KARL SCHLOSSMANN

ESTONIAN CURATIVE SEA-MUDS AND SEASIDE HEALTH RESORTS

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CURATIVE SEA-MUDS

Prof. K. Schlossmann reports in this little volume upon the properties and curative action of the remarkable mud sediments which cover the sea bottom in the many quiet bays and inlets of the Baltic Sea along the west coast of Estonia.

The therapeutic effects of the sea-mud cures at various Estonian spas have been established by the experience accumulated within more than a century of steady development. Sea-mud baths and packs have proved to be especially effective in the treatment of rheumatic diseases which are classed among the worst social evils in most northern coun-

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BY

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PREFACE

It has become increasingly evident within the past few years that there is a long-felt need for a compendious report upon the principles and methods of sea-mud treatment as practised in the Estonian mud-bath establishments and a coherent survey of the relevant data which, for the time being, are scattered piecemeal in various technical papers. At present there is a steadily growing demand for trained spa physicians, to whom as well as to many general practitioners such a survey would be of value. On the other hand, it is reasonable to assume that the work may orient even the lay reader with regard to different Estonian spas and make easier on his part an intelligent choice of a suitable health resort.

In spite of the considerable number of studies dealing with various aspects of sea-mud treatment in Estonian pelopathic establishments, some important sections of the field have been overlooked or left untouched. In the present survey an attempt is made to fill some of the more obvious lacunae with experimental findings contributed by the author and his colleagues. The writer is fully aware, however, that many of the problems relating to curative muds require a more searching analysis.

In references to studies made elsewhere mainly those recent publications have been drawn on which have materially added to the knowledge of the curative properties of various muds or have an important bearing on the methods of mud treatment. Every effort has been made to bring the material within a reasonable compass; thus many detailed descriptions of experiments have been omitted and only such discussion of therapeutic procedures is included as is thought necessary to give the reader a clear idea of the main characteristics of sea-mud treatment at various Estonian spas.

A somewhat detailed historical survey of the development of Estonian seaside health resorts as well as numerous illustrations have been included in this publication in the hope that the reader may gain a general acquaintance with the more prominent Estonian seaside resorts in their past and present stages of development.

The author owes special thanks to Mr. H. C. C. Harris, B. A., and Mr. J. Silvet for their careful assistance in translating Chapter I of this volume and in preparing the English manuscript for the press. Acknowledgment is made of the valuable assistance rendered by Mr. J. G. Estam, who read part of the proofs and suggested a number of needed improvements in style.

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Tartu, June, 1939. K. S.

CHAPTER I

HISTORICAL RETROSPECT

The primitive peoples at the dawn of history can hardly have used medicines for internal application to any large extent. It seems probable, however, that various external remedies, especially water, were made use of in the remote past. Hot and cold springs of natural mineral water have existed since time immemorial, and it is safe to surmise that in such waters, flowing out of the depths of mother earth, people early discovered mysterious curative powers. They bathed in those waters, used them in baths for the sick, or for washing the injured parts of their bodies.

Our ancestors were struck by the colour, taste or smell of some of those springs of water, and at the same time surprised at their curative effects, which were explained as "due to the help of some mysterious tutelary divinity, which haunted the springs of curative mineral waters and contributed to the cure." We know that in connection with some of these springs a mineral mud with a specific odour and external appearance is formed which is sure to attract attention. In the same way the muds of the bays, lakes and rivers, with their specific smells and external properties, must have attracted attention.

The ancient Egyptians used the mud of the sacred river Nile to cure various diseases of the skin and of the joints. Their time-honoured method, which is still used in some places (coast of Estonia, Odessa [1] etc.), consisted in rubbing the natural mud on the skin and then letting it dry in the sun (Lozinsky [2]).

The first or primitive period of balneotherapy, which is called the "période théurgique" by Chiray [3] supplies no evidence of the physicians and scientists of that period taking any special interest in the curative waters and muds. The art of curing diseases in general and balneotherapy in particular were at that time mainly a privilege of the priests, and it is therefore difficult to draw a line between rites and practices connected with religion and proceedings based on experiments and aiming at cure and hygiene.

The Greek period, with its "dogmatisme hydro-minéral" (Chiray), represents a new stage in balneotherapy. Belief in natural remedies is growing, and by the side of the treatment with waters the use of curative muds gains ground among the Greeks.

With the Romans the third or "empirical period" in the development of balneotherapy begins. The Greek physicians who practised in Rome brought over the healing methods prevailing in Greece. Thus the

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[1] Scherbakov, A., Arch. of Medic. Hydrol. XIII, 4, 1935.

[2] Lozinsky, A., Balneologia prakt. vratcha, St. Petersburg, 1916.

[3] Chiray, M., Presse Médicale, 14, p. 249. 1938.

Romans became acquainted with the curative properties of mineral waters and muds.

With the fall of the Roman Empire the prosperous days of the baths were over. There followed the long dark Middle Ages, during which the development of empirical medicine came to a standstill, and the watering-places with their bathing establishments sank into oblivion. Only a deep-rooted belief in the healing action of the curative waters and muds remained in the populace.

The Crusades brought with them numerous skin-diseases, leprosy and syphilis, for the cure of which there were no specific remedies. It is natural, then, that many people should have sought relief at the baths of sulphurous mineral water, the curative effects of which on skin diseases were known from times immemorial. At the same time mud-bath therapeutics received a new impetus in Italy and in some other places.

The Reformation and the Catholic Reaction saw in the bathing establishments a direct menace to morals. Most physicians believed that the bathing establishments were responsible for the epidemics which were raging at the time. The doctrine of Paracelsus (1563—1619), when at its culminating point, anathematized balneotherapy and was in direct opposition to the teachings of the earlier men of science (Fallopius and others).

In the 17th century there began a noticeable evolution in balneotherapy. The methods of hydropathic treatment in the numerous spas, which began to

flourish towards the end of the 17th century, found securer scientific foundations, though they were not yet free from mysticism, which at that time was a decisive factor in scientific thinking. Bordeu (1722—1776) considered mineral waters the best physiotherapeutic means, and at the same time drew attention to travelling, change of abode, surroundings and climate, which in his opinion supplemented and enhanced the results of the cure in the spa. However, the defective knowledge of balneotherapy that physicians possessed in those times could not inspire belief in the curative action of the mineral waters.

With the 19th century balneotherapy entered into its scientific stage. The rapid development of the sciences opened the way to experiments and observations, and roused interest in natural curative means among physicists and geologists, increasing at the same time the belief of physicians in balneotherapy. About the same time balneotherapy rid itself of the dogmatism of chemistry, which was now superseded by a kind of "physical and physico-chemical dogmatism" (Chiray). The advances in natural history and physics gradually removed from balneotherapy its mystical elements and opened new horizons to it.

The above-described stage of development had been reached by balneotherapy in the spas of the western states of Europe long before they began to take root in this country. In Russia, part of which state present-day Estonia was then, the active development of the spas began, it is true, more than 200 years ago, but this did not reach our country, where there

were no springs of curative mineral waters corresponding to the accepted ideas of that time.

The blind veneration of the aristocracy and of the wealthier classes of Russia for the spas of foreign countries and their negligence of the national curative means and the spas of their own country retarded the development of the domestic spas and bathing establishments for a long time; the mineral springs of the Caucasus began to be used only in the first years of the 19th century. As present-day Estonia was but a comparatively poor border-province of that great state, it is easy to understand that the state authorities felt no particular interest in developing the spas in this country. The local gentry, who were supposed to be the actual organizers and leaders of the cultural and economic life of the country and at whose disposal were the material means of calling spas into existence, spent their summers in their estates situated in the most beautiful spots of the country, or else went abroad. Thus they did not, as a rule, feel concerned in enterprises that might have brought health, recreation and some comfort into the life of the bourgeoisie, to say nothing of the common people.

The bracing and recreative effect of sea-bathing. which had been known abroad for a long time, began to be utilized by the inhabitants of the sea-coast. The best sandy beaches of the Baltic Sea, in Estonia, inhabited in the first place by fishermen, attracted the attention of the people, being visited in the summertime by nature-lovers; later these became summer-resorts. The people of the seaside towns needed

privacy for undressing and dressing before and after bathing in the sea, and so there arose a need for appropriate accommodation.

In 1805 a chemist called Brasche had the first floating bathing-tent built at Haapsalu, to make bathing in the cold sea-water more convenient, whereas previous to that people bathed from boats or simply from the shore. The bathing was done in the bathing-box in the middle of the tent, which was reached from the shore by means of a boat. This arrangement, although defective in several respects, may be regarded as the prototype of the bathing establishments of this country. Some years later Brossmann, the then district physician of Haapsalu, had bathing-machines introduced (Hunnius [1]), the use of which, however, was impeded by the soft sea-bottom. They were also unnecessary, for there is no tide in the bay. In 1812 a former customs officer, v. Bock, had bathing-huts built which were connected with the shore by means of little bridges, and this proved to be so practical that later there were great numbers of them built. The comparatively short summer of Estonia and the weather conditions often unfavourable to sea-bathing, in addition to the growing belief in the efficacy of sea-water as a means which "washes away all human ills" (Euripides), made people think of methods of lengthening opportunities for sea-bathing artificially. The simplest means for that purpose was to build permanent establishments with a requisite number of baths for

[1] Hunnius, C. A., Die Seebäder Hapsals, Reval 1853.

cold and warm sea-water bathing. This plan was conceived in 1815—1825 and realized for the first time at Haapsalu in 1825. About the same time there arose in Estonia the idea of building establishments for mud-baths, an idea which again was carried out on the initiative of private persons.

The fame of the curative sea-mud in Estonia was, at the beginning, solely a feature of popular medicine, from which it was later taken over into scientific medicine. The cradle of the mud-bath cure in Russia was the Crimean peninsula, and it is possible that rumours of the mysterious properties of mud reached Estonia from that source. It is not known for certain who was the first in Estonia to make use of sea-mud for curative purposes, but it is known that the inhabitants of the farms of Rootsiküla (an estate on the western shore of the Island of Saaremaa) quite a long time ago (about 1800) used the sea-mud for curing various pains and swellings. At about the same time the people living on the coast of Haapsalu, Vormsi and Hiiumaa are said to have used the sea-mud for cures. The mud cure was very primitive in the beginning. The whole body or the affected arm or leg was bathed in a vessel full of mud mixed with salt-water. Some sufferers went or were carried into the shallow shore-water and bathed their legs in the mud on the sea-bottom. This kind of cure is still used by some seashore inhabitants (in Hiiumaa). L u c e reports that in the district of Kihelkonna in the village of Kiirasaare a simple farmer had arranged mud-baths for ambulant patients in his bath-house. It was already a

commercial enterprise, and it is safe to assume that before the matter reached that stage the use of mud must have been handed over as a tradition from generation to generation (H. Martinson [1]).

The results and also perhaps the gains were so obvious that they attracted the attention of the upper classes, and in 1824 the landlord of the estate of Rootsiküla (38 kms. from Kuressaare), Baron Buxhoeveden, had a sea-mud bath house with 4—6 baths built on the seashore of his estate. To this establishment came patients from the neighbourhood as well as from Livonia and remoter parts. In the case of 45 patients treated with warm sea-mud baths the physician ascertained that the mud of Rootsiküla had a remarkable curative effect (von Harten [2]). The results obtained and the reports of the district physician upon the sea-mud caused the Livonian medical board, to whose ears had come repeated reports of the miracles worked by the sea-mud, to send a professor of chemistry, Dr. Grindel, to Saaremaa, to make a chemical analysis of the mud. In June 1824 he began the investigation of the sea-mud at the estate of Rootsiküla, the results of which were published in 1825 and 1828 [3],

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[1] Martinson, H., Muda kümblusravi ülesanded; Eesti Arst, Supplem. p. 11, 1934.

[2] v. Harten, M., Die Bäder zu Arensburg, Insel Oesel, Arensburg 1872, and Die Schlammbäder und Seebäder von Arensburg, Insel Oesel. Arensburg 1890.

[3] Grindel, A., Journ. d. prakt. Heilkunde von C. W. Hufeland und E. Osann, Berlin, Bd. V, p. 26, 1828, and Ostseeprovinzenblatt vom 10. März, 1825, Beil. zu Nr. 10 u. 18.

his reports being the oldest studies of Estonian sea-mud. As an outcome of this investigation there arose in influential circles a plan for calling into existence a modern bathing establishment at Rootsiküla. The plan, however, met with difficulties, for Prof. Grindel had stated in his report that he had found the layer of mud in the Bay of Rootsiküla to be about 200 metres in circumference and of small depth. This indicated clearly that the layer would not suffice when used for any length of time. Besides, there were difficulties in finding accommodation, food and competent medical advice. In 1836 the estate of Rootsiküla changed owners, and as the Buxhoeveden bathing-house proved to be too primitive, the establishment closed down. At first the opinion prevailed that the sea-mud of Rootsiküla had peculiar properties connected with its location, but J. W. L. von Luce [1], a physician practising at Kuressaare who knew Saaremaa well, expressed in his publications the idea that curative mud must be found all along the coast of Saaremaa. This assumption later proved to be correct.

In spite of the primitive character and short-lived duration of the Rootsiküla bathing establishment, people began to take an interest in the hot water and mud baths in other parts of the country, mainly in the seaside towns. Dr. K. A. Hunnius, municipal physician of Haapsalu, had on one of his professional

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[1] v. Luce, J. W. L., Topographische Nachrichten von der Insel Oesel in medicin. und oeconom. Hinsicht, p. 370—371, Riga 1823.

visits seen an old fisherman who was holding his bare feet in the sun-heated mud, and who had told him that bathing the feet in the hot sea-mud brought considerable relief from rheumatism (Kaulitz-Niedeck [1]). Later in 1821 Dr. Hunnius arrived at the same conclusion as a result of his experience.

O. W. Masing in his *Marahva Näddala-Leht* of 18th Aug. 1823 writes that sufferers from rheumatism who rubbed their affected limbs with the evil-smelling mud from the sea-bottom of the Haapsalu Bay felt relief. The mud had to be applied on the spot where it was found, for its power was said to evaporate when it was taken to another place, however small the distance.

On the initiative and recommendation of Dr. K. A. Hunnius, who was the first physician to use Estonian sea-mud as a curative means, the local philanthropist, Count Magnus De la Gardie, built in 1825 the first public seawater- and mud-bath establishment, where patients were treated with hot sea-mud baths. On the 2nd of July of the same year already the bathing establishment became by purchase the property of the chemist Brasche who introduced 6 baths with appropriate conveniences.

Some years later it became evident, however, that the establishment did not answer its purpose, and efforts were made to remove the defects. In 1830 the establishment was provided with a shower-bath, and

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[1] Kaulitz-Niedeck, R., Hapsal, ein nordisches al fresko, Reval 1930.

DR. CARL A. HUNNIUS,

on whose initiative the first public mud-bath establishment was built at Haapsalu in 1825.

OSKAR BRACKMANN (1841—1927),

the Mayor of Pärnu 1879—1918, whose life-work was chiefly concerned with developing Pärnu into a modern spa.

in 1832 the temperature was made uniform by building suitable heating-stoves in the dressing- and bath-rooms. As the number of visitors to the watering-place and of those using the baths was quickly growing, one mud-bath establishment could no longer satisfy all the patients. Two other smaller bathing establishments (belonging to the merchant Holm and to one Eckermann) were accordingly built, and in 1840 one more (belonging to Siem), which was the fourth in Haapsalu. The last three were very primitive and lacked all conveniences. At the same time the great thronging of visitors to Haapsalu made it necessary in 1840 to increase the number of swimming-huts for cold sea-baths (Hunnius).

While in Haapsalu spa life and mud-bathing were developing more or less smoothly, in other places there were difficulties to overcome. At Pärnu the idea of calling a watering-place into existence arose about the time when spa life began to develop on the Riga beach (1814—1824), of which fact the leading people of Pärnu were aware. (The majority of the data concerning Pärnu which we have kindly been permitted to use have been collected by Dr. J. Kukk from the municipal archives of Pärnu).

In 1837 the Municipal Council of Pärnu granted permission to a private company to build an establishment for cold and hot baths. The first bathing establishment with 6 public bathrooms and 4 private baths for visitors was built in 1838 in a house which used to be an old inn; this establishment was on the very

spot where the present hydropathic establishment is situated. Goebel, professor of chemistry in the University of Tartu, shows in his book [1] that in 1844 there were 54 families (154 persons) who had come as visitors from other parts to have their baths at the Pärnu hydropathic, and who were being treated with good results. Goebel gives data about the composition of the water at Pärnu. Elucidating the effect of the sea-water in general, he finds that the beach at Pärnu with its sand, sea-bottom, water, and climate, is very favourable for sea-bath cures in various diseases.

E. G. Normann [2], who was the physician of the gentry of Saaremaa and who thus on his frequent professional visits became well acquainted with the various places of the sea-shore, affirmed in 1840, just as v. Luce had done before him, that sea-mud similar to that found in the Bay of Rootsiküla was also found in the other bays of Saaremaa. He proved that H_2S and iron oxide, which are characteristic of the Rootsiküla mud, were found in great quantities in the muds taken from the various bays of the northern, western, and southern shores. Dr. Normann sent samples of the Rootsiküla and of the Kuressaare muds to Prof. Engelhardt (mineralogist and geologist of the University of Tartu-Dorpat), where A. Goebel made a chemical analysis of them, which showed that the two muds

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[1] Goebel, Prof., Das Seebad bei Pernau, an der Ostsee. Leipzig, 1845.

[2] Normann, E. G., Bemerkungen über den Oeselschen Schlamm, Inland, Nr. 15 u. 46, 1840, and Nr. 4, 18 u. 32, 1841.

consisted of identical component parts [1]. Dr. Normann also proved in his repeated polemics and on the ground of the materials collected the identity of the sea-muds of Saaremaa, but his plan of calling into existence a bathing establishment at Kuressaare, which place was indubitably best suited for visitors, was not realized for a long time. He procured the licence needed, and only after a long period of seeking and discussion did he succeed in finding a man who had enterprise enough to build a mud-bath establishment at Kuressaare. It was a master-carpenter called Jacob Georg Weise, and in 1840 the "Weise Mud-Bath Establishment" was opened on the sea-shore rather far out of town on the so-called "Weise meadows". The establishment began its activities under Dr. E. Normann's personal direction, while Weise took care of the financial side. The mud for the baths was taken from the bay in the immediate neighbourhood.

In 1845 Dr. Hunnius (sen.) succeeded in making Baron Ungern-Sternberg, owner of the Suuremõisa on the Island of Hiiumaa, interested in the mud-baths, so that with the latter's capital there was built at Haapsalu a new bathing establishment, which could compete with up-to-date foreign establishments. In 1846 the newly-built bathing establishment was rented out and opened to the public, which meant a great advance in the mud-bath cure in Estonia. With the building of this establishment three of the older establishments

[1] Goebel, A., Ueber den heilsamen Meeresschlamm an den Küsten der Insel Oesel u. s. w., Dorpat, 1854.

soon closed down so that, beginning with 1848, there remained working at Haapsalu the bathing establishments of Brasche and Ungern-Sternberg only. In 1848 the latter was taken over by a certain C. Althoff who made an attempt to eliminate all that was not quite up-to-date. In 1850 the new owner began to add drawing-rooms and elegant new bathrooms which were meant for the use of the members of the imperial household, and where the children of the Czar took their baths.

About the middle of the 19th century there began scientific research into the problems connected with mud-bath cures, where also the sea-muds and the sea-water of Estonia came under question. In 1840 Mining Engineer Ivanov [1] published the results of his analyses of the water separated from the Kuressaare sea-mud and of the mud-particles separated from the sand. In 1851 Dr. Eichwald [2] made an investigation of the infusoria found in the sea-mud and in the sea-water of the Bay of Haapsalu and of the shores of the islands, and Prof. Trapp made a chemical analysis of the samples of the sea-muds and sea-water taken by him to St. Petersburg. Prof. Schmidt [3] made a chemical analysis of the sea-mud of Kuressaare (Small Bay)

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[1] Ivanov, Gorny žurnal, Vol. II, fasc. 6, p. 339, 1840.

[2] Eichwald, III Nachtrag zur Infusorienkunde Russlands, Bull. soc. Impér. de sc. natural. de Moscou, T. XXV, p. 414, 1852.

[3] Prof. Schmidt, Dr. Schrenk's Abhandlung, p. 104, 1852.

and Haapsalu. In 1852 Dr. Schrenk [1] made an investigation of the local conditions under which the sea-muds were formed, and in 1854 A. Goebel, assistant chemist of the Cabinet of Chemistry at the University of Tartu, published the results of his analysis of the Kuressaare and Rootsiküla muds. On the basis of this he also made an attempt to elucidate the problem of the formation of the mud but unfortunately without having personally visited the places where the mud was found. This circumstance naturally detracts from the plausibility of the conclusions drawn and conjectures made by him. Besides these there appeared up to 1860 numerous other scientific investigations (Kaschin, Grum, et al.), and writings in various Russian papers on the Estonian sea-muds and watering-places.

In the second half of the 19th century spa cures and spa life in general begin to develop more intensively, in great measure owing to the facility of the new railway communications. At the same time spa technique made progress and balneology developed as an independent branch of knowledge. The building of luxurious hotels, fitted out with all kinds of comforts, began in Germany, and soon found imitation in France, Switzerland and in other countries. In Russia, as well as in Estonia, the development of spa life was, however, much more moderate. In spite of all the

[1] Schrenk, A. G., Uebersicht des obern silurischen Schichtensystems Liv- und Estlands u. s. w., Dorpat, 8. Thl., I, p. 101 ff., 1852.

defects, the activities and the number of visitors grew rapidly in Estonian watering-places where hot water and mud-baths were provided. For example, at Haapsalu the number of hot water- and mud-baths in 1841 was 1794, in 1845 — 2850, in 1850 — 7936, and in 1851 — 7857. The number of mud-baths alone amounted to about 6000 in 1851 (Hunnius). At Kuressaare the number of patients in 1841 was 10, in 1845 — 4, in 1850 — 17, and in 1851 — 31 (Mierželejevsky). In 1847—49 N. I. Pirogoff, professor of surgery at the University of Tartu, sent the patients he had operated on to the mud-baths of Kuressaare.

The situation at Pärnu was somewhat different. There the bathing establishments mainly provided hot- and cold-water baths, which in the beginning found quite a number of users, and life at the watering-place developed satisfactorily. But in 1857 already the directors of the above-mentioned establishment, Councillor of Commerce C. J. Schmidt and Town Councillor K. F. Stroehm applied to the Town Council with a request to restrict free bathing on the beach in order to prevent competition, for the income from the bathing establishment was dwindling. The request was granted but matters did not seem to improve.

The distance of the Kuressaare (Weise) mud-bath establishment from the centre of the town proved to be an impediment. When it was found that the Big Bay (Suur Viik) of Kuressaare contained rich supplies of mud fit for curative uses, Weise's widow in 1856 built a new mud-bath establishment on its

present premises near the town park (Pargi tän.), and the old one was demolished. The outbreak of the Crimean War and the blockade of the Baltic islands by the English in this connection nearly put an end to the influx of patients to Kuressaare. In the sixties, however, Prof. Pirogoff began sending greater numbers of his patients to Kuressaare and that place began to win increasing fame.

The steadily increasing number of patients made it impossible for the existing bathing establishments of Haapsalu to satisfy all demands; this caused discontent. In 1856 the Mayor of the town, chemist C. Bergfeldt, acquired by purchase the former Brasche establishment, with a view to enlarging it at his own expense. Starting the work of rebuilding with limited means, he soon fell into difficulties. In 1859 the Czar assigned a subsidy of 12,000 roubles to the establishment. In the same year (1859) members of the Czar's family took hot baths in C. Bergfeldt's establishment. In 1877 the bathing establishment was ready in its enlarged form. After having undergone further smaller changes this establishment is working at the present day under the name of the "Haapsalu Municipal Mud-Bath Establishment". The bathing establishment built in 1845 by Baron Ungern-Sternberg, which was bought in 1848 by Althoff and in 1858 by Stürmer, is at present owned by Dr. Arronet, and is known as the "Mud-Bath Establishment of Dr. Arronet & Co.".

The bathing cure at Haapsalu made rapid progress in the second half of the 19th century. In 1875 already

14,000 hot mud- and sea-water baths were taken there (Grönberg [1]). With the development of the spa the conditions of the place as a summer-resort improved too. Seaside promenades were laid out and decent new villas were built. In 1905 Haapsalu got railway connection with Tallinn and a spa-pavilion at the seaside. As a watering-place Haapsalu won great fame among the Russian aristocracy, and Russian Czars and members of the imperial household repeatedly visited Haapsalu (in 1852, 1856, 1857, 1859, and 1871).

In 1876 Dr. Mierżejevsky [2], a gynaecologist from St. Petersburg, built at Kuressaare a second, the so-called "Roomasaare Mud-Bath Establishment", which held the foremost place in Estonia and among its closer neighbours as regards architecture and modern equipment. This establishment with 30 bathrooms and 60 baths interrupted its activities during the World War, and its equipment was destroyed in the war. The reason for building this mud-bath establishment had been, according to the founder's own words, the cure of his own grave rheumatism by the Kuressaare curative mud in 1872. He was director of the establishment for nearly 40 years.

In 1883 Dr. C. Wiedemann (from St. Petersburg) and Dr. G. Carstens built at Kuressaare a third establishment, the "New Mud-Bath Establishment". In 1901

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[1] Grönberg, A., Kuurort Haapsalu, 1932.

