graph indicates. Some of

the Faroese patients have returned for treatment. Records of PASI scores have been kept for nine Faroese patients who were treated two separate times in an interval of a year. Examining the results of the first and second rounds of treatment is quite informative (graph 4). It is clear that the patients' psoriasis was more severe when they arrived for the first round of treatment, which means that their improvement was more spectacular during the first round than during the second. One possible explanation for the patients' better condition at the start of round two is that the effects of the first round recovery had not entirely disappeared when the patients returned a year later.

Summary

The Blue Lagoon is a unique natural wonder. Its geology and biology are in all probability one of a kind. A new species of bacteria has been found in the lagoon that is not known to occur anywhere else. Research on the curative effects of the lagoon have clearly shown that bathing in the lagoon is an effective treatment for psoriasis. Observations from the out-patient clinic's treatment program have lent further support to this conclusion. More research is now needed on the Blue Lagoon's curative effect on psoriasis and other diseases. Studies should focus primarily on the two microorganisms that have been discovered in the lagoon. Such research can lead to an even better and more effective cure for psoriasis. In addition, research is needed on the effect of bathing in the Blue Lagoon on other diseases. Some patients with eczema or the skin ailment iktyosis have already been treated at the Blue Lagoon and the results are promising, although it is probably too early to draw any definite conclusions.

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