[2] Mierżejevsky, Grjazeletchebnitza „Romasar", Warsaw, 1912.

the Municipal Council of Kuressaare succeeded in signing a contract for 25 years with the owners of the lands round the bay containing the curative mud, and in 1902 the private mud-bath establishments were informed that they could procure the mud only on payment of a certain sum of money (25 kopecks a boxful), in consequence of which they were forced to raise the fees for the mud-baths. In 1908 the Weise Mud-Bath Establishment (containing 32 bathrooms with 64 baths) passed into the ownership of the Kuressaare municipality. After the Crimean War the number of patients treated with mud at Kuressaare had been increasing from year to year. Patients came here from St. Petersburg, Moscow and Central Russia, and from the Baltic Provinces, taking the cure at their own expense or being sent here at the expense of the state (cadets). In 1869 the number of those taking mud-baths at Kuressaare was 114, in 1875 — 210, in 1876 — 474, in 1878 — 664, and in 1879 already 715 (Holzmayer [1]).

An attempt to revive mud-bath treatment on the Rootsiküla shore was made in 1908 by the district physician, S. Talvik, who found a suitable place for a mud-bath establishment on the land belonging to the Abaja farm, and made a contract for the use of the site. The money for the enterprise was procured by issuing shares which were bought by some local officials and small shopkeepers. The activities of Dr. S. Talvik

[1] Holzmayer, J. B., Das Bad Arensburg auf der Insel Oesel, Arensburg, 1880.

in Saaremaa displeased the local authorities. and he was forced to leave the place, having worked there from 1907 to 1909. After Dr. S. Talvik's departure the half-completed mud-bath establishment was left ownerless and deserted, and the landowner sold the building, which was getting out of repair, to be broken up.

The bathing establishment which had been built at Pärnu by a private company and which was used in a small way by the local inhabitants went downhill and seemed to be doomed to final extinction, while at the same time in other Estonian watering-places the rapid development of the bathing establishments could be seen. Then the Mayor of the town, Oscar Brackmann, took a decisive step in 1889 and took the bathing establishment and the organization of the watering-place into the hands of the municipality. In the same year the Town Council elected a committee which was to make acquaintance with the bathing activities of the Riga and Narva beaches and to make appropriate proposals with regard to the Pärnu watering-place. The Pärnu municipality, without further delay, bought at a public sale the house of the old bathing establishment, and on the 20th of May 1889 already the reorganized establishment opened its doors again. The bath-committee worked out the plan of a new bathing establishment which was accepted by the Town Council on the 29th Sept., 1889, and on the 23rd May 1890 the new establishment began its activities. At the same time it was decided to add

new extensions to the bathing establishment which were completed in 1891 and 1898. In 1903 a department for the water-cure was opened with baths, shower-baths, steam- and hot-air boxes, and a swimming basin. In 1904 a department for electric light treatment, air- and sun-bathing was built, and a department of mechanotherapeutics was opened in a separate building (A. Kroeger [1]). In the new bathing establishment salt-water, mud and peat baths were given. The sea-mud was taken from the mud-beds in the Bay of Pärnu, and the peat was brought from the peat-bog near the town. On getting acquainted with other watering-places the committee found that not only sick but also healthy visitors were needed for the summer resort, and means must be found to attract them. The bathing-machines and movable bathing-huts which were formerly in use gradually disappeared and in 1895 they were no longer seen on the Pärnu beach. Instead of these the system of fixed bathing-huts was introduced in 1899. The park was rapidly and systematically enlarged and in 1891 the spa-pavilion was built. During the World War the bathing establishment burnt down on the 28th Aug., 1915, and the building of the new establishment was taken in hand in the times of Estonian independence.

Before the World War the Pärnu mud- and water-bathing establishment worked with 32 bathrooms, and the number of baths taken grew with every year. For instance, the number of baths in 1890 was 3339,

[1] Kroeger, A., Pernau, Kur- und Seebad. Pernau, 1905.

in 1895 — 5790, in 1900 — 8956, in 1905 — 13126, in 1910 — 14616, and in 1914 — 10850.

During the last quarter of the 19th century Narva-Jõesuu, which is the most notable among the Estonian watering-places for its natural beauty, began to develop. It is situated on the southern shore of the Gulf of Finland in the region of the estuary of the Narva River, and comprises a sandy beach of rare beauty, extending for more than 10 kilometres, together with sand-dunes covered with a wood of coniferous and foliaceous trees. Up to 1870 on the dunes composed of fine sand there were but about 100 cottages inhabited by fishermen, workers of the small local factories, and the pilots guiding ships up to Narva. In the seventies of the last century, on the energetic initiative of the Mayor of Narva, E. F. Hahn, the wooded regions of the Kuterküla (Kudruküla) estate, belonging to the Narva municipality, began to be subdivided into separate lots for building villas on. At the same time roads were built, a park was laid out, and a water-supply was installed. Villas sprang up rapidly, and visitors began to arrive. In 1876 the first water-establishment (Dr. E. Kroug) was built, in 1882 the spa-pavilion, in 1902 another water-establishment (Dr. J. Salzmann), and in 1909 the Sanatorium. In 1912 a new spa-pavilion was built under the direction of Prof. V. G. Jarotzky, instead of the old one, which had been destroyed by a fire. In the water-establishments mainly physical cures were used: sea-water, fresh-water, pine-extract, mud, sulphur-

ous, carbonic acid, and steam baths, shower-baths, massage, electrization, etc. As in the neighbourhood of the watering-place (called Hungerburg then) no sea-mud is found, it was imported in casks from Saaremaa (Kihelkonna and Kuressaare). There are very few watering-places which can boast of such rapid development as Narva-Jõesuu. At the beginning of the World War there were 54 streets with a total length of 34 kilometres, nearly a thousand villas and over a thousand houses with permanent inhabitants. Part of Narva-Jõesuu was on the right bank of the Narva River, between the Rosson river and the sea. That aggregation of villas was called Magerburg. The number of summer-guests in 1914 was over 10000. The Hungerburg of those days was the favourite watering-place of the richer classes of St. Petersburg and other Russian cities. For sea-bathing the visitors had at their disposal bathing-huts on the shore and dressing-cabins which could be wheeled into the sea.

The World War, the revolution with the civil war and the War of Estonian Independence following it, brought a long break into the life of the watering-places of Estonia as well as in those of other countries. Some of our watering-places were forced to discontinue their activities for a time; in others summer life was stunted. The bathing establishments were either quite destroyed (as at Pärnu), or they were pillaged during the war, or else for lack of the most necessary repairs they became practically useless for their purposes. The government of the Estonian Republic and the local municipal autho-

rities, to whom all the above-mentioned watering-places and bathing-establishments belong now, had to begin to take measures, in addition to their more urgent tasks, to improve the condition of the watering-places, for there were very few private persons willing to invest their capital in enterprises which were comparatively unremunerative, especially at a time when there were opportunities for much more profitable investment.

During the last decade *Pärnu* has taken the lead among the Estonian watering-places in so far as modern development is concerned.

In view of the town's limited financial resources, Mr. H. Soo, the Mayor of Pärnu in 1921, tried to interest private enterprise in the erection of a new bathing establishment. This failing, the Municipal Council decided in 1922 that the town itself should build the new establishment. The plans submitted by several leading architects were rejected, however, as involving too great an expenditure, and the project was abandoned. The new Mayor, Mr. O. Kask, reopened the question in the following year, and on the 6th February, 1923, the Municipal Council again passed a resolution in favour of the erection of a bathing establishment. The new bathing establishment was designed jointly by O. Siimann, E. Wolffeldt and A. Nürnberg and was built by G. Darmer & E. Bliebernicht, Contractors, on the site of the old one, the public opening taking place on July 9, 1927. The establishment contains 52 rooms for mud, peat and water baths, together with rooms for packs, rest and massage, and is provided with

water supply, central heating, and electric light. An annexe containing the department of CO_2 baths was begun in 1929 and was completed on the 2nd June, 1930. Other extensions such as the hydrotherapeutic department, rooms for douches, and a swimming bath were opened on the 23rd July, 1936. At present the Bathing Establishment can provide up to 300 baths per diem and as many as 150 various packs and compresses.

During the same period the problem of accommodation at Pärnu has lost much of its acuteness. In recent years quite a number of new summer villas have been built and a Tourist Hostel founded. In the spring of 1937 the Pärnu Mnicipal Hotel (Rannahotell) was opened. This well-appointed hotel faces the sea front and is built in the latest style of spa architecture.

Stretching far inland, the Bay of Pärnu, with its gently sloping bottom of fine sand and its warm water, affords exceptional facilities for safe bathing. These amenities are supplemented by three miles of beautiful sandy beach, suitable for strolling, lounging, taking sun-baths or playing games on. The natural beauty of the watering-place is enhanced by the numerous shady avenues and large parks near and along the beach which impress the nature-lover with the extraordinary variety of their trees and shrubs.

To sum up, Pärnu is a summer resort where visitors can find real comfort and recreation, and where they can obtain relief from long-standing troubles and ailments. Favourable climatic factors, such as the

pure sea air and plenty of sunshine, tend to reinforce the beneficial effects of the mud-cure.

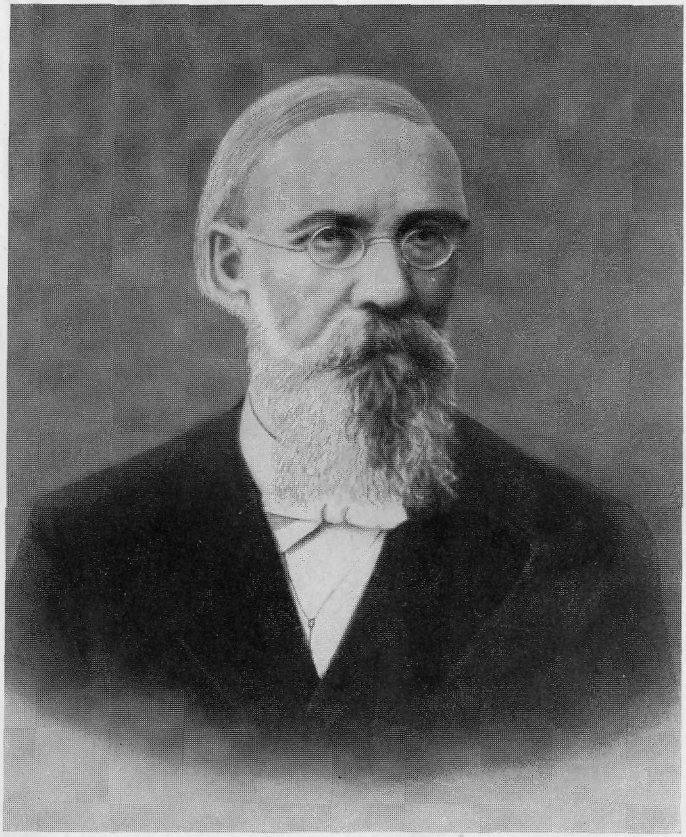
The number of summer visitors at Pärnu has been steadily increasing. In 1913, for instance, there were close on 1200 visitors, 1927 — 2508, 1931 — 2644, 1935 — 3970, 1936 — 4675, 1937 — 6122 and in 1938 — 6634. The number of baths taken also exceeds the pre-war figures. Thus, in 1910 on the whole 14,616 baths were taken, which is the record; in 1913 — 11,463, 1935 — 10,744, 1936 — 11,112, 1937 — 14,018, and in 1938 — 13,891.

Pärnu, with a charm peculiarly its own, seems to enjoy a favourable reputation abroad, since the number of foreign visitors has been growing continuously and in recent years even exceeds the number of visitors from the home country. Thus, Pärnu was visited by 2547 foreigners in 1936, by 3268 in 1937 and by 3756 in 1938.

With the beginning of the World War, spa life at *Haapsalu* declined fast, as soldiers were billeted in many of the houses and summer villas. But already in the summer of 1919 the Haapsalu bathing establishments were reopened to admit as their first patients a number of Estonian soldiers invalided in the War of Independence [1].

At present there are two mud-bath establishments in Haapsalu. The Haapsalu Municipal Mud-Bath Establishment on the west shore of the bay, of which the

[1] Alver, H., Eesti Kuurort Haapsalu. 1922.



ADOLF HAHN,

the Mayor of Narva, who initiated and directed the development of Narva-Jõesuu as a summer health resort.

HAAPSALU: THE RUINS OF THE CASTLE.

Municipality became full owner in 1938, contains 12 rooms for mud-baths, together with separate rest-rooms for men and women. In the upper storey of the building there is a boarding-house with 20 rooms and a laboratory. The second, more fashionable and better equipped, which was purchased by Dr. Arronet and Dr. Krusenstiern in 1909 and is now called Dr. Arronet & Co's Mud-Bath Establishment, is also situated on the seashore at the end of Poska Avenue. It has 32 rooms, of which 20 are for mud-baths.

The above-mentioned mud-bath establishments were put into order and renovated in Estonian times. Both the establishments together can give more than 600 baths per diem. Although these establishments cannot boast of all modern conveniences, they are quite adequate for curative purposes and can satisfy the more modest needs of the public frequenting them.

From the abundant deposits of mud near Haapsalu that from the Little Bay and the Voosi Bay is used for treatment.

Besides mud-baths, salt-water, sulphur, pine-extract, carbonic acid, combined mud-and-electric and other baths are given at the Haapsalu Mud-Bath Establishments.

Compared with Russian times the mud baths at Haapsalu have become cheaper and more accessible to people of moderate means, and so the demand for them has risen steadily during Estonian times. The general number of bathers at Haapsalu (2000—3500) has not yet reached the total (8000) record before the World War, but in spite of that the numbers of

baths are no less than those which were registered during the Russian times: 1919 — 15,000, 1922 — 21,000, 1923 — 27,833, 1924 — 23,993, 1929 — 16,842, 1931 — 13,887, 1935 — 16,546, 1936 — 16,545, 1937 — 20,651, and in 1938 — 20,526. It should be mentioned that in previous years invalids averaged 40—60 baths during a summer, but now they limit themselves to 10—30 baths for the sake of economy. With reference to the latter symptom it should be emphasized for the comfort of patients that the results of treatment do not depend only on the number of baths but on their proper application.

In 1925 the centenary of the Haapsalu spa was celebrated, while in 1939 Pärnu and in 1940 Kuressaare will be able to look back on a century of activity.

In the first years of Estonian independence several new sanatoria were opened at Haapsalu for the summer. In 1937 the sanatorium of the "General Laidoner's Fund Committee" and the Estonian Red Cross began its activities in a newly erected building which in solidity and suitability can compete with foreign establishments of the same kind.

Sea-bathing in Haapsalu Bay is made pleasant and comfortable on account of the especially warm and clean water (average warmth in July 23,3° C.; average warmth in the summer months 21.5° C., salt contents 0,6%), right depth and the beauty of the surrounding landscape. Bathing in Haapsalu Bay, which is protected from inclement weather by islands, is possible and useful for persons of more delicate health too. It is possible to continue bathing till late autumn when it

has long been finished in other spas as Haapsalu is sheltered from the cold north winds and cold fogs are completely absent.

Already from the first years of the Haapsalu spa unwavering attention has been paid to the beautifying of the town and it must be stated that much has been done during Estonian times. Beautiful beach-promenades which border the seashore almost along the whole length of the town compose the chief pride of this health resort. The park close to the Haapsalu Castle, which was laid out on the initiation of Dr. Hunnius in 1859, has been arranged for walking and viewing the ruins of the castle and recalling the distant past.

The Haapsalu municipality as well as private owners have tried their best to improve and modernize living accommodation where summer visitors can find simple comforts. The handsome bungalows have been built and equipped with all modern conveniences. For the development of the spa much remains still to be done to provide comforts for the visitors.

It must be admitted that thousands owe their recovery to the Haapsalu sea-mud and temperate sea climate. Haapsalu, with its peaceful, idyllic, little houses where even more peaceful and original people live, with the beauties of nature, the sea, the sun and the legends of the past, is the very place for a tired and overstrung patient to take a complete rest and to regain his health. The inhabitants of Haapsalu love their "Northern Venice" and many of the visitors, too, do not remain indifferent to it and return when possible.

The World War, the Russian Revolution, and the War of Estonian Independence brought the activities of the *Kuressaare* mud-bath establishments to a temporary standstill. The Municipal Mud-Bath Establishment began to function in 1919 and already in 1920 it could begin working at full speed. Most of the first visitors to the establishment were Estonian soldiers who came to recover from wounds and diseases received during the War of Freedom.

Kuressaare's old fame as a curative centre was not destroyed in the storm of wars and revolutions but has grown with each succeeding year. A new department for women was built on the establishment; it contains 32 bath-rooms with 64 baths, a rest-room, massage-room and other necessary rooms. The New Mud-Bath Establishment began to work in 1921 and continues till the present after having been modernized in various ways, with 36 bathrooms and 72 baths.

Owing to the World War, Dr. Mierželevski's Roomasaare Mud-Bath Establishment got into a more difficult position than the above-mentioned. On account of its handsome building and modern furnishings one of the best mud-bath establishments of the Russian times, it stood abandoned and empty for years and during war-times even the furnishings were stolen and broken. It began to function again in 1924 on a much smaller scale than before and till to-day the owner has not been able to give the Roomasaare Mud-Bath Establishment its previous standing. At present it has 28 bathrooms and 56 baths.

All the Kuressaare mud-bath establishments pro-

cure their mud from the Big Bay which lies 4 km. to the north-west of the town. This former bay, now really a lake, the area of which is 6½ square kilometres and which is on an average about 2—2½ metres deep, contains large quantities of mud in its seaward part. On one side a ditch connects the Big Bay with the Little Bay, where mud is also found and on the other side the connection with the Paadla Bay is already being overgrown. The latter is connected with the sea by the Nasva river (2.5 km. long, 7 m. broad and 1.5—4 m. deep).

In spite of the fact that the mud-cure of Saaremaa is centred round Kuressaare, the mud deposits found by the Kihelkonna (Rootsiküla) beach, known of old, have not been forgotten. In the summer of 1938 Strandmann opened a mud-bath establishment in the borough of Kihelkonna. For this purpose he rebuilt an old house. The establishment consists of 8 bath-rooms with mud and water-baths in every room, a rest-room, waiting-room, and a doctor's reception room. The mud for this establishment is brought from the Abaja Bay. Invalids can get board and lodging at the newly furnished and comparatively decent hotel close by. This mud-bath establishment is, of course, primitive and meant for temporary use only. The owner intends to build a large one at Papisaare 3 km. from Kihelkonna. On looking closer at Papisaare it cannot be denied that it is eminently suited for a mud-bath establishment. Papisaare and the borough of Kihelkonna are connected by a large road which was well made during the World War; the dry land is

covered by a wood of conifers and broad-leaf trees, and directly by Papisaare in the Bay of Kiirassaare sea-mud is found in great quantities; conditions for bathing there are favourable too. Before the World War the mud was taken from there to other places, e. g. Riga, Liepaja, Narva-Jõesuu and Tallinn.

In Kuressaare treatment with sea-mud is greatly aided by the very favourable climate. The Saaremaa climate, extraordinarily warm and even for a northern country, and the fresh air both strengthen and improve the health. A proof that Saaremaa's climate is mild and temperate is its abundant and variegated vegetation, as plants can be found which generally grow in warmer countries. Autumn in Kuressaare is extraordinarily warm and mild, therefore it is possible to spend one's holidays there till the end of September, although the season begins on the 1st of June and lasts till the 15th of September. Kuressaare cannot boast of fine sandy beaches for sea-bathing, like Pärnu and Narva-Jõesuu, but the sea-water with its average warmth of 21.0° C. in summer is very attractive to grown-ups and children. In the vicinity of the town — on the sea-shore — are separate bathing-huts for men and women. In the new park just being laid out people bathe free off rafts. In the same park a café with dressing-rooms and sun-bath porch has been built.

Living accommodations for visitors and invalids using the mud-baths have noticeably improved during the Estonian regime. New bungalows have been built, boarding-houses and hotels have been expanded by

adding annexes. Summer lodgings with the conveniences and comforts of European spas, able to satisfy the wishes of the most exacting public, are found to a very limited extent in Kuressaare.

Kuressaare and its surroundings offer a very variegated choice of pleasures. In the town the well-kept Kuressaare Castle of the times of the Old Livonian Order (14th century) and buildings of the 16th and 17th centuries deserve special attention. Interesting walks may be taken in the municipal park (started in 1861), the surroundings of the castle, the castle hill and the new park with its many beautiful lanes. For excursions into the interior there are model paved highways on which it is pleasant to ride in cars, buses, motorcycles and bicycles. The most beautiful and interesting of all excursions are the trips to the Loode oak wood in the vicinity of the town, the sand-bank of Järve (18 km. from the town) with favourable conditions for sea bathing, the Island of Abruka which is of especial interest on account of its rare and variegated flora, the islands of Ruhnu and Vilsandi, of which the latter is a sea-bird sanctuary. The Kaali Lake (18 km. from the town) formed by meteorite explosions and smaller craters in its vicinity is one of the places in Saaremaa worthy of attention. Besides these there are the beautiful Karu Lake, the Mustjala Cliff (40 km. from the town), several old fortresses of the ancient Estonians (Kaarma, Lihulinna, Kihelkonna, Valjala, Pöide and the fortress of Linnuse in Muhu) and old churches of the 14th and 15th centuries (in Kaarma, Valjala, Kihelkonna, Pöide, etc.).

Besides mud-baths, carbonic-acid, pine-extract and sea-water baths are also given in Kuressaare. The number of bathers has been steadily rising during the Estonian times, but the abundance of natural remedies favours a still greater rise in these numbers. Before the World War the number of visitors to Kuressaare fluctuated between 3000—4000. In 1921 there were about 2000, 1924 — 1178, 1925 — 1206, and in 1938 — 1961. In 1922 669 invalids were treated in the mud-bath establishments of Kuressaare and during the season a total of 17653 baths of various kinds was given. In 1924 the number of baths taken attained 29643, including 23371 mud baths.

Narva-Jõesuu, once the favourite summer resort of the Russian upper-middle classes, suffered badly from the ravages of wars and revolutions during 1917—1920. Quite a number of its residential villas and picturesque cottages perished in flames or were plundered by passing troops and then remained untenanted and neglected for years, pending the return of their luckless owners.

With the loss of its former wealthy clientele from St. Petersburg, Narva-Jõesuu had to cater for summer visitors chiefly from the inland towns and to a certain extent from Finland and Sweden. It soon adapted itself to the new conditions, and at present it is a rapidly growing and well-reputed seaside resort which still preserves some quaint relics of its pre-war semi-oriental architecture.

The chief attractions of Narva-Jõesuu lie in the

vast expanse of its fine sandy beach, its quiet pine forests and its bracing sea air. The beach is exposed to cool northerly winds, and so the temperature of the seawater averages only 14—14½° C. in July and August. Sea-bathing at Narva-Jõesuu has a distinctly stimulating and invigorating effect, though it cannot be recommended for invalids and children.

The climatic conditions at Narva-Jõesuu are quite favourable to convalescents and to patients suffering from anaemia, diabetes, digestive troubles, various women's diseases, and nervous disorders. Hydropathic treatment is provided by two bathing establishments. Dr. Salzmann's Hydro (20 rooms) supplies seawater, mud, steam and aeration baths, together with electropathic treatment and massage. A sanatorium is connected with the Hydro. Dr. Kroug's Bathing Establishment, formerly of excellent repute, does not quite meet the latest requirements and stands in need of modern improvements.

The season begins on the 20th of May and lasts till the 15th of September. Visitors to Narva-Jõesuu enjoy modern comfort and entertainment in its casino, cafés and hotels or on its spacious beach. Its extensive parks and pine forests afford exceptional facilities for walking tours and offer all the solitude and natural charm of a peaceful countryside. Excursions to the near-by Russian frontier and many other places of historic interest or artistic appeal (the old city of Narva, the river Rosson, the Silent Lake etc.) are very popular with foreign tourists.

The northern shore of Estonia, with its kaleidosco-

pic changes of picturesque scenery, is certainly one of the most beautiful parts of this country, and it is only natural that a number of charming little summer resorts *(Võsu, Käsmu, Selja, Toilse, Toila, Loksa, Klooga, etc.)* should have sprung up here, most of them but little touched by the bustle of modern seaside life. Their further development is chiefly dependent on private enterprise, though the government and the local authorities also take an active part in promoting their welfare.

Pirita, with its fine beach, lies within easy reach of Tallinn and is a popular summer resort where many thousands of people from the capital find their principal recreation during week-ends and on holidays, enjoying the sea air and disporting themselves on the splendid sands.

Limitations of space forbid anything like a survey of the numerous inland health and pleasure resorts which have also made considerable progress in the course of the last twenty years.

CHAPTER II

NATURAL CURATIVE SEA-MUDS FOUND IN ESTONIA

INTRODUCTION

The Estonian natural sea-muds used for the treatment of different ailments are subaquatic sediments of very complicated structure and chemical composition. Rich deposits of these marine products cover the sea bottom in the many quiet bays and inlets of the Baltic Sea along the west coast of Estonia. In some estuaries the depth of the mud beds attains 2—3 metres. As pointed out in the previous chapter, the therapeutic effect of the mud was discovered more than a hundred years ago by the seashore population, who used it in its natural state for the external treatment of different diseases, especially those of a rheumatic nature. Becoming acquainted with these facts, the local physicians began experimenting with the sea-mud on their patients and the results obtained proved to be highly satisfactory. At that time the first mud-bath establishments were opened by private persons in suitable seaside towns of Estonia where systematic treatment was introduced. In the course of years three seaside towns

— Kuressaare, Haapsalu and Pärnu — developed into health resorts of considerable fame.

Before the World War many scientific reports summarizing the results of the treatment were published by the physicians who specialized in mud cures. It must be remembered, however, that the bath establishments of the Russian period were insufficiently equipped with laboratories for scientific research. Much attention was paid to the results of the chemical analyses of the mud samples made in laboratories far away, and to the various chemical elements found in more or less considerable proportions. Thus a great difference of opinions concerning the qualities of the muds prevailed, especially if the investigator happened to be prejudiced in favour of the particular mud he recommended.

After the World War the Estonian Government was confronted with the necessity of restoring the bath establishments which had fallen into decay or been entirely destroyed during the long years of war. This task was performed in the first few years of Estonian independence. Many bath establishments were rebuilt and entirely new premises were erected in order to accommodate the constantly increasing numbers of health-seekers. Much work has been done, and today Estonian spas already possess comfortable bath establishments. In the light of modern research it was realized that besides up-to-date bath establishments it is of great importance to develop and improve methods of treatment in accordance with the principles of modern balneotherapy. It was not easy to provide

all the mud-bath establishments with well-trained medical men able to control and regulate the biological action of a mud-bath.

Local authorities and the Governmet now take an active interest in the protection of Estonian sea-mud beds and support the development of health resorts. By the decision of the Government dated May 19, 1939, the control and utilization of Estonian curative muds are being regulated in accordance with the Nature Protection Act. The methods of treatment with therapeutic sea-muds in the establishments are improving steadily, and the spa physicians pay great attention to the achievements of various mud-bath establishments abroad. The investigators follow with interest the valuable suggestions of "The International Society of Medical Hydrology" founded in 1921 "to encourage in all countries the clinical and experimental study of Medical Hydrology".

The Standard Measurement Committee and The Council of The International Society of Medical Hydrology [1] adopted the new generic name P e l o i d (from the Greek word $\pi\eta\lambda\acute{o}\varsigma$ = mud, clay, or the like), with its derivatives P e l o l o g y and P e l o t h e r a p y, for the substances applied in baths and packs in medical practice (muds, peats, etc.). The natural peloids, to which the Estonian curative sea-muds belong, are ready for use without any particular preparation, whereas artificial peloids have to undergo essential physical or chemical changes before use. The Society

[1] Arch. of Medical Hydrology, p. 182, 1933, and p. 12, 1938.

of Medical Hydrology has considered many plans proposed for the classification of peloids (A. Scherbakov, W. Benade [1], etc.) in order to provide a nomenclature suitable for international use. A definite classification has not yet been adopted but valuable directions for practical requirements are already given. The Peloids Committee of the Society has proposed and described different methods of experimental procedure for the determination of the chemical, physical and biological properties of the curative muds, which have been used as far as possible in the present investigation [2].

Pelology is only just emerging out of crude empiricism, and it is therefore apparent that a great difference of opinion still exists regarding the results of treatment with mud-baths and packs. This is partly due to the fact that entirely dissimilar experiments have frequently been compared. Owing to the variability of the muds used for treatment and the constitutional differences of the patients, the effects of treatment are hardly ever exactly comparable. No doubt the work already done by the Society of Medical Hydrology and the reports published in the "Archives of Medical Hydrology" have shed much light on all the questions of scientific pelology.

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[1] Benade, W., Balneologe, H. 2, p. 49, 1937.

[2] Report on Peloids, Arch. of Medic. Hydrology, p. 11, 1938.

From the biological point of view the Estonian sea-muds used in medical practice are natural semi-solid mixtures of complex composition resulting from an interaction of finely divided inorganic matter (sand, clay, chalk, salts, etc.) and water with variable proportions of organic substances and living micro-organisms. The enormous beds of sea-mud are formed by very complicated biochemical reactions which take place under the water in airless conditions. The sea-muds, matured during a long period in varying geographic, climatic and biological conditions, may be regarded as colloid systems, the dispersion medium of which is water saturated with hydrogen sulphide (H_2S) and the dispersal phase of which is composed of solid particles of different size. Microflora and organic life play an important part in the reactions necessary for the formation of therapeutically effective sea-muds. The organic matter present in matured sea-muds in different quantities is a very important component upon which the physical properties of the therapeutic sea-muds depend.

The south and west coasts of the large islands (Saaremaa, Hiiumaa and Vormsi) and the west coast of the Estonian territory are especially favourable for the formation of sea-mud beds, whereas the north coasts are almost devoid of mud deposits. Meteorological observations have proved that the sedimentation of the sea-mud is favoured by the predominant south and south-west winds which bring waves with great amounts

of various organic and inorganic substances into the estuaries. On the other hand, these estuaries are protected against the surges coming from the north during stormy weather [1]. With regard to the particular conformation of the estuaries, we may distinguish between three types of Estonian sea-mud beds. First, those in the quiet estuaries which cut deep into the mainland. The sea flows into them at high tides, but at the same time they are protected by the islands against heavy seas during tempests. The second type of mud beds comprises the water basins which once were widely connected with the sea, but to-day communicate with it only through narrow channels (Small Bay at Haapsalu) or a river (Big Bay or Lake at Kuressaare). Some basins communicate with the sea only at high tides. The access of substances from the sea to such mud lakes is insufficient or entirely closed. The third type of mud beds is formed on the shores of the open sea, especially at havens or harbours (Virtsu, Kuivastu), where comparatively deep under the water surface enormous deposits of sediment are gathered on the sea bottom.

The particular properties and the formation of Estonian sea-muds depend upon the correlation of certain local conditions. As known from geological studies [2], the strata of limestone and dolomite present

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[1] M. v. Harten, Die Schlammbäder und Seebäder von Arensburg, Arensburg, 1872.

[2] Goebel, A., Ueber den heilsamen Meeresschlamm etc., Dorpat, 1854.

in abundance on the islands and in the basins where the mud beds are forming contain abundant compounds of sulphur. In the sea-muds there goes on a continual anaerobic decomposition of various sea-plants (Fucus vesiculosus, Zostera marina, Zannichellia maritima, etc.) which also contain sulphates [1]. Under the influence of incessant biochemical reactions which take place in the mud beds on the sea bottom the compounds of sulphur give rise to the different products of disintegration among which hydrogen sulphide (H_2S) predominates. The muds used in medical practice in Estonia are notorious for their specific odour of H_2S. It is evident, however, that the formation of sea-muds in the estuaries is partly influenced by the mineralogical and vegetable substances of the coast.

When freshly taken from the sea bottom, the mud samples are black, dark grey or with an additional greenish tint. According to origin, the mud represents a semi-solid jelly-like or plastic and oily substance which feels soft or velvety and finely sandy between the fingers. The more or less pronounced smell of H_2S disappears when the mud is kept in the open air. The sea-muds retain water for a long time and take a higher consistence when warmed. The degree of the plasticity of the Estonian sea-muds obtained from different beds is variable and depends upon the quantity of the colloidal hydrates of sulphur, iron and iron oxide present in the mud. The sea-muds eagerly absorb

[1] Forchhammer, Ueber den Einfluss der Fucusartigen Pflanzen etc., Erdmann's Journ., Bd. III, p. 385, 1845.

oxygen from the air and assume a light grey colour when kept in the open air. When dried, the sea-muds represent a grey-coloured hard mass which can be triturated with difficulty.

When examined under the microscope, the sea-mud reveals the presence of sharp-cornered, colourless grains of silica which are often covered with iron oxide, opaque stone fragments, formless conglomerates of clay, pieces of mollusc shells, silicous residues of unicellular marine algae (diatoms), amorphous substances of vegetable and animal decomposition and many other micro-organic residues. Of microscopic organisms about 77 genera embracing over 160 different species have been found [1] in the Estonian sea-muds and in the sea water upon the mud beds. The predominant organisms are various diatoms which have a wall of silica (Navicula, Campylodiscus etc.). Of the sea plants which participate in the formation of sea-muds the Chara and Fucus species, Potamogeton pectinatus, Zostera marina, Zannichellia maritima, Cladophora glomerata and others should be mentioned. Of the animals Theodoxus fluviatilis, Paludina (Radix ovata) balthica and numerous larvae of the order Diptera (Culicidae) have been found. Microscopic examination of freshly taken samples reveals the presence of various motile and non-motile bacteria (Schizomycetes).

The depth of the Estonian sea-mud beds is

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[1] Eichwald, Dritter Nachtrag zur Infusorienkunde Russlands. Bulletin de la soc. Impér. d. sc. natural. Moscou XXV, 1852.

variable and attains 0.3—0.5 m. in the Small Bay at Haapsalu, 0.5—0.75 m. in the Bay at Rootsiküla, and 1—2 m. in the Big Bay at Kuressaare, but there are places in some beds where the depth attains 2—3 m. The total depth of the water over the mud beds is also variable and changes from 0.5 to 2 m. Usually no mud beds are found in estuaries where the depth of the water exceeds 3 m. The sea-mud beds generally lie on a solid stratum of greyish clay mixed with small-grained white silica sand. In some estuaries the clay reposes on a layer of coarse-grained sand formed by the demolition of granite.

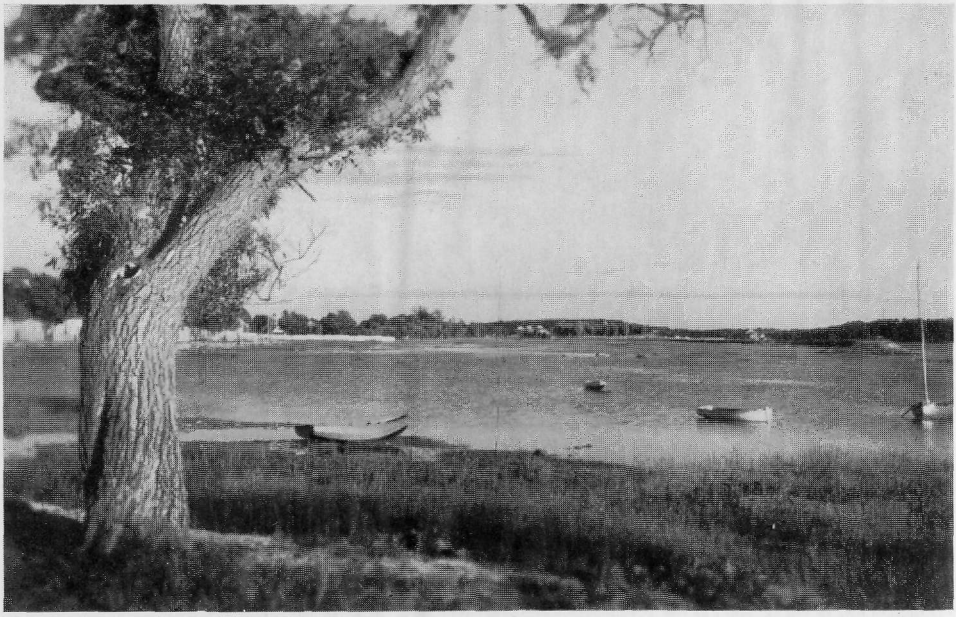
As a matter of fact, it should be noted here that samples of the sea-mud obtained from the different regions of a bed, or at various times from the same region, need not always be of similar composition. In sea-mud deposits various mechanical, chemical and biological processes go on uninterruptedly, and thus the composition and properties of the mud are slowly but continually changing. Under certain accidental conditions rapid changes in the upper layers of the sea-mud may take place which depend upon the natural circumstances of the deposit and the methods of getting the mud. Thus, for example, the sea-mud obtained during tempests usually contains superfluous quantities of sand, shells, marine animals, sea-plants and other accidental matters. Such mud is not suitable for medical practice. The upper layer of the deposits in quiet estuaries usually consists of a light, flaky and homogeneous mass of vegetable and animal origin which has not attained the degree of complete maturity. All

that need be said here is that mud gathered by an inexpedient method or at an unsuitable time should not be used for therapeutic baths and packs. In this way it is possible to avoid many distressing misunderstandings in practical sea-mud cures.

It is important to note that the quantity of curative sea-mud in the estuaries increases very slowly. The processes of decomposition and especially the complicated biochemical reactions need long periods, perhaps centuries, before the subaquatic sediments attain the degree of maturity required of the qualified therapeutic peloids. Although nature has supplied many Estonian estuaries with enormous deposits of sea-mud, their employment in medical practice is growing from year to year with great rapidity and we should seriously consider whether it is right to look upon the sea-mud deposits as an inexhaustible natural treasure without reasonable economy in their utilization. The mass of natural sea-mud once applied to bath or pack is not used again, and no methods for the regeneration of mud already used are adopted at the Estonian health resorts. Every patient knows that mud once applied is thrown away as worthless for further therapeutic use. From the hygienic and aesthetic point of view this method is agreeable to patients, but it causes considerable loss in the mud economy and imposes increased expenses upon them. It is evident that the beds of curative sea-mud which number among the most important natural resources of Estonia are in pressing need of effective protection, or else the damage once done will be difficult to repair.

HAAPSALU: A VIEW OF THE BAY.

HAAPSALU: THE SANATORIUM OF GENERAL SIR JOHN LAIDONER FUND.



HAAPSALU: THE LITTLE BAY.

HAAPSALU: THE BAY AT NIGHT.

The rôle of micro-organisms in the formation of the sea-muds has not yet been definitely established. Corresponding investigations have demonstrated that the mud beds of the sea are to a great extent microbiogenic sediments and may therefore be called the burial-places of micro-organisms. The products resulting from the analytic and synthetic activity of microbes may be either organic or inorganic, soluble or insoluble, volatile or non-volatile. The organic matter present in the matured sea-muds of the native mud beds resists bacterial attack and may be looked upon as having gone out of organic circulation as slowly accumulating waste products. A definite relation has been shown to exist between the transformation of the organic matter added to the sea-mud beds and bacterial multiplication.

It has been established that organic nitrogenous bodies are rapidly decomposed in sea water and in the sediments on the sea-bottom. Experiments carried out [1] with copepodes (Calamus finmarchicus) as representatives of the nitrogen-rich marine zooplankton showed that they were rapidly decomposed in sea water; this was accompanied by active bacterial multiplication, oxygen consumption and liberation of nitrogen as ammonia (NH_3). Organic substances, simple and complex in nature, as Fucus and its constituents, asparagine and the fresh diatom material added to sea-

[1] Waksman, Hotchkiss, Caray and Hardman, Journ. of Bacteriology, 35, 477—486, 1938.

water were also rapidly decomposed [1]. We have obtained similar results in experiments with different samples of the Estonian sea-mud.

The survival of micro-organisms and their multiplication in curative muds has been dealt with by several investigators. Ivanov [2] reached the conclusion that the muds are not bactericidal for pathogenic micro-organisms; on the contrary, they represent a favourable medium for the development of bacteria. As is known, a natural medium is not found to be really bactericidal unless the concentration of hydrogen ions is greater than pH 3.85 or less than pH 11.35; conditions which are not found in natural curative muds [3]. The fango of Italy and the mud of Pistany were considered injurious to patients from the bacteriological point of view, because streptococci, staphylococci and bacillus proteus were found in them (Diel and Judt). Corresponding investigations have, however, shown that the above-mentioned flora was in every case harmless (avirulent) when tested on animals. Kucera [4] suggests that the microflora of natural muds cannot do any harm when applied to an intact skin. Besides, in practice pasteurization is carried out by heating the mud before application, and there is no reason why

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[1] Waksman and Carey, Journ. of Bacteriol., 29, 531—543 and 545—561, 1935.

[2] Ivanov, cit. A. Lozinsky, Balneologia prakt. vratcha, p. 467, 1916.

[3] Cruveilhier and Magnier, Acad. de Médecine, Paris, Vol. C, 451, 1937.

[4] Kucera, Cas. lék. ces., Nr. 41, 1937.

a specimen of mud should not be repeatedly used for the same patient. From the psychological point of view, however, it is desirable to use fresh portions of mud for each application and to prepare the baths or packs so that everyone is permitted to see the course of the process. For practical purposes the curative muds should in the first place be examined for the pathogenic organisms, especially for the typhoid paratyphoid-coli group and then for the saprophytic microflora.

Numerous samples of Estonian sea-mud, freshly taken from several mud beds, were examined bacteriologically in the Institute of Bacteriology of the Tartu University. The results of these studies are summarized in the present chapter. The bacterial content of the samples examined was determined by means of the usual plate method, which shows the number of viable bacteria capable of developing into colonies in a specific medium. The numbers thus obtained represent, of course, a fraction of the total number of bacteria, viable and dead, present in the sea-mud, but it seems that the plate method is still the most reliable for comparative purposes. Vinogradsky's simplified direct microscopic method, recommended for the determination of the total number of microbes, generally showed many more organisms in the sea-mud examined, but the identification of the microbes was not possible by this method.

For the determination of viable microbes several dilutions with freshly taken sea-mud samples were prepared in water and plated on the medium; those

plates which had less than 700 colonies were selected for counting. The plates were incubated for 5 days at 25—30° C. in anaerobic and aerobic conditions, and 2 days at 37° C. aerobically. For the cultivation the following meat-peptone-agar of Omeliansky was used: meatwater 1000.0 c.c., peptone 5.0 gms., glucose 5.0 gms., asparagine 1.0 gm., mannitol 2.0 gms., sea-salt 5.0 gms., natr. phosphoric. (Na_2HPO_4) 1.0 gm., gelatin 10.0 gms. and agar 15.0 gms.; pH 7.0. In the experiments made for the determination of bacterial changes in a freshly taken sea-mud sample the vessels containing the sea-mud to be examined were incubated for 2 to 5 days at 25 to 30° C. and the rate of bacterial multiplication was investigated by the usual plate method.

In the experiments with asparagine and glucose to 10 gms. of freshly taken mud 90.0 c.c. of the following solution were added: glucose 20.0 gms., asparagine 0.5 gms., K_2HPO_4 — 0.5 gms., $Na_2S_2O_3$ — 0.3 gms. and water 500.0 c.c. The flasks containing the mud mixed with the nutrient solution were incubated in a dark room at 25—30° C. for 2—5 days; then the rate of bacterial multiplication was determined by the plate method. Some of the results obtained are summarized in Table I, which also contains the corresponding data obtained by H. Priima and E. Tallmeister [1] in the Institute of Bacteriology of the Tartu University.

[1] H. Priima and E. Tallmeister, Hydrogen Sulphide Fermentation in the Estonian Sea-Muds and its Causes, Tartu, 1938.

TABLE I

BACTERIAL CONTENT OF THE SEA-MUDS

Sample	*Number of Bacteria in 1 gm. of Mud*					
	Freshly Taken Mud			*Addition of Asparagine and Glucose Incub. for 2 Days*		*Sea-Mud Incubated 2 Days*
	Aerobic for 5 Days at 25° C.	*Aerob. for 2 Days at 37° C.*	*Anaerob. for 5 Days at 25° C.*	*at 25° C.*	*at 37° C.*	*at 25° C. Aerobic*
Pärnu (Virtsu) 28 V 38	268,500	66,100	57,000	59,500,000	68,400,000	570,000
Pärnu 8 VIII 38	88,000	20,400	33,000	583,800,000	96,500,000	225,000
Haapsalu (Small Bay) 27 VII 38	72,200	3,728	15,800	83,160,000	53,130,000	318,000
Voosi 27 VII 38	109,300	11,000	31,500	163,250,000	98,940,000	438,000
Hiiumaa (Käina Bay) 5 VIII 38	86,900	21,900	73,400	2,083,000	2,481,000	252,000
Kuressaare (Big Bay) 3 VIII 38	142,900	27,400	12,400	951,000	1,844,000	375,000
Kuressaare 8 VIII 38	135,600	12,700	15,300	581,950,000	96,400,000	482,000
Rootsiküla 8 VIII 38	47,800	2,800	86,200	42,550,000	21,325,000	152,000
Saulepa 5 VII 38	144,900	28,400	44,800	847,300	700,000	275,000
Vihasoo 31 VIII 38	12,600	7,000	11,300	921,000	844,000	76,000

The rate of bacterial multiplication in natural sea-muds suggests certain hypotheses and conclusions. It is evident that under natural conditions the organic matter of the sea-muds is in a state of equilibrium between formation and decomposition. The number of bacteria present in a native sea-mud depends upon the state of equilibrium between bacterial multiplication and bacterial destruction. Changes in the number of viable bacteria are brought about by changes in the food supply, environmental conditions and by the modification of agents unfavourable to bacteria, as, for example, substances resulting from bacterial metabolism, bacteriophagic agents and organisms feeding upon bacteria (protozoa etc.).

Although there is no doubt that under natural conditions the bacterial population of the sea-muds is partly kept down to a certain minimum through the consumption of the bacteria by marine animals, the most important condition inhibiting their multiplication in the sea-muds is, however, the presence of certain controlling factors injurious to bacterial development. It is not always the lack of food substances in the sea-mud which checks bacterial multiplication. For instance, the results of bacteriological examination show that in samples of the sea-mud brought to the laboratory and allowed to remain undisturbed, rapid multiplication of the micro-organisms takes place, which results in the decomposition of the organic substances present in the mud. These processes are accompanied by the absorption of oxygen and liberation of CO_2, NH_3 and H_2S. At the same time microbes play an

important function in synthesizing new compounds of substances in the sea-mud.

It is interesting to note that the aeration of a mud sample by stirring promotes a much more abundant bacterial growth than in the undisturbed mud. Evidently the natural sea-mud of a mud bed contains sufficient oxygen for the oxidation processes which go on incessantly in the presence of organic matter. The increase of oxygen concentration in the sea-mud is, however, very important for the promotion of bacterial activities; at a reduced oxygen tension the organic matter is slowly attacked by bacteria. It has been found that the bacterial content and the rate of bacterial multiplication taking place in the deeper layers of a sea-mud bed kept undisturbed are different from the content and multiplication found in the surface layer where fresh organic matter is almost constantly being added by sedimentation.

The results of bacteriological examinations show that the natural sea-mud offers in certain conditions a comparatively favourable medium for bacterial development. The modifications taking place in a sample of the sea-mud kept at 25—30° C. are sufficient to incite the bacteria to begin multiplying rapidly and utilizing the organic substances of the matured sea-mud, both in suspension and in solution. The numbers of viable bacteria increased from 50 to 400 per cent. during 2 days at 25° C. and much more within 5 days. After 10—15 days an equilibrium of bacterial multiplication is established.

Appreciable increase of bacterial multiplication

takes place, especially if different organic substances are added to the samples. The results summarized in Table I show that in muds to which asparagine and glucose were added the number of bacteria capable of developing into colonies on the agar plates increased 300—3000 times during 2 days at 25° C. The maximum number of bacteria corresponded to the time of the maximum rate of asparagine and glucose decomposition. The rise in bacterial population, however, was followed by a rapid drop, as soon as the nutrients added to the mud were exhausted.

Experiments [1] with sea water and sediments taken from the sea bottom have demonstrated that the decomposition of glucose added to them was always controlled by the degree of the decomposition of the organic matter present in the water. The rapidity of the decomposition of the organic matter required for the metabolism of the bacteria depends upon the temperature, oxygen tension, abundance of organic matter and chemical nature of the organic matter itself.

The maximum multiplication of bacteria in freshly taken natural sea-mud brought to the laboratory takes place at 25—30° C. At lower and higher temperatures the rise in bacterial number is much slower. The determination of bacterial content in freshly taken samples of the sea-mud showed that the number of bacteria capable of developing into colonies at 25° C. was always higher than the number obtained at 37° C. These investigations confirm the opinion that the

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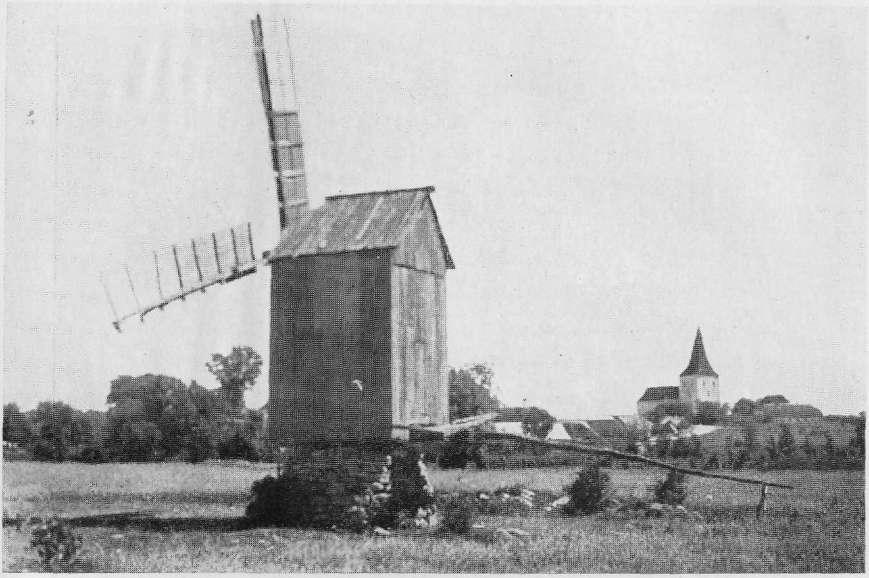
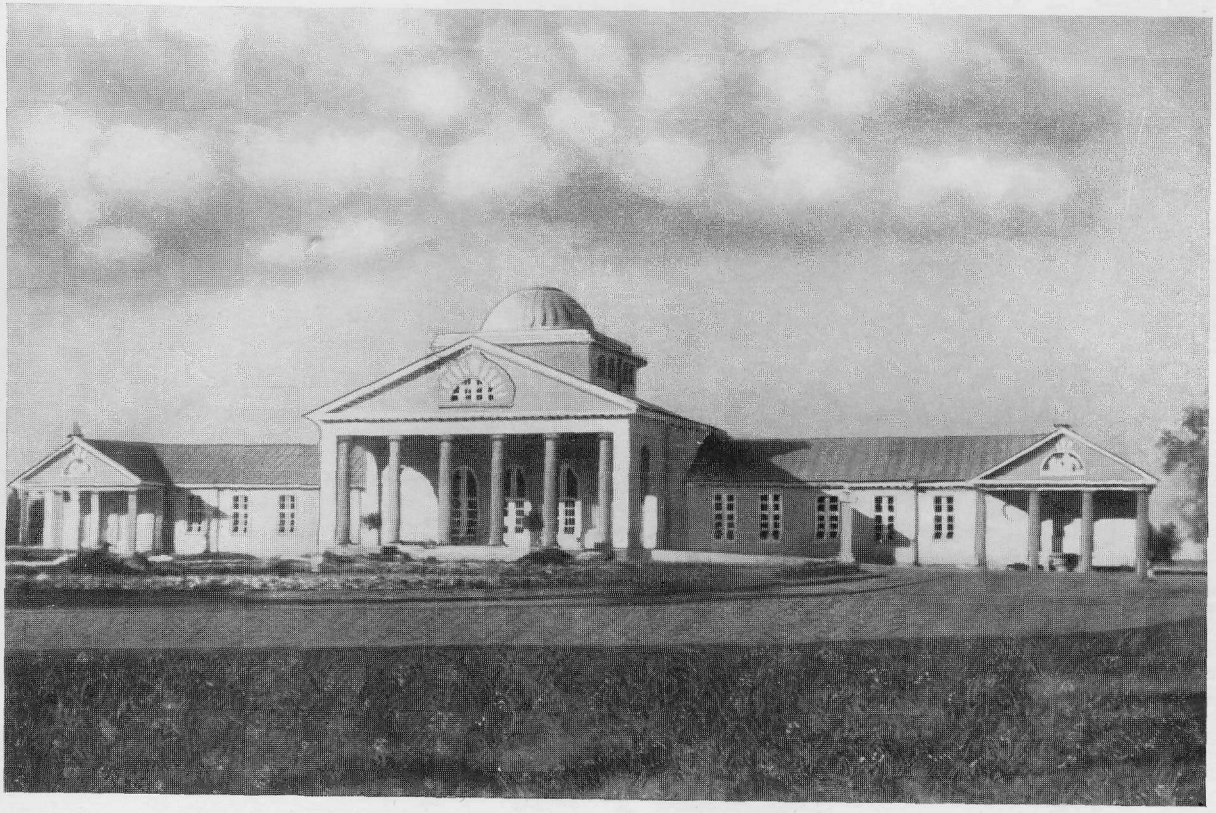
[1] Waksman and Carey, Journ. of Bacteriol. 29, 1935.



SAAREMAA: ONE OF THE TYPICAL WIND-MILLS ENCOUNTERED ON ALMOST EVERY FARM.

KURESSAARE: THE OLD EPISCOPAL CASTLE.



PÄRNU: THE MUNICIPAL BATHING ESTABLISHMENT.

optimal temperature for the multiplication of bacteria in the Estonian sea-muds is somewhat higher than the average summer temperatures (June—July—August) of the sea water at the depth of 4 feet which were found to be 21° C. at Haapsalu, 18.75° C. at Kuressaare and 18.4° C. at Pärnu (Klau, Lozinsky et al.).

The number of colonies developed anaerobically at 25° C. per 1 gm. of the sea-mud was lower than the corresponding figures obtained aerobically at the same temperature. Most of the bacteria found in the sea-mud are facultative anaerobes which grow both in the presence or absence of oxygen. Several investigators [1] have already proved that most biological reactions in the natural curative muds take place especially under anaerobic conditions. Although we are justified in concluding that the facultative anaerobes play the most important part in the formation and maturation of the Estonian sea-muds, no definite answer can as yet be given to the question as to what is the real course of the bacterial multiplication and decomposition of the organic matter in the sea-mud under natural conditions. We still know far too little of the factors controlling and favouring bacterial development and action in the sea-mud beds.

The species of bacterial population were found to be variable in samples obtained from different mud beds. We have till now isolated from the freshly taken Estonian sea-muds, by the usual

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[1] Keilhack, Veröffentl. der Zentralstelle für Balneologie, H. 9, 1929; Werigo, cit. Balneolog. prakt. vratcha, 1916.

method of cultivation, the following 37 species of bacteria: B. cereus, B. mycoides, B. subtilis, B. cohaerens, B. simplex, B. teres, B. robur, B. vulgatus, B. novus, B. centrosporus, B. laterosporus, B. albus; Pseudomonas syncyanea, mildenbergii and fluorescens; Flavobacterium flavum, flavescens, aquatiles, maris and xanthium; Serratia marcescens and rubrica; Achromobacter agile, dendriticum, guttatum, stutzeri, rathonis, nebulosum, geminum, globiforme and fermentationis; Proteus vulgaris, Micrococcus varians and Sarcina flava; Actinomyces roseus and albus [1]. 23 species produced H_2S in variable amounts when grown in the Hunter-Crecelius medium [2]. Most of them were saprophytic organisms, generally found in sea water, air, and soil.

It should be noted that the determination of the bacterial content as well as bacterial multiplication in the natural sea-muds may serve as a sensitive index for the estimation of changes which take place in the organic and inorganic matter present in the sea-mud. Slight changes in the quantity of organic matter and in the degree of temperature may induce an extensive alteration in the number of bacteria. The bacteriological method may be supplemented by the investigation of biochemical reactions in the sea-mud, as, for instance, oxygen absorption, liberation of ammonia, CO_2 and especially of H_2S.

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[1] According to Bergey's Manual of Determinative Bacteriology, 1934.

[2] Hunter and Crecelius, Journ. of Bacteriol. Vol. 35, 2, p. 185, 1938.

HYDROGEN SULPHIDE FERMENTATION

The eventual presence of the odour of hydrogen sulphide does not necessarily indicate the decomposition of organic substances in the sea-mud by the bacteria. This odour may also be caused by hydrogen sulphide of mineral origin. There is no doubt, however, that in medical peloids a very important part is played by the special bacteria producing the circulation of sulphur, iron and calcium. In the case of sulphur, for instance, the therapeutic action depends on the degree of dispersion. Many species of bacteria found in the Estonian sea-muds, which decompose the organic residues of plant and animal origin under natural conditions, play an important part in the production of H_2S (Proteus vulgaris, B. mycoides, Actinomyces albus and roseus, etc.). The energy thereby liberated favours the synthesis of new substances in the form of bacterial cells, which tends to compensate for the loss caused by the gradual destruction of the organic matter.

It is known that the decomposition of organic matter, especially plants, in the sea-muds is accompanied by the formation of methane (CH_4) and hydrogen (H_2) in statu nascendi capable of reducing different compounds of sulphur and of producing H_2S. Analogous reduction of sulphur and of various compounds of sulphur accompanied by the liberation of H_2S is also produced by several species of specific microorganisms present in the sea-mud, as for instance, Spirillum desulfuricans (Beijerinck), Spirillum aestuarii (van Delden), etc. The determination of those micro-

organisms in the natural sea-muds would be a valuable index for the estimation of the therapeutic activity of the sea-mud, but the methods of their cultivation have proved to be somewhat complicated and inconvenient for practical uses.

In the present investigation an attempt was made to supplement the bacteriological method by the determination of H_2S liberated from the sea-mud to which various compounds of sulphur were added. The determinations of H_2S were made by Treadwell's modified method [1]. Into each of three sterile flasks 10 gms. of freshly taken sea-mud were introduced; to one of them 100 c.c. of solution No. 1 (Water 1000.0, Natr. lacticum 3.0, Asparagine 1.0, Magnes. sulfuric. 1.0, Natr. sulfuric. 0.5, Kal. phosphoric. (K_2HPO_4) 0.5 and traces of Cupr. sulfuricum) were added; to the second flask 100 c.c. of solution No. 2 (Water 500.0, Glucose 20.0, Asparagine 0.5, Kal. Phosphoric. (K_2HPO_4) 0.5 and Natr. sulfurosum ($Na_2S_2O_3$) 0.3 and to the third 100 c.c. of solution No. 3 (beef-peptone-broth 300.0 and Flores sulfuris 0.3) were added [2]. Into the fourth flask 50 gms. of freshly taken mud were introduced. All these flasks were put into the incubator and connected with an aspirator by means of two special globe-tubes; the tube next to the flask contained 0.01 n iodine solution

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[1] Treadwell, F. P., Chemische Untersuchungen der Schwefeltherme von Baden, 1897.

[2] Omeliansky, Prakt. rukovod. po mikrobiologii, p. 208—209, 1922.

and the second 0.01 n Natr. thiosulphate solution (Fig. 1). The flasks were incubated for 2 days at 25—30° C. Then the two solutions were mixed and the quantity of hydrogen sulphide (H_2S) combined with iodine was estimated by iodometry. For the estimation of H_2S in the mixtures of mud to 10—25 c.c.

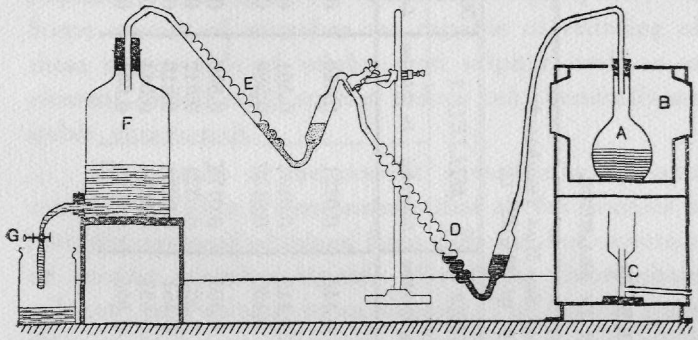

Fig. 1. Hydrogen sulphide determination. A. Fermentation flask; B. incubator; C. regulated warming; D. globe-tube with iodine solution; E. globe-tube with Natr. thiosulphate solution; F. aspirator.

of the mixture examined a superfluity of 0.01 n iodine solution acidified with HCl was added and then the quantity of free iodine was determined by titration with 0.01 n Natr. thiosulphate solution. 1 c.c. of 0.01 n iodine solution corresponds to 0.00016 gms. of H_2S (Treadwell [1] and Abderhalden). The results obtained with different samples are summarized in Table II.

The reduction of sulphur and compounds of

[1] Treadwell, Lehrbuch der analytischen Chemie, Bd. II, 1927.

TABLE II

H_2S FORMATION IN SEA-MUDS.

Sample	*H_2S per 1 kg of Sea-Mud Incubated for 2 Days at 25—30° C.*							*H_2S per 1 kg. of Fresh Mud*
	MILIEU 1		*MILIEU 2*		*MILIEU 3*		*50 gms. Mud*	
	Liberated	*In Solution*	*Liberated*	*In Solution*	*Liberated*	*In Solution*	*Liberated*	
Haapsalu . . . . (Small Bay)	0.0204	0.0832	0.0697	0.442	0.0221	0.646	0.0056	0.187
Voosi	0.0221	0.0510	0.0816	0.415	0.0102	0.561	0.0029	0.269
Kuressaare . . . (Big Bay)	0.0283	0.0425	0.0583	0.430	0.0150	0.586	0.0027	0.120
Hiiumaa	0.0187	0.034	0.0408	0.504	0.0178	0.850	0.0021	0.134
Rootsiküla . . .	0.0397	0.080	0.1262	0.522	0.0221	0.612	0.0051	0.281
Pärnu (Virtsu) .	0.0204	0.091	0.0833	0.451	0.0238	0.816	0.0046	0.541
Saulepa	0.0102	0.062	0.1564	0.637	0.0221	0.544	0.0034	0.215
Vihasoo	0.0238	0.068	0.0507	0.555	0.0204	0.661	0.0037	0.210

sulphur by means of micro-organisms has been discussed by several authors [1], and the results already obtained show that the activity of sulphur-reducing microbes is variable. For the compounds of sulphur the following decreasing rate of reduction was found:
Sulphide (Na_2S etc.) → Sulphite (Na_2SO_3 etc.) → Thiosulphate ($Na_2S_2O_3$ etc.) → Sulphate (Na_2SO_4 etc.) → S. Some species of microbes are capable of reducing all these compounds of sulphur and sulphur itself as an element, whilst other species reduce but chemically unstable compounds.

The results of the present investigation as summarized in Table II demonstrate that all the samples of Estonian sea-mud obtained from different beds contained specific microbes capable of reducing thiosulphate, sulphate, and sulphur as an element. The highest quantities of H_2S were liberated from the mixtures which contained thiosulphate (Milieu 2). Considerably smaller amounts of H_2S were liberated from the mixtures containing sulphate (Milieu 1) and sulphur (Milieu 3). The smallest quantities of H_2S were liberated from the mud incubated without the addition of any foreign substance.

It was found that the quantities of H_2S liberated from the mixtures depended upon the quantity of dry substance present in the mud examined. The greater the amount of dry substance, the more H_2S was libe-

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[1] Dufrenoy, cit. Arch. of Med. Hydrol., No. 4, p, 131, 1924. Markov, cit. Arch. of Med. Hydrol., July, p, 178, 1936, Rubentschik, Arch, of Med. Hydrol., July, p. 163, 1936.

rated if the dry substance did not happen to contain too much sand. The quantity of H_2S liberated was in many cases related to the total number of microbes capable of developing into colonies on the agar plate, but the quantity of H_2S always depended upon the microbes capable of reducing the compound of sulphur. Increased formation of H_2S cannot be explained by a simple chemical process, because the preliminary destruction of bacteria present in the muds by means of chloroform or heat almost entirely inhibits the liberation of H_2S. It is necessary to note that solutions 2 and 3 themselves neutralize some quantities of iodine, which circumstance hinders the exact iodometric determination of H_2S produced by the bacteria in the mixtures of mud and water. We presume, however, that the method of the determination of H_2S liberated under the conditions described in this report can serve as a valuable biological indicator for the estimation of the activity of therapeutic sea-muds.

DECOMPOSITION OF CELLULOSE

The decomposition of cellulose, thoroughly studied by Omeliansky. Van Iterson, Vinogradsky and others, is known as a widespread process in nature which uninterruptedly takes place also in different sea-muds, where the residues of plant origin are deposited. Cellulose is broken down by aerobic and anaerobic bacteria, denitrifying bacteria, moulds and Actinomycetes [1].

[1] Lipman, Microbiology, London, 1921.

PÄRNU: THE SPA HOTEL.

PÄRNU: A VIEW OF THE BEACH AND THE SPA HOTEL.

The products into which cellulose is decomposed have not yet been exactly studied.

Among the anaerobic cellulose-decomposing microbes found in the Estonian sea-muds different sporolated and non-sporolated types of bacteria and spirochaetes are predominant. Two types seem to be most active: 1. Bacillus cellulosae hydrogenicus which breaks down cellulose with the liberation of H_2 and CO_2, and 2. Bacillus cellulosae methanicus which breaks down cellulose with the liberation of methane (CH_4) and CO_2. Among the aerobic cellulose-decomposing microbes there were found in the sea-muds Bacillus ferrugineus, Proteus Nadsonii, Cytophaga and Actinomycetes. As noted by Omeliansky and van Iterson, the destruction of cellulose is performed by the enzyme cellulase. The most active and the most wide-spread cellulose-decomposing microbes in the liman-muds are Cytophaga, especially a new species Cytophaga holophila [1].

The determination of cellulose-decomposing microbes in the curative sea-muds is a valuable index for the estimation of the degree of changes which take place in the organic residues of plant origin. For practical purposes, however, this method was found to be very complicated and inconvenient. The investigations referred to in this paper have demonstrated that in the mud establishments the bacteriological method can be replaced by the determination of the rate of the de-

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[1] Rubentschik and Goikhermann, C. R. de L'Inst. Baln. et Clim., Odessa, t. II, 100—108, 1933.

struction of cellulose added to the mud suspensions. In this report only a brief survey of the method used and the results hitherto obtained will be given.

For the estimation of the activity of aerobic cellulose-decomposing microbes 25 c.c. of the following solution — $NaNO_3$ 1.0 gm. $MgSO_4$ 0.5 gm., KCl 0.5 gm., $FeSO_4$ 0.01 gm., H_3PO_4 2.0 gms., distilled water 1000.0 c.c., ex tempore neutralized by

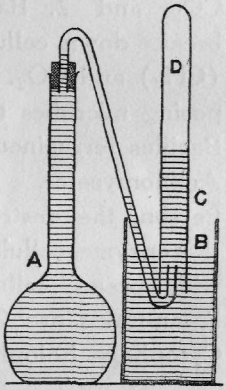

Fig. 2. Anaerobic decomposition of cellulose. A. Fermentation flask; B. water container; C. gas measuring tube; D. gaseous products.

the addition of 2 per cent. KOH, were poured into a flask; the layer of the solution on the bottom of the flask was about 1 cm. high; between the cotton-wool plug and the glass a strip of filter paper reaching the bottom of the flask was inserted, and the flask thus prepared was sterilized; 2 gms. of the mud under examination were added to the solution and incubated at 30° C; the degree of destruction of the paper was examined daily. At first grey or brownish spots appear on the paper; then the paper turns slimy, later the end of it is cut off just at the surface of the solution.

For the determination of the activity of the anaerobic cellulose-decomposing microbes, pieces of sterile filter paper, about 2 gms. of chalk and 2 gms. of freshly taken sea-mud were introduced into a sterile fermentation flask of 100 c.c. (Fig. 2) and then filled up with the following sterile solution: distilled water 1000.0 c.c., ammonium phosphate 1.0 gm., K_2HPO_4 1.0 gm., $MgSO_4$ 0.5 gms. and traces of NaCl; the flask was incubated at 30° C. and the gaseous products liberated were collected into a measuring tube [1]. The activity of the cellulose-decomposing microbes in a sea-mud sample can be estimated by means of the quantitative determination of the gaseous compounds of microbial metabolism.

The results obtained by these methods have proved that the degree of the destruction of the cellulose was variable in the sea-muds hitherto examined. Thus the beginning of the decomposition of paper was found after 7 days for Haapsalu, 9—10 days for Saulepa, 14 days for Kuressaare, 21 days for Hiiumaa, 28—30 days for Vihasoo.

A notable relationship exists between the degree of the decomposition of paper in vitro and the number of cellulose-decomposing microbes present in the mud under natural conditions. It seems that the methods described may be used in practice for the estimation of the cellulose destruction which takes place in the curative sea-muds. It is interesting to note that in the

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[1] Omeliansky, Prakt. rukov. po mikrobiologii, p. 202, 1922.

summer of 1938 the activity of the cellulose-decomposing microbes in the sea-water of the southern coast of Saaremaa was especially high; it caused the destruction of especially impregnated nets and did considerable damage to the fishermen.

From the evidence it appears that the symbiotic activity of different bacteria is necessary for the formation of therapeutic sea-muds. The bacterial activities in the sea-muds comprise two important processes: 1. the decomposition of organic and inorganic matter, resulting in the liberation of the elements in the forms H_2S, NH_3, PO_4, CO_2, CH_4N, and of organic substances soluble in water; 2. the assimilation of some of the dissolved substances and their transformation into bacterial cells, which in their turn die and are decomposed. According to Bujor [1], different anaerobic microbes reduce $CaSO_4$ with the liberation of H_2S. By the hydrolysis of $FeCO_3$ in water $Fe(OH)_2$ is formed which gives with H_2O and O the compound $Fe_3(OH)_6$, or with O_2 alone the colloidal ferric hydrate $2Fe_2O_3 \cdot 3H_2O$. This gives in contact with H_2S the colloidal FeS upon which the black colour of the natural mud depends. The contact of the mud with the air induces the oxidation of FS and changes the black colour into grey, which can again be transformed into black by various microbes. Thus it is evident that the hydrogen sulphide (H_2S) fermentation, which is a very important factor in the formation

[1] Bujor, P., Nouvelle contribution à l'étude de la biologie du lac salé de Tekirghiol. Jasi. Viata Românascâ, 1928.

of valuable therapeutic sea-muds, cannot be considered analogous to the putrefaction of animal or vegetable matters, but should be attributed to a much more complicated process.

CHEMICAL COMPOSITION OF THE SEA-MUDS

Scientific balneology continues to develop under the influence of modern biology and physics. At the present time we can no longer confine ourselves to the study of the common chemical elements found in the sea-muds, which served for the characterization of therapeutic muds in the past. Modern chemists (Bardet *et al.*) assert that besides these elements there are certain others, though in infinitesimal amounts, the existence of which we scarcely suspected a few years ago. These imponderables form important substances, of which physicians are only just beginning to understand the therapeutic action. Much work has been done during the past few years which has increased our knowledge of the composition and physiology of cells, and to-day all well-equipped biologists and medical men have good opportunities of controlling the biological action of infinitesimal doses. The investigations of recent years in the domain of bacteriology, oligodynamics, fermentations, anaphylaxis, cellular phylaxis and tissue cultures supply us with many proofs of this. B i l l a r d says that there is in the human body a kind of pre-established defence which is put in action to protect the organism against disease. The quantities of matter put into action may be in-

finitely small, but the liberated energy may be infinitely great. "It is possible to obtain a great effect from small causes" (G. LeBon).

Analyses of the Estonian sea-muds have been made by many chemists (Ivanov 1840, Schmidt 1852, Goebel 1854, Tammann 1898, Glasenapp 1905, Weiderpass 1924, Dreyer 1926, Keilhack 1929, the Estonian State Laboratory 1930, etc.). The results obtained prove that their chemical composition has remained practically unchanged for about a hundred years. The author's investigations, the results of which are summarized in the following report, were made during the summer of 1938 and winter of 1938—39.

For the determination of the total moisture a weighed quantity of sea-mud was dried to a constant weight at 105° C. The data obtained on the Estonian sea-muds, shown in Table III, are compared as far as possible with the data obtained by several authors on foreign muds.

It is necessary to emphasize that the considerable variations found in the relative quantities of water and solids depend upon the origin of the sample examined and the weather at the time when the sample was taken. Thus, the water content has been found to be: at Haapsalu (Small Bay) — 70.42% (Tammann) and 76.63% (State Laboratory); at Kuressaare — 92.43% (Goebel), 93.55% (Glasenapp) and 93.45% (Kand).

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[1] Alexandrov, Arch. of Med. Hydrol., May, p. 195, 1929.

[2] Keilhack, Veröffentl. d. Zentralst. für Balneol. H. 9, 1929.

The chemical nature of the organic matter of the marine bottom sediment proved to be somewhat similar to that of the humus in land soils, both in chemical composition and in resistance to decomposition (Boysen-Jensen and Waksman). The chemical composition of the organic matter in sea-muds soluble in water is still open to question. The amount is variable and

TABLE III

WATER, SOLIDS AND pH OF SEA-MUDS

Sample	*Water*	*Solids*	*pH*
Kuressaare (Big Bay)	93.53%	6.47%	7.0—7.2
Rootsiküla	67.25%	32.75%	7.0—7.1
Pärnu (Virtsu)	60.49%	39.51%	6.9—7.3
Haapsalu (Small Bay)	68.51%	31.49%	7.0—7.2
Voosi	68.8 %	31.2 %	7.0—7.1
Hadjibey Liman (1)	59.5 %	40.5 %	—
Wilhelmshaven (Schlick) (2) .	58.73%	41.27%	—

was found to be 0.42% at Pärnu, 3.65% at Kuressaare, 1.86% at Haapsalu, 1.56% at the Odessa-Estuary. Among the soluble organic substances present in the sea-muds in variable quantities, the products of the decomposition of animal and vegetable matters, such as amino-acids, fatty acids, and ptomaines, are the most prominent. The quantitiy of humus in the Estonian therapeutic sea-muds was found to be 7.76% at Pärnu, 22.07% at Kuressaare, 12.8% at Haapsalu, 1.88% at the Odessa-Liman and 1.96% at Wilhelmshaven (Keilhack). The sulphur present in the Estonian sea-muds was found in the form of FeS, H_2S, and sulphates ($CaSO_4$),

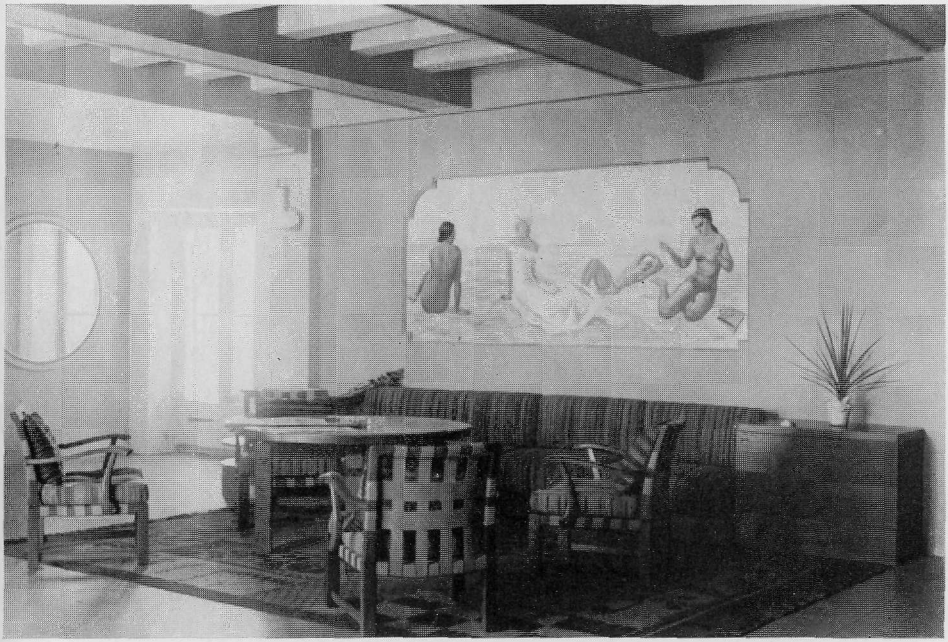
$(NH_4)_2SO_4$, while free sulphur appears in insignificant quantities. Traces of manganese, iodine and bromine were found in the Estonian sea-muds, but it should be mentioned that further determinations of these and other rare elements which might be present in the sea-muds must be made with up-to-date methods of investigation.

TABLE IV

COMPONENTS OF ESTONIAN SEA-MUDS DRIED AT 105° C

	Kuressaare Big Bay	*Haapsalu Small Bay*	*Voosi Inlet*	*Pärnu (Virtsu)*
	By State Laboratory 1930.	*By Dreyer 1926.*	*By Dreyer 1926.*	*By Weiderpass 1939.*
SiO_2 . .	22.50%	64.87%	62.88%	45.80%
Fe_2O_3 .	2.25%	7.28%	7.88%	9.68%
Al_2O_3 . .	5.52%	15.39%	17.94%	0.19%
CaO . .	21.15%	2.18%	3.41%	14.78%
MgO . .	1.86%	3.15%	2.20%	0.85%
SO_3 . .	1.11%	0.69%	0.49%	—
S	0.41%	1.24%	1.42%	traces
K_2O . . .	1.28%	0.93%	1.20%	0.78%
Na_2O . .				0.90%
Cl . . .	0.03%	0.78%	1.28%	—
P_2O_5 . .	0.12%	0.25%	0.32%	—
CO_2 . . .	16.40%	2.94%	1.03%	10.80%
Organic matter	33.52%	10.81%	12.67%	15.58%

The components of some Estonian sea-muds are presented in Table IV. In order to have the corresponding data for the comparison of similar therapeutic muds used abroad, the results of an analysis of the mud taken from the bottom of the Hadjibey Liman are shown as follows:



PÄRNU: A CORNER OF THE LOUNGE IN THE SPA HOTEL.

PÄRNU: A TYPICAL BROAD AVENUE IN THE PARK.

PÄRNU: A VIEW OF THE PARK.

PÄRNU: ENJOYING THE MIDDAY CONCERT ON THE BEACH.

A. Water-soluble substances in 100 parts of mud.	
Chloride of sodium	4.41
,, ,, magnesium	0.95
Amine combination	0.29
Sulphate of magnesium	0.63
,, ,, calcium	0.95
Calcium in organic acids	0.12
Sulphide of magnesium	0.24
Fat and fatty acids	0.53
Iodine	0.0005
Humic acid	0.08
Free sulphur	0.26
Calcium	0.26
Organic substances	0.85
Hydrogen sulphide	0.035
B. Soluble in muriatic acid.	
Calcium	2.51
Magnesia	0.61
Iron oxide	0.25
Sulphide of iron	0.42
Alumina	0.65
Carbonic acid	0.91
Phosphoric acid	0.36
C. Insoluble in HCl.	
Silicic acid	23.75
Alumina	0.63
Iron oxide	0.31

In Estonian curative sea-muds Cl', SO_4'' and CO_3'' prevail as anions.

In examining the results of the mud treatment hitherto obtained, it should be noted that the amounts of different elements found in the curative muds, taken alone, can hardly serve as a scientific basis for the estimation of the therapeutic properties inherent in them. The comparison of the data summarized in the present report with the therapeutic experiences acquired during a hundred years in the past makes it evident that muds of different chemical composition have proved to produce almost identical curative effects. It is not the assiduous study of the composition of the curative muds, but the rational observation of the patients treated with the mud which has upheld the fame of mud-bath medication in spite of all the changes in times and fashions.

CHAPTER III

PHYSICAL PROPERTIES OF THE ESTONIAN SEA-MUDS

The physical properties of the Estonian sea-muds were determined in freshly taken and uniformly mixed samples. The physical properties obtained are given in Table V, where some corresponding data of Hadjibey Liman mud are also shown.

TABLE V

PHYSICAL PROPERTIES OF THE MUDS

Sample	*Water Content*	*Specific Gravity (1)*	*Specific Heat*	*Thermal Conductivity*	*Heat Capacity*	*Heat Retentivity*
Pärnu (Virtsu) . .	60.49%	1.32	0.522	0.00200	0.689	344
Haapsalu	68.51%	1.18	0.768	0.00191	0.906	474
Kuressaare . . .	93.53%	1.04	0.855	0.00168	0.889	529
Rootsiküla	67.25%	1.26	0.601	0.00193	0.757	392
Hadjibey-Liman .	59.5 %	1.32	0.590	low	—	—

A. SPECIFIC GRAVITY

The specific gravity was measured by the usual pycnometer method, and by weighing a glas tube (10 c.c.) filled with the sea-mud to be examined entirely free from air pockets.

B. THERMAL PROPERTIES

1. The specific heat was determined by the following method of mixtures as proposed by Lewis [1]: Introduce a weighed quantity of the mud (m_1) into a thermos flask; bring the mud and the apparatus to the same (room) temperature (t_1); add a suitable quantitiy (m_2) of boiling water (t_3); shake well and read the temperature (t_2). The water-equivalent (w) of the apparatus has been determined, using water (sp. ht. = 1) in place of the mud. Heat lost by boiling water $[Sm_2(t_3—t_2)]$ = heat gained by mud $[Sp\ m_1(t_2—t_1)]$ + heat gained by calorimeter $[w(t_2—t_1)]$, and $Sp = \frac{Sm_2(t_3-t_2)-w(t_2-t_1)}{m_1(t_2-t_1)}$ where S is the specific heat of the water and Sp the specific heat of the mud.

2. The thermal conductivity was determined by Gregory's [2] method using a specific measuring apparatus where the mud was confined between two concentric cylinders of thin copper and closed at one end. The conductivity was revealed by the equation given in Gregory's paper.

3. The heat retentivity or the power of the mud to retain its heat was determined by direct

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[1] Lewis, S. J., Thermal properties of Peloids, Arch. of Medic. Hydrol., XIII, 3, p. 56, 1935.

[2] Gregory and Stephens, Arch. of Med. Hydrol., XIII, 3, p. 55, 1935.

experiments and by the derivation of the value in accordance with the following formula (I. S. M.) [1]:

$$R = \frac{\text{specific heat} \times \text{specific gravity}}{\text{conductivity}}.$$

4. The heat capacity, at a stated temperature, equals the specific heat multiplied by the specific gravity; the results thus obtained represent the specific heat by volume (I. S. M.).

According to Lewis, the specific heat for the fully dried peloid was found to be 0.245. As the water content increases, the specific heat increases, the thermal conductivity decreases, and the heat retentivity increases. It is evident that well-dried muds have the power to absorb moisture from the skin, and probably draw on the deeper tissues. It seems possible that they will exhibit therapeutic properties different from those of the native muds, and may find application in treating various complaints (Lewis).

For practical purposes the heat retentivity of the curative muds used in the Estonian bath establishments may be measured by the following simplified method. Five appropriate glass-vessels respectively containing 1 *l.* of natural sea-mud, and 75%, 50% and 25% mixtures prepared with tap water, and tap water alone as a control, were heated to 45° C. and exposed in a room at 20° C. After ½, 1, 2, 4 and 6 hours the tem-

[1] I. S. M. = International Standard Measurements.

perature in the middle parts of the contents was registered. The data thus obtained are presented in Table VI. Of course, the results are more impressive and of greater exactness, when the same measurings are made in similar conditions in the baths ready for use. Corresponding experiments [1] demonstrate that three baths consisting of sweet water, brine (7.7° B.)

TABLE VI

HEAT RETENTIVITY OF THE SEA-MUDS AT 20° C

Sample	*Mud per cent*	*Beginning*	*Temperature after Exposure at* 20° C					
			½ *h.*	1 *h.*	2 *h.*	4 *h.*	6 *h.*	8 *h.*
	100 %	45° C	40.0	36.8	31.4	24.8	22.8	20.6
Pärnu (Virtsu)	75 %	45° C	42.6	38.5	34.5	24.6	22.6	20.1
Spec. gravity	50 %	45° C	42.0	38.5	32.0	24.5	22.2	20.2
1.32	25 %	45° C	42.0	38.4	32.0	24.1	22.0	20.0
Haapsalu	100 %	45° C	42.4	38.5	32.2	25.1	22.8	20.8
(Small Bay)	75 %	45° C	43.1	40.4	33.5	25.6	22.3	20.2
Spec. gravity	50 %	45° C	43.0	39.5	33.0	23.5	22.2	20.1
1.18	25 %	45° C	41.0	35.5	29.9	23.4	21.2	20.1
	100 %	45° C	43·2	39.2	35.8	27.8	23.5	20.5
Kuressaare	75 %	45° C	43.1	39.5	33.1	26.3	22.9	20.5
Spec. gravity	50 %	45° C	43.0	39.6	33.0	26.0	22.1	20.1
1.04.	25 %	45° C	38.8	34.5	28.8	23.0	20.5	20.0
Tap water, spec. grav. 1.001		45° C	38.7	34.1	28.6	22.2	20.2	20.0

[1] Feldstein, R. H. M. C., Bucarest, 1925, Ref, Arch. of Med. Hydrol. IV, 1, p. 113, 1926.

and mud (sp. grav. 1.55) respectively, heated to 40° C. and cooled for two hours, registered: the mud bath 36.5° C., the brine 30° C. and the water 28° C. Analogous results were obtained with the sea-mud at Pärnu [1].

It should be emphasized that the thermal properties of curative muds represent an important factor in their balneological significance. As is known, the quality of the sea-mud, especially in estuaries with free access of water, depends upon several factors not always sufficiently taken into account by the suppliers of mud. It seems, therefore, reasonable that corresponding controls of muds by simplified methods should be performed periodically. The estimation of the thermal properties of the semi-solid bath media may serve as an indicator useful for spa physicians to show the changes of the curative value of a mud-bath in relation to the variations in the water content. It also helps to compare one mud with another with regard to the way in which they vary in therapeutic properties with a rise or fall in the water content.

C. DISPERSIVE PROPERTIES OF THE SEA-MUDS

The chief dispersive properties of the sea-muds were estimated by means of sedimentation tests, where the velocity of sedimentation, the sediment volume and the swelling capacity of freshly taken samples were determined.

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[1] V a d i, W., Eesti Arst, Supplem., p. 11, 1932.

1. Sedimentation Test

a. The velocity of sedimentation was determined as follows: one volume of the sea-mud was mixed thoroughly with several volumes of sea-water, stirred vigorously and poured over into a 50 c.c. measuring cylinder up to 50 c.c., and mixed. The cylinder was exposed in a room at 20° C. and the volumes of the water liberated above the sediments were read after different intervals.

The results of sedimentation thus obtained are shown in Table VII.

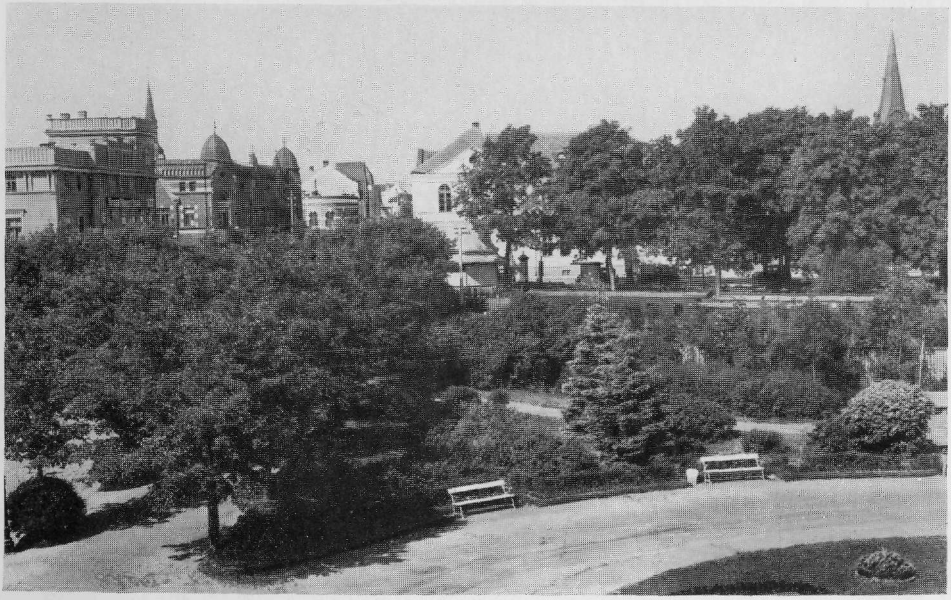
TABLE VII

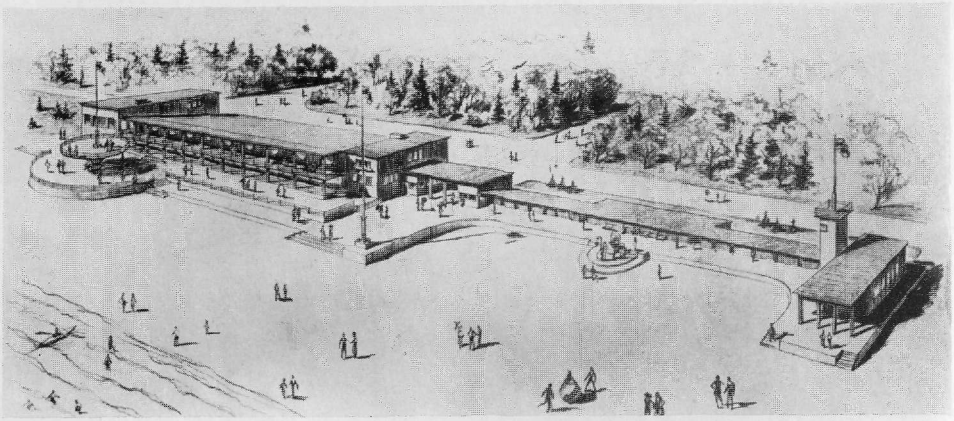
SEDIMENTATION VELOCITY OF THE SEA-MUDS

Sample	*Mud per cent by Volume*	*Time in Minutes, Water Freed in cc.*								
		5′	10′	15′	30′	45′	60′	90′	120′	180′
Kuressaare	20%	17.2	24.2	25.5	27.9	30.0	30.9	31.0	31.1	31.2
	40%	1.5	2.8	4.5	7.5	13.2	15.1	18.3	19.4	19.6
	50%	0.7	1.0	1.5	2.5	3.7	4.9	7.8	8.8	12.1
	60%	0.4	0.8	1.4	2.0	2.6	3.4	5.1	7.2	8.3
	80%	0	0.4	0.5	0.6	0.7	1.0	1.0	1.1	1.2
Pärnu (Virtsu)	20%	9.8	28.9	31.1	33.2	34.0	35.1	35.2	35.5	36.5
	40%	0.4	0.9	1.3	2.0	3.1	4.2	6.1	7.5	9.8
	50%	0.2	0.4	0.5	0.5	0.6	0.8	1.0	1.1	1.4
	60%	0	0	0	0.2	0.3	0.3	0.4	0.4	0.4
	80%	0	0	0	0	0	0	0	0	0
Haapsalu	20%	32.8	34.6	35.8	36.3	37.1	37.1	37.2	37.3	37.4
	40%	15.6	18.9	22.4	24.1	25.8	27.3	28.1	28.5	37.4
	50%	9.4	13.8	17.1	19.0	21.1	22.3	23.2	23.4	24.0
	60%	2.6	5.1	8.5	12.4	14.1	15.6	17.4	18.3	19.5
	80%	0.6	0.8	1.0	2.4	3.1	3.9	5.3	6.5	8.4

PÄRNU: SOME MEMBERS OF THE MEDICAL FRATERNITY POSING FOR A SNAPSHOT.

PÄRNU: A VIEW OF THE TOWN.





PÄRNU: THE NEW CAFÉ ON THE BEACH (UNDER CONSTRUCTION).

NARVA-JÕESUU: HOTEL CAPRICCIO.

b. The sediment volume, or the space which the substance of 10 grams of the natural sea-mud mixed with sea water occupies after the sedimentation, was determined as follows: 10 gms. of freshly taken natural sea-mud was mixed thoroughly with sea water, more water was added to make the whole about 40 c.c. and the whole then stirred vigorously; the mixture was poured over into a 100 c.c. measuring cylinder, rinsed and made up with water

TABLE VIII

SEDIMENT VOLUME AND SWELLING CAPACITY.

Sample	*Sediment Volume*		*Swelling Capacity*	*Water Content in Native Mud*
	Native	Dried		
Pärnu (Virtsu).	20 cc.	6.0 cc.	3.33	60.49 %
Haapsalu . . .	16 cc.	6.0 cc.	2.66	68.51 %
Kuressaare . .	20 cc.	4.0 cc.	5.0	93.53 %

to 100 c.c.; in order to remove air, the cylinder was held in vacuo. The volume of the sediment was read after 14 days.

c. For the determination of the swelling capacity of the sea-muds similar experiments were made using the same quantity of natural sea-mud after it had been dried completely and ground fine.

$$\text{Swelling Capacity} = \frac{\text{the Sediment Volume of the native sea mud}}{\text{the Sediment Volume of the dried mud.}}$$

The results obtained with different sea-muds in use at Estonian mud-bath establishments are summarized in Table VIII, where the differences between three

samples examined are obvious to the reader. E. Käer [1] reports that the volume of the disperse phase of the Estonian sea-muds was found to be considerably greater than that of Cahren-Fango (Berlin) and Pistany mud.

2. Size of Inorganic Particles in the Sea-Muds

As mentioned above, the particles of the sea-mud are organic and inorganic in nature. For the determination of the size of inorganic particles it is necessary, in the first place, to separate the organic from the inorganic. In our investigation the method proposed by S. J. Lewis [2] was used. The mud was freed from water by means of alcohol (95 per cent.) and ether and the organic matter was separated from the mineral matter by means of a mixture of bromoform and carbon tetrachloride (Sp. gravity about 2). The results are presented in Table IX. In this table the corresponding data found in the mud of Wilhelmshaven (Schlick) and of the Odessa Liman are also shown [3].

According to the generally accepted view, the quality of curative muds depends in a great measure upon the size of the particles present in them or upon the degree of dispersion. In this respect the most

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[1] Käer, E., Eesti Arst, p. 16, 1924.

[2] Lewis, S. J., Arch. of Medic. Hydrology, XVI, p, 21, 1938.

[3] Keilhack, Veröffentl. d. Zentralstelle f. Balneologie, H. 9, 1929.

essential part of a valuable therapeutic mud should be seen in the amount of the finest particles, which brings the muds formed by sedimentation nearer to the volcanic muds or *fanghi* as, for instance, the *Fango* of Bataglia in Tuscany.

TABLE IX

SIZE OF INORGANIC PARTICLES

Sample	*Particles Expressed in Percentages by Weight*			
	Sand 2—0.2 *mm.*	*Fine Sand* 0.2—0.1 *mm.*	*Powdered Sand* 0.1—0.05 *mm.*	*Clayey Particles* 0.05—0.01 *and under* 0.01 *mm.*
Pärnu (Virtsu)	0.8	6.8	10.7	81.7
Haapsalu . . .	1.4	5.1	16 3	77.2
Kuressaare . .	1.2	4.5	9.4	84.9
Odessa Liman.	0.5	5.3	31.7	62.5
Schlick of Wilhelmshaven	0.4	1.6	4.8	93.2

In comparing the results presented in Table IX it is evident that the Schlick of Wilhelmshaven contains the highest proportion of fine particles and the mud of the Odessa Liman contains the highest percentage of powdered sand. Nevertheless, both the mud of the Odessa Liman and the Schlick incontestably deserve their reputations as valuable remedies for different diseases. Keilhack admits the similarity of the Wilhelmshaven and the Odessa Liman muds to the clay-fango, and places the Estonian sea-muds nearer to the peat-muds, because they contain a considerable percentage of fine sand and of humus. It is, however, needless to point out that in spite of these substances

the Estonian sea-muds have proved to be of great therapeutic value if applied judiciously by well-equipped spa physicians.

D. ADSORPTIVE PROPERTIES OF THE SEA-MUDS

Adsorption undoubtedly belongs to those properties of curative muds which may have some bearing on their therapeutic activity. In the muds, which represent a colloidal system, ions and different molecules become concentrated and fixed around the colloidal particles of the mud. The finer the state of subdivision reached by the solid phase, the greater the total surface area and the degree of adsorption. As a consequence of adsorption, the probability of different chemical actions (catalysis etc.) which take place on the colloidal particles is increased.

An examination with the ultramicroscope [1] revealed about 20 milliards of colloid particles per 1 gm. of the sea-mud. The colloid particles disappeared entirely if hydrochloric acid and potassium chlorate were added to the samples of sea-mud and kept for 24 hours (coagulation). The number of colloid particles increased about seven times if different alkalis were added to the sea-mud (peptonization).

The results of the experimental studies of adsorption presented in this report were obtained with sea-muds dried (at 40° C.) and thoroughly crushed, and with native samples of the sea-muds. The experiments

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[1] Kand, M., Eesti Arst, Supplem. p. 7, 1926.

were repeated on several occasions with strikingly similar results.

1. Adsorption of dyes. One example of basic dyes, methylene blue and one of an acid type congo red (Merck) were used. 30 c.c. of a 1:10,000 solution of the dye in water were shaken with a weighed quantity of mud, natural or dried, and exposed in a room at 20° C. After 20 minutes the mixture was centrifugalized and the unadsorbed dye estimated by comparison with a specially prepared standard solutions scale. The results of one series of experiments are presented in Table X.

The results show that the samples of the Estonian sea-muds obtained from three separate beds are very active adsorbents of the basic dye. The acid dye proved to be little affected. There was no striking difference in the degree of adsorption observed in the samples examined. Similar results were obtained with the Harrogate mud which was found to be a very effective adsorbent, especially of methylene blue [1]. To sum up, evidence is presented that the Estonian sea-muds are negatively-charged colloids with a powerful affinity for positive ions. The same result was obtained by the cataphoretic method.

2. Adsorption of hydrogen and hydroxyl ions. These tests may be carried out with different inorganic and organic acids and alkalis. In our experiments lactic acid, hydrochloric acid and

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[1] Woodmansey, A. and Linfoot, S., Arch. of Medic. Hydrol. XIV, 3, 161, 1936.

TABLE X

ADSORPTION OF DYE

Proportion of Dye and Dried Mud	*Amount of Unadsorbed Dye*					
	Methylene Blue			*Congo Red*		
	Pärnu	Kuressaare	Haapsalu	Pärnu	Kuressaare	Haapsalu
30 c.c. dye + 0.1 gm. mud	12 %	14 %	12 %	85 %	85 %	80 %
30 c.c. dye + 0.2 gm. mud	2 %	5 %	3 %	70 %	65 %	58 %
30 c.c. dye + 0.3 gm. mud	1 %	3 %	1.25 %	57 %	58 %	55 %
30 c.c. dye + 0.4 gm. mud	all adsorbed	2 %	all absorbed	54 %	53 %	40 %
30 c.c. dye + 0.5 gm. mud	all adsorbed	1.5 %	all absorbed	35 %	50 %	30 %
30 c.c. dye + 0.6 gm. mud	all adsorbed	1.25 %	all absorbed	25 %	45 %	15 %
30 c.c. dye + 0.8 gm. mud	all adsorbed	all adsorbed	all absorbed	6.5 %	23 %	10 %
30 c.c. dye + 1.0 gm. mud	all adsorbed	all adsorbed	all absorbed	3.5 %	15 %	3.5 %

uric acid were used. To a weighed portion of native sea-mud 50 c.c. of suitable dilutions of the acids were added. After repeated shaking and standing for 30 minutes at 20° C. the suspension was filtered through No 597 of Schleicher-Schüll filter paper. 10 c.c. of the filtrate were measured off and titrated by means of NaOH solution. It seems convenient to measure the pH of the suspension potentiometrically, using quin-hydrone electrodes. The findings of the experiments are summarized in the following Tables XI and XII.

TABLE XI

ADSORPTION OF LACTIC ACID (MOL. 90.05)

10 gms. of mud shaken with 50 c. c. of 1/5, 1/10, 1/20 and 1/40 n acid.

Filtrate 10 *c.c.*	*Acid in* 10 *c.c. of Mixture* (*c*)	*Amount Adsorbed* (*x*)			
		Pärnu	Haapsalu	Kuressaare	Rootsiküla
1/5 n	0.18 gr.	0.1188 gm.	0.0657 gm.	0.0432 gm.	0.0333 gm.
1/10 n	0.09 gr.	0.0783 gm.	0.0432 gm.	0.0333 gm.	0.0261 gm.
1/20 n	0.045 gr.	0.0414 gm.	0.0306 gm.	0.0229 gm.	0.0157 gm.
1/40 n	0.0225 gr.	0.0207 gm.	0.0198 gm.	0.0180 gm.	0.0099 gm.

TABLE XII

ADSORPTION OF HYDROCHLORIC ACID

10 gms. of mud shaken with 50 c.c. of 1/5, 1/10, 1/20 and 1/40 n HCl.

Filtrate 10 *c.c.*	*Acid in* 10 *c.c. of Mixture* (*c*)	*Amount Adsorbed* (*x*)		
		Pärnu	Kuressaare	Haapsalu
1/5 n	0.0730 gm.	all adsorbed	0.0156 gm.	0.0356 gm.
1/10 n	0.0365 gm.	„ „	0.0154 gm.	0.0327 gm.
1/20 n	0.0182 gm.	„ „	0.0146 gm.	all adsorbed
1/40 n	0.0091 gm.	„ „	all adsorbed	all adsorbed

For the experiments with the dried muds a $^1/_{10}$ n dilution of HCl was used; to weighed portions of dried mud 30 c.c. quantities of the diluted acid were added. After being shaken and standing at 20° C. for 20 minutes, the mixture was filtered and 10 c.c. of the filtrate were titrated with a $^1/_{10}$ n solution of NaOH. The findings are presented in Table XIII.

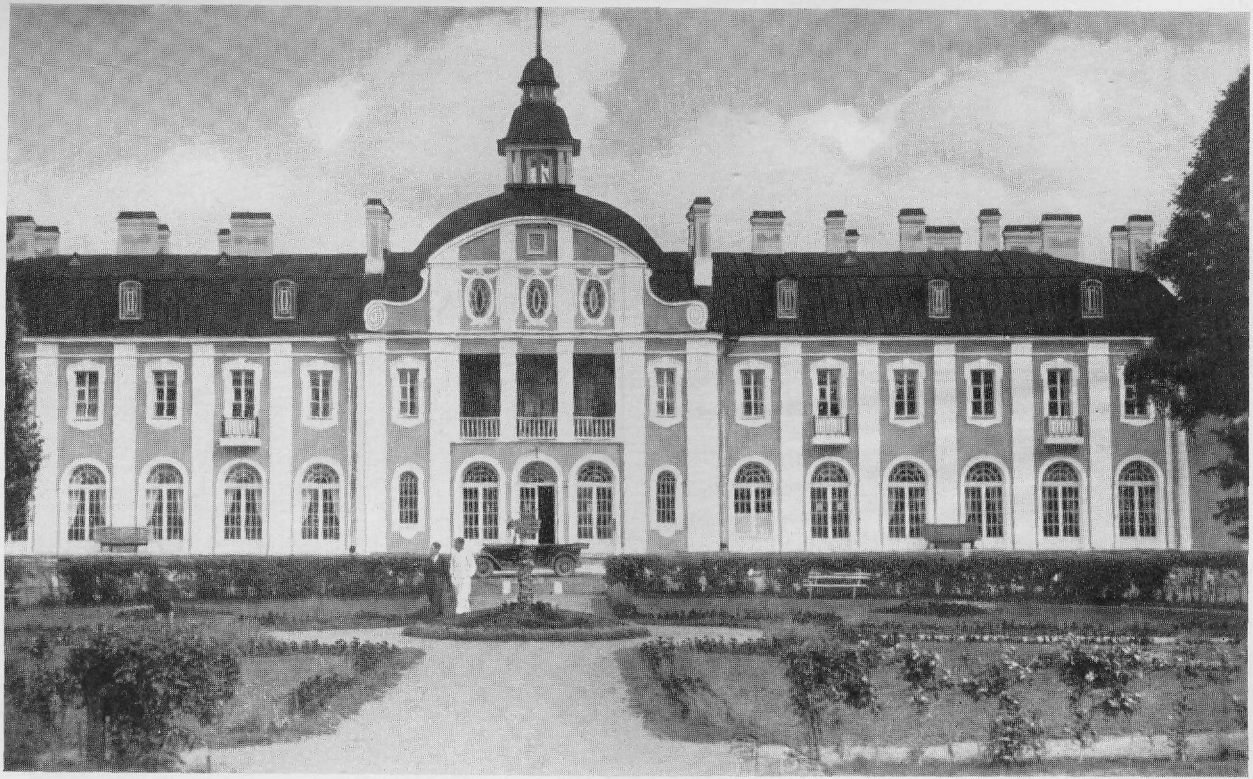
TABLE XIII

ADSORPTION OF HYDROCHLORIC ACID

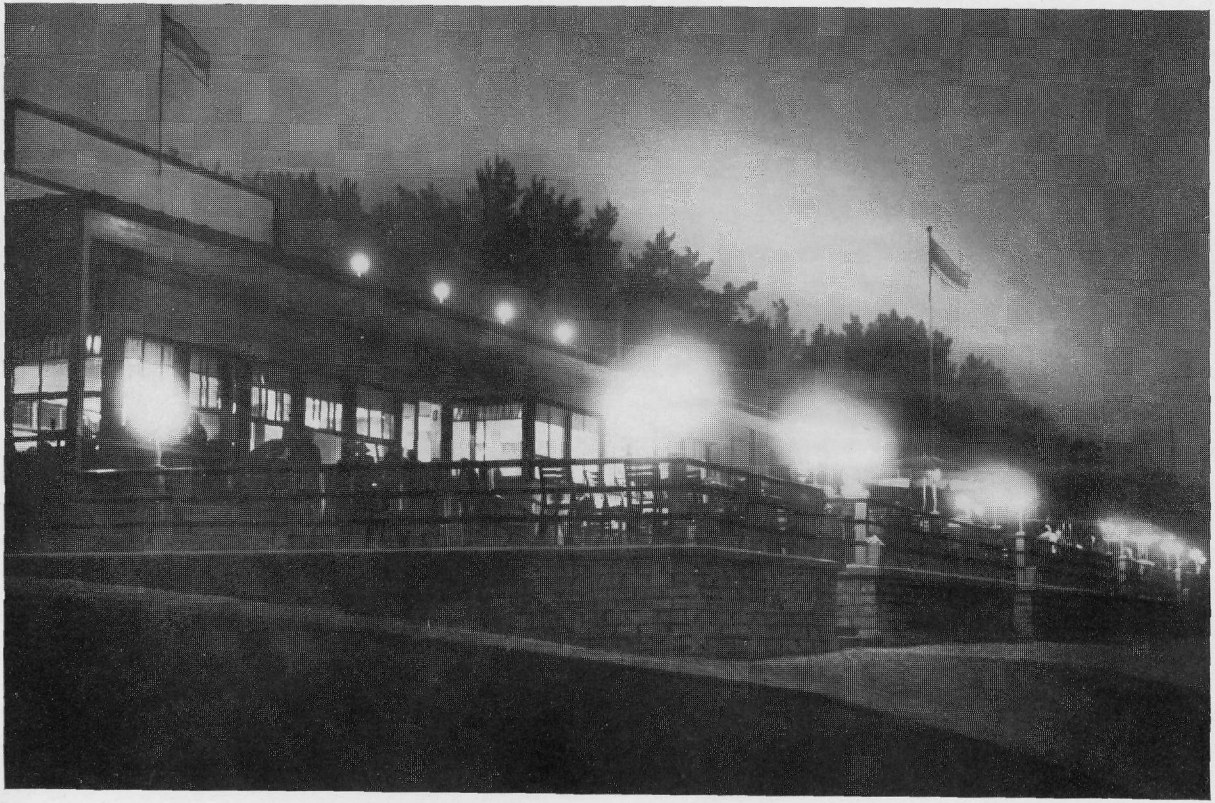
Proportion of 1/10 n NCl and Mud	*Amount Adsorbed*		
	Pärnu	Haapsalu	Kuressaare
0.1 gm. mud + 30 c.c. acid	0.0087 gm.	0.0041 gm.	0.0044 gm.
0.2 gm. mud + 30 c.c. acid	0.0124 gm.	0.0062 gm.	0.0051 gm.
0.3 gm. mud + 30 c.c. acid	0.0160 gm.	0.0069 gm.	0.0069 gm.
0.4 gm. mud + 30 c.c. acid	0.0200 gm.	0.0073 gm.	0.0076 gm.
0.5 gm. mud + 30 c.c. acid	0.0211 gm.	0.0080 gm.	0.0087 gm.
0.6 gm. mud + 30 c.c. acid	0.0262 gm.	0.0102 gm.	0.0102 gm.

It is necessary to note, however, that the addition of mineral acids (HCl, H_2SO_4, etc.) to the native or dried sea-muds produces an energetic liberation of CO_2 and H_2O, which demonstrates that the decrease of the acidity in the mixture is caused not only by the adsorption of acids, but also by different chemical processes.

In a further series of tests the adsorption of sodium hydroxide (NaOH) was carried out by using different samples of native and dried sea-muds as adsorbents. No material difference in the degree of adsorption between native and dried muds was apparent. The results of two experiments are shown in



NARVA-JÕESUU: THE SPA PAVILION.



NARVA-JÕESUU: THE SPA CAFÉ AT NIGHT.

Tables XIV and XV. In these tests 0.5 gm. of dried muds and 10 gms. of native muds were shaken with different dilutions of NaOH and exposed for 20 minutes at 20° C. 10 c.c. of filtrate were titrated with HCl solution.

The adsorption of uric acid was carried out with

TABLE XIV

ADSORPTION OF SODIUM HYDROXIDE

Proportion of NaOH *and Mud*	NaOH *in* 10 *c.c. of Mixture*	*Amount Adsorbed*		
		Pärnu	Haapsalu	Kuressaare
0.5 gm. mud + + 30 c.c. 1/10 n NaOH	0.04 gm.	0.0072 gm.	0.0072 gm.	0.0100 gm.
0.5 gm. mud + + 30 c.c. 1/20 n NaOH	0.02 gm.	0.0048 gm.	0.0052 gm.	0.0068 gm.
0.5 gm. mud + + 30 c.c. 1/30 n NaOH	0.013 gm.	0.0040 gm.	0.0044 gm.	0.0052 gm.
0.5 gm. mud + + 30 c.c. 1/40 n NaOH	0.01 gm	0.0036 gm.	0.0036 gm.	0.0048 gm.
0.5 gm. mud + + 30 c.c. 1/50 n NaOH	0.008 gm.	0.0032 gm.	0.0032 gm.	0.0040 gm.
0.5 gm. mud + + 30 c.c. 1/60 n NaOH	0.007 gm.	0.0028 gm.	0.0030 gm.	0.0036 gm.

TABLE XV

ADSORPTION OF SODIUM HYDROXIDE

10 gms. of mud shaken with 50 c.c. of 1/5, 1/10, 1/20 and 1/40 n NaOH

Filtrate 10 *c.c.*	NaOH *in* 10 *c.c. of Mixture (c)*	*Amount Adsorbed (x)*		
		Pärnu	Haapsalu	Kuressaare
1/5 n NaOH	0.08 gm.	0.0150 gm.	0.0120 gm.	0.0140 gm.
1/10 n NaOH	0.04 gm.	0.0099 gm.	0.0075 gm.	0.0077 gm.
1/20 n NaOH	0.02 gm.	0.0074 gm.	0.0056 gm.	0.0041 gm.
1/40 n NaOH	0.01 gm.	0.0052 gm.	0.0034 gm.	0.0025 gm.

freshly taken samples of the natural sea-muds. For the tests 10 gms. of mud were mixed with 50 c. c. quantities of 0.2:1000, 0.1:1000 and 0.05:1000 dilutions of uric acid. The mixtures were shaken and exposed for 45 minutes at 20° C. In 10 c.c. of filtrates, obtained by the filtration of the mixtures through filter paper, the quantity of unadsorbed uric acid was estimated by titration with Kalium ferricyanide solution [1]. The results of these experiments showed that only about 3—5 per cent. of the uric acid added had been adsorbed by the Estonian sea-muds. One may conclude, therefore, that the Estonian sea-muds are not very effective adsorbents of uric acid.

Similar experiments in adsorption with sodium urate and sodium chloride were made. The results were negative under the conditions of the experiment. These observations indicate that neutral salts are practically not adsorbed by the natural sea-muds. On the other hand, the capacity of Estonian sea-muds for conducting an electric current at 15° C. was found to be considerably higher than the electric conductivity of water. This property evidently demonstrates that the sea-muds already have adsorbed different neutral water-soluble salts in native conditions.

It should be remembered that a large number of observations [2] on adsorption revealed the fact that

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[1] Jonesco, Bibesco and Popesco, Journ. de Pharm. et de Chim. T. 3, 1926.

[2] Souci, S. W., Veröffentl. der Zentralstelle für Balneologie, H. 34, 1933 and Schade und Kähler, ibid. H. 3, S. 21, 1926.

different peats used in medical practice are very active adsorbents of sodium urate. The adsorption of different substances (dyes, acids, alcalis, sodium urate etc.) was also observed under conditions where the peat mass was separated from the substances by different porous membranes.

In the experiments with adsorption reported in this paper for the separation of dyes and acids from the natural sea-muds, the author used collodion and Schleicher-Schüll's sacks, which were half filled with a suitable dilution of dye or acid and then put into the sea-mud examined. The dialyzers thus prepared were continually shaken at 20° C. The adsorption of the dye (methylene blue) was estimated during 3 days, and the pH of the dilution of acid ($^1/_{10}$ n HCl) was measured potentiometrically during 12 hours. It was found that a 1:10,000 solution of methylene blue was gradually passing through the membranes and disappeared from the sacks almost entirely in 3 days. The values of the pH of the diluted acid were gradually increasing and after 10—12 hours neutrality was obtained. The penetration of the sea-mud into the sacks was not observed.

Very interesting results have been reported [1] which were obtained through experiments made with human skin from a still-born child. It was found that the intact epithelial layer was impenetrable to water and to different water-soluble substances. If the epi-

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[1] Schade u. Kähler, Veröffentl. der Zentralstelle für Balneol., H. 3, 1926.

thelial layer was taken off or damaged, water and soluble substances could pass through the skin. A suitable solution of trypaflavine injected intracutaneously into a patient disappeared rapidly under the influence of peat packs at 40° C. applied to the injected region. It seems that such an effect depends upon the hyperaemia and perspiration caused by the thermal packs. The part played by the peat as adsorbent could not be established, because the quantitative determination of trypaflavine in the peat was impossible. Pregel's solution injected subcutaneously was eliminated through perspiration if an artificial local venous congestion was made; without it the experiment proved to be negative.

The preceding investigations on adsorption indicate that natural sea-muds are active adsorbents of different ions and substances. This property seems to justify the conclusion that sea-muds can also adsorb different substances eliminated by perspiration in a mud-bath. It is evident that the adsorption may therefore effect a diminution of the osmotic concentration of the sweat. Such a diminution of the concentration of certain secretes was found to be usually accompanied by an increased elimination of them by the corresponding glands (H. Schade). It is known, for instance, that the secretion of hydrochloric acid by the gastric glands is regulated by the acidity of the gastric juice [1]. It is quite probable that mud baths also stimulate and increase the secretion of poisonous

[1] Lean, H. M. and Griffith, W. J., Journ, Physiol, 66, 356, 1928.

substances foreign to the human body. The property of adsorption, undoubtedly, occupies an important place among the other therapeutic factors of the sea-muds. Experiments made with methylene blue and fuchsin [1] have shown that the Estonian curative sea-muds possess a considerably higher faculty of adsorption than the volcanic mud named Cahren-Fango, the mud of Pistany and common dirt.

E. ASTRINGENCY AND CATALYSIS

The astringency of the sea-muds seems to play a subordinate part as a curative factor. Corresponding measurements have demonstrated that the total amount of substances capable of acting as astringents present in 100 gms. of freshly taken Estonian sea-muds is equal to 0.183—0.192 gm. of tannic acid. The measurements were made by the Neubauer-Löwenthal method [2] using for the experiments aqueous extracts prepared with 300 gms. of natural sea-mud and 600 c.c. of distilled water. The extracts used were almost free from soluble proteins. The principal astringents present in Estonian sea-muds are probably soluble compounds of aluminium (alum) and iron (sulphate), and humic acid which are capable of forming different chemical combinations with proteinic substances, causing an increase in the hardness and

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[1] Loewe, S. and Bekman, R., Eesti Arst, Supplem., p. 11., 1926.

[2] Beythien, Handb. d. Nahrungsmittel-untersuchung Bd. I, p. 701, 1914.

contraction of the tissues. The astringency of the sea-muds can arrest discharges from diseased skin. This property was found to be especially pronounced in certain therapeutic peats [1].

Catalase or peroxidase tests were made by the following simple method. 5 gms. of freshly taken sea-mud were shaken in a flask with 40 c.c. of distilled water; 10 c.c. per cent. dilution of hydrogen peroxide (1 volume of Perhydrol Merck + 9 volumes of distilled water) were added and the flask was connected by means of a tube with a graduated tube for collecting gases; the mixture was exposed at 20° C. and slowly shaken. After 30 minutes the quantity of oxygen freed from H_2O_2 was estimated. The average amounts of gas (O_2) freed and collected into the measuring tubes during 30 minutes were found to be: for Pärnu (Virtsu) 38 c.c., for Haapsalu 59 c.c. and for Kuressaare 43 c.c.

The experiments gave evidence of the existence of the catalase in all the Estonian sea-muds examined, but no striking difference in the degree of catalytic activity was observed. The alkaline reaction of the mud increased catalytic action, acidity decreased it. It was found [2] that the catalytic action of the soil is caused not only by the bacterial enzymes, but also by the inorganic components of the soil. Salzmann [3], work-

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[1] Potonié, R., Pharmaz. Zeitung, Nr. 5, 1934.

[2] Pěnkava, J., Zemědělsky-Arch. IV, 1—12 and 99—106, 1913.

[3] Salzmann, Münch. med. Woch., p. 664, 1929.

ing with Kissingen peat, demonstrated that it possessed a remarkable catalytic action which was, according to him, caused by the iron present in the peat. It seems possible that the chief substances causing the catalytic action of the Estonian sea-muds are bacterial enzymes, hydroxide of iron, especially colloidal iron, and traces of manganese.

F. WATER CAPACITY

Water capacity, or the maximum weight of water which one gram of the total solids of the sea-mud

TABLE XVI

WATER CAPACITY

Sample	*Maximum Weight of Water Held* (w_6)	*Grams of Total Solids* (w_2)	*Water Capacity* $= \frac{w_6}{w_2}$
Pärnu (Wirtsu).	26.30	12.90	2.03
Haapsalu . . .	23.25	8.75	2.65
Kuressaare . .	13.93	2.62	5.31

can hold permanently when it is allowed to remain at room temperature so that evaporation of water is prevented in a tightly closed vessel, was determined by the procedure recommended by the "International Standard Measurements Committee" (Arch. of Med. Hydrol., p. 17, 1938). The results of the determination, made on 30 gms. of the sea-mud, are presented in Table XVI.

To summarize the data, it is apparent that the water capacity of the Estonian sea-muds examined is

not particularly high. Earlier comparative investigations [1] showed that the water capacity of the peats was remarkably higher than that of the Estonian sea-muds.

G. CONSISTENCE AND PLASTICITY

The consistence and plasticity of the Estonian sea-muds are distinctly different and depend upon the origin of the mud. The unctuous and sticky mud of Pärnu which clings to the body is in its native state of the highest plasticity, but the density and plasticity of the smooth and incohesive muds of Haapsalu and Kuressaare are relatively low. The first is convenient for packs and other forms of thermal treatment, as mud compresses, mud-sacks, mud-pants and mud baths of different concentration. The natural sea-muds of Haapsalu and Kuressaare may be used as pure and diluted mud baths, but they are less convenient for packs and compresses. The density of the sea-muds may be increased by warming and evaporation, or by the addition of dried and finely ground sea-mud, the powder of curative peats, or several indifferent substances capable of increasing the plasticity of the mud mass. Such preliminary preparations are necessary if the incohesive muds are applied in the form of packs. The addition of acids to the mud mass destroys the FeS and the plasticity as well.

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[1] Snamensky, M., Zeitschr. f. Gesamt. Physikal. Therap. 33, H. I, 1927.

NARVA-JÕESUU: A VIEW OF THE PARK FROM THE SPA PAVILION.

NARVA-JÕESUU: THE BEACH.

NARVA-JÕESUU: THE BEACH IN FRONT OF THE CAFÉ.

The density of a mud in its native state may be determined by the Swedish Cone Method, that is to say measured by the time a wedge of defined angle and weight takes to penetrate a certain depth [1]. The consistence of the diluted mud mass as used in the clinic may be determined by a special P e l o m e t e r (similar to a urometer) constructed in the Institute of Bacteriology of the University of Tartu.

H. RADIOACTIVITY

The radioactivity of the sea-mud in its native state may be determined ready-for-use and dry. The radioactivity of the Estonian natural sea-muds was first determined by I. Borgmann and London (1904) [2]. These findings were later confirmed by several other investigators. The results of the latest measurements [3] made with H. W. Schmidt's universal electrometric apparatus are summarized in Table XVII. The measurements were made on freshly taken samples at the actual place of the sea-mud beds and in the laboratory. The quantity of emanation given off by the sea-muds was expressed in Mache units (M. U.) for 1 litre of natural mud. It should be noted that the nature of

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[1] F r e u n d, E., Medizinische Klinik, Nr. 18, 1934; Bericht d. staatl. geotechn. Commission (Sweden).

[2] B o r g m a n n I., Journ. Russk. Phys. Chim. Obstch, 36, 182—204, 1904 and 37, 63—76, 1905.

[3] D r e y e r F. and K a n d M., Eesti tervismuda radioaktiivsus, Tallinn, 1922, and Beiträge zur Kunde Estlands. 9, 137—153, 1923.

the emanation does not seem to be exactly established at the present time. As a result of their observations Dreyer and Kand were inclined to the view that the radioactivity of the Estonian sea-muds (especially at Haapsalu) is caused by thorium and the products of its decomposition. The sea-muds obviously contain not only the emanation but also the elementary substances of the thorium group. The degree of the radioactivity of the Estonian sea-muds was found to be variable and seemed to depend upon different factors which may influence the quantitiy of emanation, as, for instance, origin of the sample, state of the mud bed, season, weather and other circumstances.

TABLE XVII

RADIOACTIVITY OF THE SEA-MUDS

Samples	*Maximal Activity*	
	Freshly Taken	30 *Days Conserved*
Haapsalu Väike Viik	33.6 M. U.	35.5 M. U.
Hiiumaa Suur-Sadam	14.0 „ „	1.9 „ „
Hiiumaa Kassari . .	6.9 „ „	2.1 „ „
Kuressaare	6.3 „ „	5.4 „ „
Vormsi	2.8 „ „	1.8 „ „
Voosi	2.5 „ „	3·2 „ „
Kihelkonna	1.3 „ „	0.6 „ „

From the therapeutic point of view one may conclude that the empirical specificity of the Estonian sea-muds established long ago can hardly be explained theoretically by the chemical composition, the physical properties or the radioactivity of the mud. Besides these factors, which are already known, there are naturally many others yet unknown.

CHAPTER IV

CURATIVE FACTORS AND THE ACTION OF THE SEA-MUDS

In studying the effect of curative mud applications we are accustomed to see, in the first place, those modes of action which can be demonstrated in relation to the functions or to alterations in the pathological processes of the individual organs. It should be pointed out, however, that the scope of mud treatment is not exhausted by such a limited effect. The therapeutic effect obtained in spa treatment cannot be explained by a mere comparison of the analysis of the muds and the manifest physiological effects. The sum of the effects cannot be calculated by the simple addition of the components (Müller, Schoger, Luniatschek, etc.). Treatment with mud baths produces a biological total effect where different factors which provide an impulse towards recovery are at work on the human body. According to H. Vogt [1], people would long since have ceased visiting the spas if all they produced was a pharmaceutical entity that could be exported by rail. Most authors agree that treat-

[1] Vogt, H., Arch. of Med. Hydrology, XVI, 1, 1938.

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[1] Vogt, H., Arch. of Med. Hydrology, XVI, 1, 1938.

hood of the diseased foci. K ions are capable of emitting radioactive rays (β and γ) which increase the permeability of the capillaries [1].

The skin is also characterized as the sense organ of the sympathetic nervous system (Müller and Delbanco). The functional irritations of the skin, produced by hot sea-mud baths or packs, are transferred by means of the sympathetic nervous system to the organs of internal secretion which play an important part in metabolism (thyroid, sexual organs, etc.). Thus it is evident that the skin, as a biologically active organ with a very complex structure of cells, nerves, and blood and lymph vessels, is influenced directly by mechanical and chemical factors and secondarily by the heat of the applied mud. Experiments have proved that mud baths remarkably increase the conductivity of the human skin for the electric current. On the contrary, the conductivity is decreased by baths of sea-water and not influenced by clay baths (Nalbanov and Tarassov 1932). It seems possible that the sea-mud baths are instrumental in increasing the permeability of the skin to certain substances (Schlossmann).

For the discussion of the action of the sea-muds we must, of course, have sufficiently reliable data concerning their chemical composition and physical properties. Closer acquaintance with the effects of

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[1] Kaufteil u. Kisch, Klin. Wochenschr. 28, 1927. Grunow, W., Veröffentl. d. Zentralst. f. Balneologie, H. 15, 1929.

warm sea-mud baths suggests that in the first place different physical factors come into consideration, whilst chemical components of the mud play a subordinate part. Some experiments made on a dog with mud-baths at Marienbad [1] demonstrated that there could be no question of a specific action of the mud applied, but only of a powerful thermal effect. A mud bath of 39° C. had a remarkable stimulating effect on the metabolic changes without injuring the organism in any way. In spite of the powerful stimulation, the functions of heart, kidney and the heat-regulating centres remained wholly undisturbed. Of course, the effect observed on the diseased human body may be different from the results obtained on a healthy dog. Appropriately applied sea-mud baths, nevertheless, should be estimated as the most valuable form of thermotherapy which is supplemented by the local chemical action of easily soluble or volatile substances present in the sea-muds.

The determinant properties of the sea-mud, i. e. its high heat retentivity and low conductivity, which are of great importance for the curative thermal action, depend upon a high degree of friction and of resistance to the dislocation of particles in the mud mass. The higher the consistence of a mud, the lower is its heat conductivity and the higher its heat retentivity. It is evident that the consistence of a sea-mud bath or pack is of great importance and must, therefore,

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[1] Tuszkai, Ö., Arch. of Med. Hydrology, VII, 2, p. 197, 1929.

be exactly determined in the mud-bath establishments. At some spas, however, the consistence of a mud, in the conditions in which it is used, is usually controlled arbitrarily by personal judgment.

The size of particles is of more importance than insignificant differences in the chemical composition of the sea-mud. The particles greatly affect the water-holding capacity and, therefore, the thermal capacity and conductivity. Coarse, sandy mixings, agglomerations of solids and other non-homogeneous inclusions are disadvantageous. In the first place great emphasis should be laid on the plasticity and soft unctuous consistence of the mud which may be easily applied close to the skin. In consequence of the physical and thermal properties of the sea-mud, the indifferent point of a mud bath is higher than that of a water bath. Owing to the low conductivity of the sea-mud, a high temperature is more easily supported in a mud bath than would be possible in a water bath. 34° C. of a water bath gives a similar sensation of warmth as 36—37° C. of a sea-mud bath. In a sea-mud bath the body gets heat from a very thin mud layer next to the body surface. The conduction of heat from the surrounding mud mass is moderate and a mud-bath temperature of 42° C. causes no harm. The sensation of pain caused by hot sea-mud packs is only of short duration; then the warming-up continues slowly.

Corresponding measurements[1] have shown that

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[1] Zondek, B., Münch. med. Wochenschr. p. 810 and 1041, 1920; p. 300, 1921; p. 579, 1922; Schade, H. and Haa-

heat applied through the medium of hot mud penetrates deep into the tissues and produces hyperaemia in the diseased foci, which has an analgesic effect on the inflamed tissues. In addition to the relief of pain, a resolution of the inflammatory residue, and different physicochemical changes in the foci of inflamed tissues, as, for instance, decrease of CO_2-tension generally accompanying the inflammation, decline of the inflammatory acidosis and considerable increase of proteins in the exudates are effected (Bier, Schade and Haagen). As suggested by several investigators (Pinali [1], etc.) the products of such a resolution act like a vaccine or non-specific protein, calling forth the formation of antibodies which accomplish their destruction. Experiments made on dogs with hot peat packs (48—50° C.) have proved that the heat applied locally reached the organs situated about 8 cm. under the body surface and raised the temperature of the inflamed foci by about 0.27—0.43° C. During the local application of hot air (40—61° C.) for one hour, the temperature of the human skin rose from 32.2° C. to 38.9° C., of the subcutaneous tissue from 35.4 to 40.1° C., in the peritoneum from 37.0 to 37.9° C., and in the rectum from 37.3 to 37.6° C. The general body temperature of the patients rose also and exceeded the norm by 1.0—2.5° C. Studies in experi-

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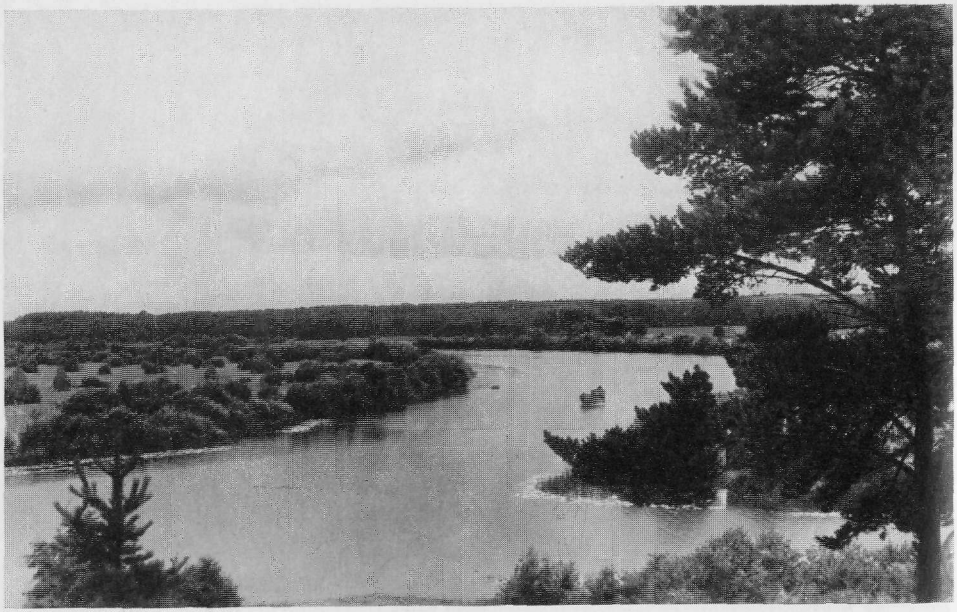
g e n, W., Veröffentl. der Zentralstelle für Balneologie, H. 12, 1929.

[1] P i n a l i, R., Giorn. Ital. di Sc. Idromin. e Climat., 6, 1931.

NARVA-JÕESUU: A STRETCH OF THE BEACH.

NARVA-JÕESUU: THE SWAN POND IN THE PUBLIC GARDENS.



NARVA-JÕESUU: A VIEW OF THE RIVER ROSSON.

NARVA-JÕESUU: DR. KROUG'S BATHING ESTABLISHMENT.

mental hyperthermia on dogs [1] have demonstrated that a rise of body temperature was accompanied by an increase of the frequency of the pulse and breathing, preliminary arterial hypertension which later decreases remaining below the norm during the mud bath.

It is known that anaphylactic shock is associated with a rapid fall in blood pressure. This phenomenon does not occur with dogs and rabbits sensitized with protein, if the body temperature is experimentally increased to 42° C. before the second or desensitizing injection of protein [2]. It was found that hyperthermia may also temporarily inhibit anaphylactic manifestations, especially the asthmatic attacks of man. The shock produced by the injection of peptone is generally reduced by a high and continuous temperature. The hypotensive action of histamine was found to be similar, both before and during the pyrexia of the animal. Schmidt [3], in discussing the therapeutic factors of mud treatment, suggests that the thermal action is by no means simple, for it consists in a combination of thermal radiation from the mud to the body and thermal congestion through prevention of heat loss while the physiological processes of thermal production by the patient himself still continued.

It is indispensable that a physician who has spe-

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[1] Binet, L,. L'hyperthermie provoquée, Paris, 1937. Bursten, M., Presse Médicale, 36, p. 715, 1938.

[2] Pasteur Vallery-Radot, Mauric et Holtzer, Anaphylaxie experimentale et humaine, Paris, 1937.

[3] Schmidt, L., Arch. of Medic. Hydrology, XVI, 1, p. 8, 1938.

cialized in bath practice should carefully study the reaction of each individual to the mud baths, especially at the beginning of the bath cure. The frequency of the pulse and breathing, blood pressure and alterations in the body temperature following the sea-mud bath should be registered. It is difficult to know in advance what degree of hyperthermia would be the most advantageous for a patient and his disease. That optimum degree must be fixed as exactly as possible by an observation of the individual patient. Experiments have demonstrated [1] that every degree of the rise in body temperature produces an increase of the metabolic processes. Hyperthermia cannot, of course, cause hyperaemia in all the tissues and organs, because the total quantity of blood is not increased. The hyperaemia produced by a sea-mud bath is manifested especially in the skin and the subcutaneous tissue. Hot mud packs have a pronounced local action and are therefore regarded as favourable for the treatment of different localized pathological processes. Intense hyperaemia and hyperthermia penetrate into the deeper tissues and bring about curative reactions.

The mechanical influence of the curative sea-mud represents a second important factor on which the effect of the thermal cure is based. The plasticity of the mud ensures accurate application of packs to the skin without air spaces. The viscosity or the rate of the hydrostatic pressure of the sea-mud is a distinctive characteristic which makes the action of

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[1] Haldane, Journ. of Physiology, 55, 4, 1921.

a mud bath different from that of a water bath. In mud-bath establishments the viscosity of the mud mass may be measured by the rising speed of a piece of cork [1] or Freund's ball placed on the bottom of the mud mixture in the bath, and by the sinking of different metallic disks placed on the surface of the mud mass [2].

The relatively high pressure of the mud mixture on the body, resembling micro- and macro-massage, hinders movement in the mud bath, owing to which the energy of the cardio-vascular system is increased. According to Alexandrov, movement in the mud bath requires about 300—400 times as much energy as in the water bath. The friction arising between the body and the mud particles (sand, silicious fragments etc.) causes mechanical irritation and hyperaemia of the skin. The viscosity and hydrostatic pressure cause notable changes in the act of respiration. According to Zörkendörfer, the viscosity and pressure of the mud mass hinder the movement of the thoracic walls during inspiration (resistance $= v + p$); during expiration, however, the viscosity hinders and the pressure favours the respiratory movement of the thorax (resistance $v - p$). Owing to these conditions, the expiration increases and the inspiration decreases in the mud baths. These modifications of the act of respiration increase intrathoracic pressure, which has been

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[1] Stark, W., Wien. med. Presse, Nr. 45/49, 1906.

[2] Zörkendörfer, W., Die Viscosität der Moorbäder. Der Balneologe, H. 2, p. 80, 1938.

confirmed by corresponding experiments on animals and observations on human beings. Such an expiratory state can influence the function of the cardio-vascular system.

The chemical influence of the curative sea-muds depends upon the absorption of some kinds of ions by the skin and the inhalation of gaseous substances. Zörkendörfer [1] suggests that the local chemical action of a mud mass is produced by easily soluble or volatile substances, organic acids, free sulphuric acid and its astringent salts (ferric and aluminium), free humic acids, ovarian hormones and some other substances present in the muds. The studies made on the liman mud at Odessa have proved that the volatile substances of medical muds act as very powerful irritants and are therefore as important as the thermal factors [2]. In the sea-mud labile, therapeutically effective modifications of sulphur (H_2S, HNaS, Na_2S, etc.) are continually created. prevailing in a sort of dynamic balance. Corresponding investigations made on the mixtures of H_2S in the buffering solutions of $H_2KPO_4 + Na_2HPO_4$ have demonstrated that the dynamic balance of the labile modifications of sulphur depends upon the degree of pH. In mixtures with a low degree of pH (pH = 6—7), the dominant constituent of sulphur was H_2S. At pH = 8 the dominant constituents were H_2S and NaHS, and at pH = 9 NaHS and Na_2S, dominated conformably to the equilibria of hydrolysis:

[1] Zörkendörfer, Med. Klinik, H. 17, 1934.

[2] Danischevsky, G., Arch. of Medic. Hydrology, XIII, 1, 1935.

$$NaHS + H_2O \rightleftarrows SH_2 + NaOH$$
$$SNa_2 + H_2O \rightleftarrows SHNa + NaOH$$ [1].

The best understood chemical action of different muds so far is that of sulphur. As known, sulphur baths have been popular for centuries in the treatment of rheumatism and the pains of old age. They are sedative and relieve different kinds of pain. Basch [2] suggests that their therapeutic effect is due to the absorption of H_2S, and gives proofs of H_2S poisoning caused by sulphur baths. The utilization of sulphur by the organism may be of different kinds. It is essential to the regulation of cell proliferation and regeneration, to the nutrition and metabolism of cells, to the elaboration of hormones, adrenalin and insulin and brings on a detoxicating action. There occur changes in the vessels as well as in the blood and the tissues due especially to the action of H_2S [3]. The absorption of sulphur from Pistany mud by the skin of experimental animals was proved many years ago [4]. Schmidt [5] investigated the permeability of the human skin to H_2S and found that this gas could penetrate into the organism through the skin. Strong concentrations (0.818%) set up an inflammable oedema on the skin which manifestly represented resistance to resorption. Comparatively more

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[1] Roques, Caujolle et Rey. Bullet. de l'Academ. de Méd. 119, 19, p. 515, 1938.

[2] Basch, I., Brit. J. of Physical. Med., Vol, 12, 4, 1937.

[3] Valedinsky, Russian J. of Baln. and Phys., 2, 1934.

[4] Kilian, Bratislavske lekarsk. Listy, 3, 1936.

[5] Schmidt, Arch. intern. de Pharmacodynamie et de Thérapie, LV, III, 1937.

H_2S penetrated from weak solutions which corresponded to balneological conditions. It also was found that the skin was permeable to carbonic acid and to Na_2SO_4. To NaCl and NaJ the skin is only permeable when their concentration amounts to 10—27%. It proves impermeable to weaker solutions [1].

The problem of the permeability of the skin to different substances may be studied by means of the very simple Hediger and Bürgi apparatus [2]. It consists of a hollow hemisphere of glass which can be made to adhere to the skin and into which two tubes lead for filling and emptying. The receptacle is filled with the liquid containing the substance to be examined. The apparatus remains on the skin of human beings for an hour on an average. With this method Bürgi was able to prove the permeability of the skin to carbonic acid in pure water, to volatile narcotics, aromatic oils and metallic mercury. It was possible completely to anaesthetize a rabbit through the skin by means of narcotic substances (tetrachlorethane etc.). Roques, Caujolle and Rey, using the Hediger-Bürgi method, found that the skin did not absorb S_2O_3-ions (Natr. hyposulphite), and absorbed but limited quantities of Na_2S; the absorption of NaHS was found to be about 6% (calculated on H_2S), and the absorption of H_2S dissolved in water was in 20—30 minutes from 7% to 40% for solutions from 0.025 to

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[1] Lehmann, G., Arch. intern. de Pharmacodynamie et de Thérapie, LV, III, 1937.

[2] Bürgi, E., Arch. of Medical Hydrology, XVI, 2, p. 35, 1938.

0.750 gram-molecule of H_2S per litre. Experiments have proved that the absorption of sulphuric elements depends upon the degree of pH of the solution: a decrease of pH is accompanied by an increase of absorption and vice versa. For instance, from a solution containing 0.003 gram-molecule per litre of total sulphur, expressed in H_2S, the absorption was found to be 9% at pH = 9.0, 13% at pH = 8.0, 17.5% at pH = 7.0 and 19% at pH = 6.0. At some Estonian mud-bath establishments the addition of sodium bisulphate ($NaHSO_4$) to the sea-mud (200—1000 gms. per bath) is practised; this turns the mud mass acid and produces an increased liberation of CO_2 and H_2S. It seems that the non-dissociated molecules of H_2S possess a penetrating power superior to that of SHNa, SNa_2 molecules, and SH- and SNa-ions. All these results may serve as a basis for sulphuric and carbonic acid bath treatment. They prove that these gases act not only superficially, as used to be assumed, and reach the blood not only by the air breathed in, but also directly through the skin. The important therapeutic action of sulphur in the curative sea-muds may be increased by the addition of sulphur bacteria which transform the sulphur into easily absorbed compounds.

It is interesting to note that besides the substances already mentioned, the skin was found to be permeable to salicylic acid (Kionka), to arsenic (Leva), to oxygen (Benecke) and to calcium and potassium (Harpuder and Wermel). On the contrary, several investigators [1]

[1] Strunka u. Priess, Zeitschr. f. physiolog. Chem. 76, 136.

TABLE XVIII

H_2S in 100 litres of Air

Kuressaare .	*Room* 7	*Room* 8	*Room* 17	*Room* 16	*Room* 4	*Room* 10	*Room* 12	*Corridor*
	5.0 mg.	5.17 mg.	6.89 mg.	4.20 mg.	4.76 mg.	4.31 mg.	4.46 mg.	4.20 mg.
Pärnu	*Room* 7	*Room* 6	*Room* 3	*Room* 8	*Room* 10	*Room* 4	*Room* 5	*Pack room*
	3.52 mg.	3.44 mg.	2.24 mg.	5.75 mg.	4.0 mg.	4.20 mg.	3.20 mg.	4.35 mg.
Haapsalu . .	*Room* 4	*Room* 6	*Room* 9	*Room* 10	*Room* 14	*Room* 12	*Room* 3	*Room* 11
	5.91 mg.	5.20 mg.	4.76 mg.	5.57 mg.	5.33 mg.	5.79 mg.	4.90 mg.	5.72 mg.

do not admit the access of H_2S to the blood through the human skin, and suggest that only certain compounds of H_2S with the corneum are formed which belong to the class of polysulphides.

During a sea-mud bath variable quantities of H_2S are eliminated from the mud mass, which penetrate into the lungs with the air breathed in. From the lungs H_2S has relatively easy access to the blood. According to Diakonov, H_2S brings on the destruction of the red blood corpuscles and is combined with the iron liberated from them. H_2S is an offensive gas, but in hydrology we generally have to deal with subtoxic doses which stimulate different functions. It has been proved (Lehmann, Greulich etc.) that weak signs of H_2S poisoning appear if 100 litres of air contain 20 mgms. or more of H_2S. Of course, the transient poisoning of a diseased organism may be produced by considerably smaller doses of H_2S, but in these cases the toxic action is generally followed by a beneficial stimulating effect.

In order to elucidate the question of the influence of H_2S inhaled by the patient during a mud bath, we made numerous measurements of H_2S in the air of the bathrooms of the Estonian mud-bath establishments in July and August 1938. The results obtained are presented in Table XVIII. The measurings were undertaken at the municipal bath establishments.

The quantity of H_2S in the air of different bathrooms was found to be variable, depending upon the quantity of H_2S liberated from the mud mass during the bath and upon the degree of the fresh air supply.

Admitting that the patient remains in the bath-room for 40 minutes, and makes 16 inspirations per minute, and draws 340 c.c. of air into the lungs with each inspiration, the quantity of air breathed in during a bath amounts to 217 litres. From the corresponding calculations it follows that the minimum quantity of H_2S drawn into the lungs during a bath is about (2.17 × 2.24) 4.86 mgs., whilst the maximum quantity may amount to (2.17×6.89) 14.95 mgs. Such small doses of H_2S can hardly cause a harmful poisoning effect; they rather stimulate different vital processes essential to the nutrition and metabolism of cells.

For comparison it should be remembered that the quantity of H_2S in the bath-rooms at Kemeri was found to be from 1.41 to 7. 92 mgs. per hectolitre [1].

Numerous measurements undertaken at the Estonian sea-mud establishments have demonstrated that traces only of ammonia (NH_3) were present in the air of the bath rooms.

As stated, traces of iodine were found in the Estonian sea-muds. According to Nicolescu, the iodine of the peloids is very finely divided and in a lipoid-soluble state, which is much more effective and penetrating than water-soluble iodine [2]. Besides the catalytic functions, the infinitesimal amounts of iodine and bromine may cause alterations in the electrical proper-

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[1] Sadikov and Lozinsky. Gigiena i Sanitarnoe djelo (Russ.), 1914.

[2] Nicolescu, P., Mode of Action of Peloids. R. H. M. si C., Bucarest, 1—3, 1934.

ties of the ions. As emphasized in a previous chapter, we cannot to-day controvert the action produced in cells by infinitely small quantities of substances.

The influence of radio-active substances present in the Estonian sea-muds in infinitely small quantities can hardly be regarded as an essential curative factor, though we cannot, of course, absolutely deny the therapeutic importance of the relatively low radioactivity of the sea-mud [1]. It is known that several curative muds devoid of radioactivity have, nevertheless, a notable therapeutic effect. Of course, it would be reasonable not to advertise at all the low radioactivity of a mud used in medical practice. The therapeutic significance of electrical phenomena taking place in the sea-mud has not yet been sufficiently studied.

It is believed that the influence of the biological properties of the curative muds excites the nerve end-organs in the skin, which may affect the organs of internal secretion and the vegetative nervous system so as to alter the equilibrium of electrolytes in the blood and change the colloidal structure of the liquids and cells of the organism (Alexandrov).

As already pointed out in a previous chapter, the adsorption of different substances by the natural sea-muds may be considered as a property which occupies an important place among other therapeutic factors. The adsorption removes different substances eliminated

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[1] Arronet, H., St. Petersburger med. Wochenschr., No. 42, 1905.

by the skin; on the other hand, the diminution of the osmotic concentration of sweat produced by the adsorption stimulates and increases the secretion by the skin of substances foreign to the body.

The astringency of the natural sea-muds seems to play a subordinate part in mud treatment. The astringents (alum, humic acid, iron sulphates, etc.) are capable of increasing the hardness of the skin and of arresting discharges from a diseased skin. Therapeutic peat baths have proved to have a sedative action on skin disorders marked by itching [1]. The shrinkage of the skin caused by the astringents opens the pores of the sweat glands and thus increases the perspiration.

The pronounced catalytic action of the natural sea-muds undoubtedly participates in different biochemical reactions which take place on the surface of the skin during a sea-mud bath. The catalase evidently increases the velocity of certain reactions and alters the course of others, but a detailed discussion of these questions is rendered difficult for lack of relevant investigations.

Many authors have shown that bitumen and resinous substances contain an estrogenic substance identical with the female sex hormone folliculin (Aschheim and Hohlweg). The quantity of this hormone was found to be 500 mouse units or 100 rat units in 1 kg. of the peats examined. Observations made by Wehefritz and Gierhake on other samples

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[1] Kingmüller, V., Dermatol. Zeitschr. 25, 9.

(Pyrmont) confirmed the presence of estrin in the peats. Under the ultramicroscope extracts obtained from peats reveal the properties of folliculin. It seems possible that similar hormones are present in the Estonian sea-muds, but the required determinations have not been made.

In addition to all these curative factors which depend upon the properties and action of the sea-mud, psychological, psychotherapeutic and climatotherapeutic factors should be taken into consideration. According to Reichart, the spa milieu with its often stressed advantages gives the patient's defensive mechanism much more chance of responding to the stimuli applied than in his home, or in the surroundings of an urban hospital. The psychological effect of mixing with other patients in various stages of convalescence encourages the invalid and gives him fresh hope of recovery. There are many other psychological curative factors in the spa milieu, in the geographical situation and the surroundings of a health resort which are not understood because we still know far too little about these matters.

On the other hand, health resort practice provides much psychologically interesting material owing to the cosmopolitan character of its clientele. Many authors [1] emphasize the pressing necessity of psychotherapy in spa and other health resort practice. The chief task of the spa physician should be to classify

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[1] Gordon, R. G., Arch. of Medic. Hydrology, XV, 4, p. 302, 1937. Veraguth, O., ibid. p. 306,

his patients and to determine the appropriate treatment required. The spa physician will be successful if he can determine how far a patient's attention should be directed towards his symptoms and how far away from them. The spa physician must in some measure be a psychotherapist in order to understand each individual patient who passes through his hands and not confine himself to the wholesale administration of different baths and packs. The treatment in every spa should be directed to both body and mind. According to H. Vogt, the beneficial system which is constituted of mud, water, climate, air, sun and landscape lures patients into natural recovery. It is evident that with the bare estimations of blood pictures and measurings of blood pressure, metabolism and nervous reactions, important and indispensable as they are, we shall never arrive at an understanding of the particular nature of the processes occurring during the treatment with mud baths. It is necessary to study the whole range of the curative factors involving body and mind and making up the dynamic action of spas and climate health resorts. The therapeutic action of the sea-mud represents a complex, the single factors of which cannot and must not be isolated.

CHAPTER V

REACTIONS FOLLOWING MUD APPLICATIONS

A series of phenomena following the sea-mud applications indicate changes in the deeper tissues which may be transient or more permanent. Long ago an interesting correlation between the action of mud baths and protein injections was observed. Both mud baths and the injection of proteins are generally accompanied by an exacerbation of the disease (negative phase), which is at a later stage followed by improvement (positive phase). One remarkable effect of the mud treatment is the generalized reaction produced by local applications of mud. This property makes it possible to treat various localized diseases to which the application of mud packs is impracticable owing to eczema, injuries of the skin, etc. The packs applied to any portion of the body produce a local and a general reaction which bring about the improvement of the pathological process. Schmidt reported a patient with gono-arthritis successfully treated by this method.

The complex of phenomena produced by the mud baths, the so-called "B a t h R e a c t i o n", is of fundamental importance in the mud cure, but it should

be noted that this reaction requires a precise regulation for the individual patient, otherwise it may lead to certain harmful effects. Many authors [1] have reported that treatment with mud baths, as also specific and non-specific treatment by the protein shock depend for their therapeutic effects on a disturbance or preliminary deterioration which may be regulated. This artificial disturbance, if appropriately dosed by the physician, induces an increasingly beneficial response in the defensive mechanism which may conquer the existing disease. The beneficial effect becomes evident only after weeks or even months. According to Reichart [2], it is not the mud bath that brings recovery, but the defence or the reacting power of the patient. The most beneficial dosage seems to be that which regularly stimulates the defensive mechanism without producing any obvious subjective or objective disturbance. As the defensive forces of the organism increase, the stimulus also should be increased in order to obtain the best progressive therapeutic effect.

Bath reactions are usually much milder than reactions following protein injections, but they nevertheless show that the "threshold dose or stimulus" (Zimmer) has been exceeded. Several spa physicians emphasize the importance of the bath reaction in the production

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[1] Fox, The Lancet, April, 1910; Stinzing, Deutsche med. Wsch., p. 311, 1922; Behne, Deutsche med. Wsch., p. 583, 1931; Laqueur, Ref. Arch. of Med. Hydr., p. 469, 1931; Zimmer, Rheuma Jahrbuch, 1930 — I; Géronne, Zsch. f. phys. u. diat. Ther., p. 275, 1921.

[2] Reichart, Arch. of Med. Hydrol., X, 3, p. 77, 1932.

of a cure [1], but according to Reichart (Pistany) and others, the bath reaction is certainly not an essential precursor of a good result from treatment and should be avoided as far as possible. The reaction, however, is not always entirely under the control of the physician, who can only regulate the degree of the stimulus, whereas the extent of reactivity is quite unknown or may be but approximately estimated.

As known, the stimulating power of the mud used at one spa is not exactly similar to the action of the mud applied at another spa. So it seems imperative that the instructed physicians of the Estonian mud-bath establishments, where comparatively different muds are used, should adapt the methods of mud application to the specific conditions of their respective establishments. What strength of stimulus should be applied to the individual case at the beginning of treatment and how rapidly, and to what extent it is permissible to increase it, can only be learned by experience. It is judicious to start with the milder forms of mud actions and gradually strengthen them, trying to apply the maximum stimulus that the organism can stand without a disturbing reaction. By varying the temperature and the concentration of the mud baths or the extent of the mud packs, as well as by suitably combining both these factors, it is possible to vary the mud action by very fine grada-

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[1] Burt, Arch. of Med. Hydrol., p. 13, 1928, and p. 445, 1931; Kornmann, Zsch. f. wiss. Bäderkunde, April, 1927; Simo, Wiener med. Wschr., Nr. 13, 1929; Falk, Eesti Arst, p. 235, 1922.

tions. By the interpolation of rest days and by reducing the duration of the mud action the artificial stimulus may be kept very close to the therapeutic optimum. If a slight reaction occurs, it should not be taken too seriously. Severe and injurious reactions can almost always be avoided by the physicians.

The very different phenomena of the bath reaction, experienced generally at the beginning, seldom at the later stages of treatment, depend upon the reactivity of the individual patient, and the strength of the mud action. In the first place mention should be made of the thermal debility which consists in the tiredness, headache, sleeplessness, want of appetite, weakness and nervousness of the patients. In some cases diarrhoea, urticaria and eczema were observed (Teas [1]). Increased pain, local reaction and stiffness in the affected parts are often observed. In more severe cases increased swelling, local heat and a slightly raised temperature may occur. A slight rise of body temperature during the first two or three hours after the hyperthermal bath is a common reaction and not injurious to the patient. Measurements made at several spas have shown the following increases of body temperature: rise by 1—1.35° C. (Vinaj and Comel [2]). by 0.5—1.3° C. (Kisch, Fellner and Jacob), by 1.4—2.8° C. (Sadikov at Kemeri) and by 0.7—2.5° C. (Feldstein-Bucarest). According to H. Alver [3] and

[1] Teas, P., Eesti Arst, Supplem. p. 19, 1932.

[2] Comel, Ricerche sull' azione biologica del fango termale. Triest, 1930.

[3] Alver, H., Eesti Arst, Supplem. 1936.

P. Teas (Haapsalu), the body temperature in most cases attained 37.2—37.5° C.; in exceptional cases it attained 38.0—39.0° C. The body temperature increases gradually during the thermal bath and falls to normal soon after the bath. In some cases the raised temperature may continue for 10—18 or more hours. The temperature of the air expired during the application of thermal mud also increases (by 2.0—3.5° C.). As to the body temperature, it should be noted that a systematic measurement of it during mud-cure may afford a valuable objective index for the estimation of the mud action and the individual reactivity of the patient.

The measurements of the cutaneous temperature made by Pisani [1] by means of the Benedict-Terzano electric thermometer have yielded clear proof that the skin temperature may be raised by the local application of hot mud-packs at a temperature of 47° C. by 2.8° C. in the parts covered with the mud and by 2.1° C. in the parts left free from the mud. The application of mud-packs at a temperature of 16° C. during 20 minutes increased the skin temperature by 0.8° C. in the parts left free and decreased it by 1.7° C. in the parts covered with the mud. These variations in the temperature show the rapidity, the precision, and the distribution of the vascular reactions both in the affected part of the skin and at a distance. Corresponding measurements have shown that the skin temperature is not identical in all parts of the body. The difference may amount to 3—4° C. The lowest temperature was

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[1] Pisani, S., Arch. of Hydrology, IX, 3, p. 473, 1931.

found in the skin of large joints affected with chronic diseases, especially in cases accompanied by alterations in the metabolism of uric acid. This hypothermia causes a subjective sensation of chilliness in the legs (*jambes gelées*).

The treatment with sea-mud baths and packs produces typical morphological and chemical alterations of the blood which depend upon the disease treated and the temperature of the mud baths or packs applied. Comparative studies of healthy subjects and of those affected with various diseases have demonstrated that mud baths and packs induce first a diminution of the number of leucocytes (leucopenia) in the peripheral circulating blood [1]. The leucopenia develops during the application of the mud and attains its maximum between 5—30 minutes (Sadikov). It is accompanied by a slight rise of the number of lymphocytes and monocytes. After a bath, especially during the thermal crisis, a slight leucocytosis with a move to the left has been observed [2]. The number of eosinophils is generally diminished (hypeosinophilia). When the acute or negative phase of the illness is relieved by the positive phase or improvement of the symptoms, the leucocytosis begins to decrease, the leucocytary formula shows a move to the right and a gradual increase of the number of eosinophils, monocytes and lymphocytes is observed

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[1] Comel, Ref. Arch. of Med. Hydrol. IX, 2, p. 447, 1931; Alexandrov, ibid. VII, 2, p. 196, 1929.

[2] Schulhof, Arch. of Med. Hydrol. XV, 1, 1937; Teas, Dissertation, Haapsalu, 1933.

(Teas). According to Lorenzi [1], the leucocytosis depends upon the function of the inner organs (spleen), which are influenced by the presence of hormonic substances set free by the skin. The number of erythrocytes is increased (25—30%), but the haemoglobin content is not increased so much as the number of erythrocytes, and thus a decreased globular value is present. The mechanism of these changes may be capillary or produced by stimulation of the spleen and bone marrow [2]. The surface tension of the blood serum is sometimes diminished. The pH values generally remain unaffected.

Several authors affirm that the general thermal reaction is accompanied by loss of equilibrium or deviation of the electrolytes in the blood serum. The Ca and K content is often diminished during the reaction and becomes normal after the reaction is over. The relation K: Ca remains diminished during the period of treatment. The content of Cl and organic phosphorus in the blood serum almost invariably increases after each mud bath, returning to the normal subsequently [3].

The quantity of globulin in the blood serum decreases gradually during the mud bath and afterwards, whilst the quantity of albumin slightly decreases first and returns to normal or increases afterwards. The rise in the coefficient for albumin may be explained

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[1] Lorenzi, R. I, c. T. F. 1932.

[2] Trivellini, Biochim. Terap. Sperim. XIX, Fasc. I, 1932.

[3] Teplov. Zeitschr. f. d. ges. physik, Therap. 36, 4.

in part on the hypothesis that interstitial liquids enrich the blood, and in part as being affected by the absorption of pathological exudations (Bich [1]). The products of protein disintegration thrown upon the circulation cause a reaction which is both general and focal. In the greater number of patients a slight diminution of residual nitrogen is found. The quantity of blood sugar decreases in 65 per cent. of the patients towards the end of the cure. The blood uric acid content is unaffected in healthy people, but in arthritic subjects there is often a conspicuous rise which probably may be attributed to a flow of uric acid from the tissues into the blood stream (Comel [2]). According to Schazillo [3], the blood uric acid decreases progressively in rheumatic patients during the treatment; elimination through the skin by perspiration is probable. A small increase in urea nitrogen occurs in all cases during the cure. The elimination of urea by the urine generally increases [4], but the elimination of uric acid is diminished [5].

From the investigations of various workers it is fairly well established that any abnormal tissue de-

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[1] Bich, Giorn. ital. di Sc. Idrominerale e Climat., May 1931.

[2] Comel. Volcanic Muds: Biological Action. Triest, 1930.

[3] Schazillo. Z. f. w. B. 1929, Ref. Arch, of Med., Hydrol., p. 323, 1930.

[4] Livschitz. Zeitschr. f. d. ges. physikal. Therap, 37, p. 161, 1929.

[5] Comel and Bich. Bio-clinica e Terap. Sperim. 17, 2, 1930.

struction which increases the proportion of fibrinogen and globulin will increase the velocity of the sedimentation of the red blood corpuscles (S. R.). Thus the sedimentation reaction may serve as a very sensitive indicator of inflammatory conditions. Many observations made at different foreign spas [1] demonstrate that the velocity of the sedimentation following the mud treatment is accelerated, especially in cases of chronic inflammations or their residues in the joints, the female pelvis, the organs of digestion, etc. Acceleration of the velocity is recognized as signifying a morbid condition, while return to normal indicates amelioration. In acute rheumatism, or in cases of exacerbation of chronic rheumatism, the figures for the S. R. are very high (about 100 mm. sinking in an hour by Westergren's method). If the illness is improving, the figures for the S. R. diminish in a wave-like curve down to normal value which is attained when the patient has been free from symptoms for some weeks. If the S. R. does not sink to normal values, there is danger of a new development of the morbid symptoms. Cases with high S. R. values do not generally tolerate thermal mud treatment well, cases with low values standing it better.

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[1] Westergren and Kahlmeter, Ref. Arch. of Med. Hydrology, V, 1, p. 216, 1927; Kahlmeter, Klin. Wochenschr. Nr. 20, 1926; Einstoss and Hirsch, Deutsch. med. Wochenschr. Nr. 13, 1926; Race, Arch. of Med. Hydrology, V, 3, p. 283, 1927; Grunow, Deutsch. med. Wochenschr. p. 700 and 727, 1925; Brussilovsky and Turteltaub, Zeitschr. physik. Therap. 31, 48, 1926.

In cases of degenerative osteo-arthritis (deformans) the S. R. values differ slightly from normal, while in cases of primary inflammatory chronic articular rheumatism higher values are observed. Stationary non-inflammatory gout shows a marked increase of S. R. value. Arthritis traumatica does not induce the acceleration of S. R. value following the mud baths (Schober), while cases with inflammatory processes show first a more or less insignificant acceleration of sedimentation which can diminish towards the end of treatment, or persist for weeks after the cure.

Observations made at Estonian mud-bath establishments [1] have shown approximately analogous alterations of the velocity of sedimentation during the mud-bath treatment. In 36.6 per cent. of cases treated with mud baths at Kuressaare, the high S. R. values gradually diminished during the cure without a preliminary increase of the velocity. A rapid increase of the velocity of sedimentation during the mud cure was found characteristic of tuberculous arthritis.

The results hitherto obtained indicate that the method of the sedimentation of the red blood corpuscles may be used with advantage at every mud-bath establishment. A reduction in the velocity of the sedimentation indicates that the inflammatory process is subsiding, and the stages of an inflammatory process could thus be determined. The sedimentation reaction helps the differentiation of the pathological process, indicates

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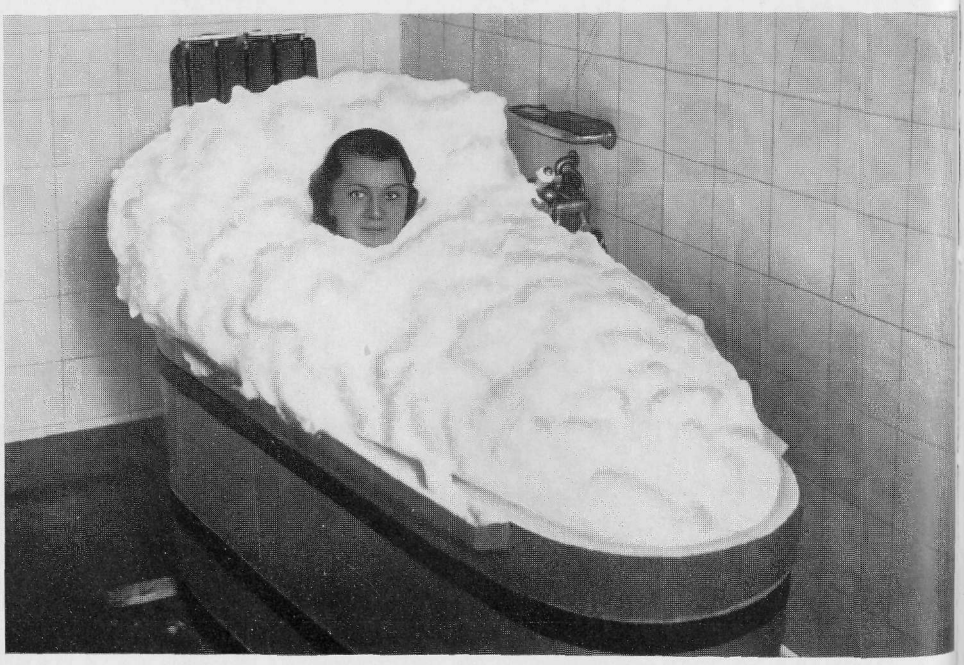
[1] T e a s, Dissert., Haapsalu. 1938. P a l d r o k, H., Der Balneologe, 5, 8, 1938.

HAAPSALU: A MUD-CART BEING LOADED WITH MUD IN THE LITTLE BAY.

KURESSAARE: UNLOADING A CARGO OF MUD FROM THE BIG BAY.

KURESSAARE: DISCHARGING FRESH MUD INTO THE MUD-TANKS.

PÄRNU: A SOAP-LATHER BATH IN THE BATHING ESTABLISHMENT.



the effects of treatment and suitable doses of mud action.

Many observations [1] made on the blood pressure of patients undergoing mud treatment have shown that the arterial blood pressure diminished with each mud application throughout the treatment. Mud baths and mud packs produced a definite fall of systolic blood pressure which may amount to 45 mm. Hg. At Haapsalu the diminution of the blood pressure attained 10—20 mm. Hg. (Dehio and Teas). In conformity there was a less marked drop of diastolic pressure. So the pulse amplitude increased about 6—10 mm. Hg. The frequency of the pulse increased during the mud baths (by 20 +), reverting to normal values or decreasing afterwards. This effect was more striking in cases where the original blood pressure was elevated and the application of mud more extensive.

This action of the mud bath may serve as a clinical guide in regulating the mud application. Corresponding observations show that the mud cure is well borne by patients suffering from hypertension and mitral incompetence, but less so where the pressure is below normal or the aortic regurgitation is present. The study of electro-cardiograms demonstrates [2] that the

[1] Lorenzi, Giorn. ital. di Sc. Idrominerale e Climat., May 1931; Guthmann and Hess, Monatschr. f. Geburtsh u. Gynäkol. 94. p. 55, 1933; Pinali, Arch. of Med. Hydrology, 4, p. 131, 1924; Blacher, W., Ztschr. f. d. ges. physik. Therap. 1924; Schotter, A., Eesti Arst, No. 5, 1933; Tsitovitš, Eesti Arst, Supplem., 1927.

[2] Broussilovsky, C. R. de L'Instit. Balnéo-physiothér., Odessa, t. I, 1932.

action of hot mud baths and packs is not so noxious to the heart as often mentioned by several authors. Many heart diseases can bear this method of treatment which stimulates the cardio-vascular system. In cases of mitral diseases the blood pressure increases, the pulse frequency decreases and the sphygmographic curve takes the normal shape. In cases of aortal diseases the blood pressure decreases. Vascular dilatation decreases the blood pressure and lessens the work of the heart. The mud treatment may thus be favourable for cases of vascular hypertonia (Pinali).

Studies with the capillar microscope [1] show that the mud application induces the dilatation of the capillaries of the skin and markedly increases the quantity of the blood stream (about 76.3%). The maximal effect develops during the mud application or 30 minutes after the removal of the mud, and continues from 1 to 3 hours. There develops also a deep hyperaemia which endures for a longer time than the superficial hyperaemia. The results described lead to the conclusion that the variations of the blood pressure are probably attributable to the widespread dilatation of the capillary vessels of the skin and viscera, with diminution of the blood output and increase of the velocity of blood.

According to Comel, the gaseous exchanges show a more or less remarkable diminution during the mud bath and packs: the decrease of eliminated CO_2 is less than that of O_2 absorbed; the respiratory

[1] Richter and Szabo. Orv. Hetil. 130, 1938, ref. Der Balneologe, H. 7, p. 320, 1938.

quotient rises accordingly. During the reaction following the mud application a remarkable diminution of energy metabolism occurs. The diminution of gaseous and energy metabolism is to be attributed to the complete rest of the subject in surroundings at a higher temperature than that of his body. Different modifications of the respiratory function in frequency (bradipnoea, or increase of the frequency), depth (often increased) and rhythm (periodical forms of respiration) occur, which induce the decrease of pulmonary ventilation.

During mud baths at lower temperatures (34—38° C.) a diminution of basal metabolism occurs, while at higher temperatures (38—42° C.) the basal metabolism generally increases and associates itself with the liberation of proteins and other substances from the diseased foci. It follows that the mud treatment should be applied with precaution in cases when the patient has an increased basal metabolism before the beginning of the cure (Alexandrov 1932).

The urinary secretion shows a remarkable diminution in most cases following the mud baths and packs; the density of the urine increases, and the surface tension decreases sometimes (Comel). A significant decrease of the acidity of the total urine of 24 hours is remarkable during treatment with mud baths (Tuszkai [1]). The elimination of uric acid is definitely diminished in most cases for the following 24 hours, while the phosphate elimination shows but little vari-

[1] Tuszkai, Ö, Arch. of Med. Hydrology, VII, 2, p. 197, 1929.

ation. The mud baths increase the elimination of chlorides by the kidneys and may therefore effect a diminution of the osmotic concentration of the blood. The elimination of the urea is also increased (Kisch). The specific gravity test for renal function of Volhard made at Pärnu [1] showed that the water (1 l.) taken by the patients was eliminated in about three hours following a mud bath at 37.5—38° C. for 30 minutes. The pH values of the urine increased and reached pH 7.2—7.3. The author concludes that hot mud baths induce an increased water diuresis and lessen the acidity of the urine. He recommends mud baths for the treatment of different renal calculi (stones) and corresponding diathesis.

Ruhmann [2] suggests that all sorts of irritant action on the body surface, which are accompanied by cutaneous hyperaemia, induce the formation of substances similar to acetylcholine (hormone of animal tissue). These substances, which are built in the tissue at the point of irritation, have the faculty of producing a dilatation of the blood vessels. If the cellular lesions are more intensive, substances of the type of histamine are formed, which possess a toxic action on the capillaries. If the mud baths are too hot or too long-continued, the irritant action and the formation of histamine are excessive. In those cases generally a pronounced cure crisis and thermal debility follow, which is analogous to an anaphylactic phenomenon. If the method of mud application is less active, the

[1] V a d i, Eesti Arst, Supplem., p. 25, 1936.

[2] R u h m a n n, 80 Jahre, Münch. med. Wochenschr., 1933.

cure crisis is absent, but the therapeutic effect is always present.

The observations of Lozinsky and Svechnikova (Piatigorsk 1932) demonstrate that treatment with the mud application may be effective in cases of chronic processes of anaphylactic origin. The desensitization of the organism, gradually produced by mud therapy, generally takes a longer time. It should be noted that focal reaction indicates a favourable prognosis, whereas its absence shows that it would be reasonable to desist from further treatment.

Since 1921 numerous reports [1] have appeared which try to affirm that the phenomena and beneficial effects following the mud baths are analogous to those observed in protein therapy. To-day we are aware that the organism can react in the same manner to relatively different agents. According to Besançon [2], instead of specific disease we think of the specific reactional modalities of the organism, the reactivity of which has been changed by a specific germ. The future of therapeutics lies more and more in a precise knowledge of the physiological mechanism of symptoms and of the general pathogenesis of the disease rather than in specific etiology. Therefore, in medications it does not seem reasonable to look for a specific remedy for each disease.

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[1] Blacher, W., Ztschr. f. d. ges. physik. Ther. 29, 4, 1924, and Vortrag gehalt. auf dem 4. Estnisch. Ärztetag in Hapsal am 3. VI. 1925. Alexandrov, W., Zeitschr. f. d. ges. physik. Ther. 36, B, 1, 1928.

[2] Besançon, 12-th Congress of Medicine, Paris.

CHAPTER VI

SEA-MUD CURE AND THE RESULTS OF THERMAL TREATMENT

In Estonian mud-bath establishments the cure is generally taken in summer, but there are no special contraindications for the application of such cures in all seasons. The results of a winter treatment at Odessa (Russia) have proved as good as those obtained in summer. No complications were observed in the form of chills connected with the use of mud baths in winter. Many hospitals in large Russian towns have also introduced a winter cure with the use of mud imported from different spas (Alexandrov). It should be noted that some pathological processes need thermal medication without delay in winter months, because every method of treatment is effectual only at the proper time. In order to begin treatment as early as possible, it is desirable to have a form of mud bath which can be used at home or in hospitals not far from home. Observations made on 370 surgical cases [1] have shown that mud treatment arranged in a home hospital was

[1] Nolde and Bakoushinsky, Centr. State Balneol. Inst. Report, III, p. 144, Moscow, 1930.

not worse than treatment at spa establishments. Home treatment may be of great value to patients who would suffer severely from the strain of travelling, or to those who cannot afford a complete cure at the spa and would benefit by an after-treatment at home.

For home treatment the Pistany mud is dried, pressed, and despatched in cubes [1]. These mud cubes are diluted with water and used for local mud baths or poultices. Estonian sea-mud has long since been in use for home treatment in some inland towns, but as a matter of fact the transport of the mud has never been competently organized and is limited to rather insignificant amounts. At present some quantities of dried mud are sent abroad, where it is chiefly used for the preparation of cosmetics. A more extensive export and transport of the sea-mud, both natural and dried, is planned for the future. This enterprise will need, however, the work of a thoroughly experienced organization.

There are many opportunities for home treatment with mud applications, and this method should be adopted on a larger scale. Nevertheless, it should be borne in mind that the climate and other conditions specific for every health resort are curative factors of great importance, because patients coming there sometimes have felt better even before the treatment has commenced.

In Estonian mud-bath establishments many diffe-

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[1] Schmidt, L., and Weiss, E., Arch. of Medical Hydrology, 3, p. 89, 1923.

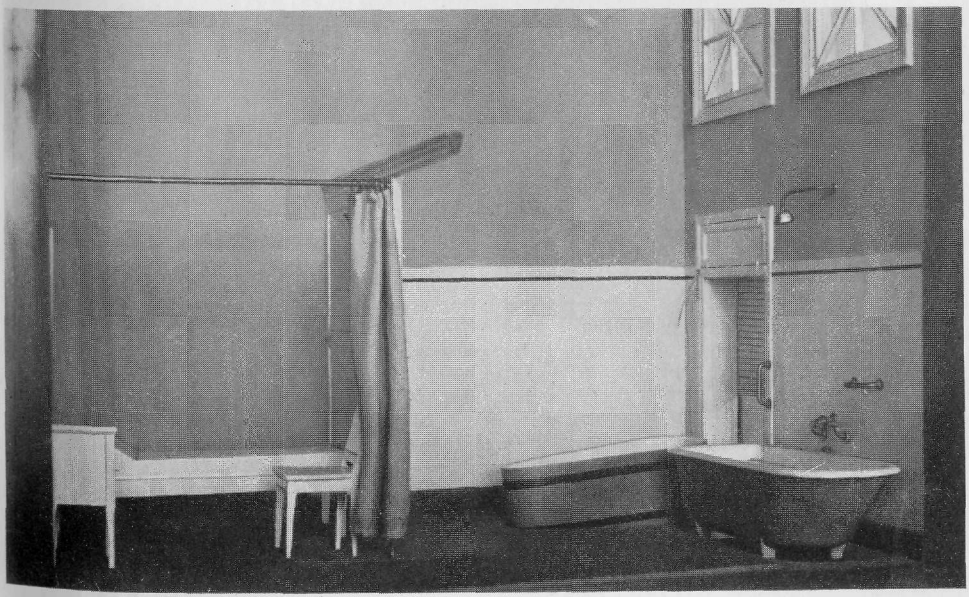
rent methods of treatment are in use: whole baths at various concentrations and temperatures, partial (local) baths, compresses and packs combined with accessory treatment as massage, water baths, physiotherapy, air baths, etc. The sea-mud is used in its original state, thickened artificially or mixed with sea-water, according to how the mud is required (whether thick and plastic for compresses and packing, or of thinner consistence for partial or whole baths). To the diluted sea-mud mass sometimes varying quantities of common salt ($NaCl$), sea salt, sodium bisulphate ($NaHSO_4$), sodium bicarbonate ($NaHCO_3$), sodium perborate ($NaBO_3.4H_2O$) and pine extract are added. The thick sea-mud is well mixed and warmed by steam or on the top of a stove, not on a fire, and stirred with a wooden spoon. Wooden vessels as most convenient are used for the applications of sea-mud to the hand, elbow, foot, and knee. In the packs the sea-mud is laid directly on the skin; in the compresses it is first wrapped up in thin muslin. The bed or couch can be protected by an oil-cloth, on which a rug is laid, then the waterproof, then a piece of linen and finally the sea-mud, in which the affected part of the body is thoroughly immersed and wrapped up. When the treatment is finished, the mud is removed from the body.

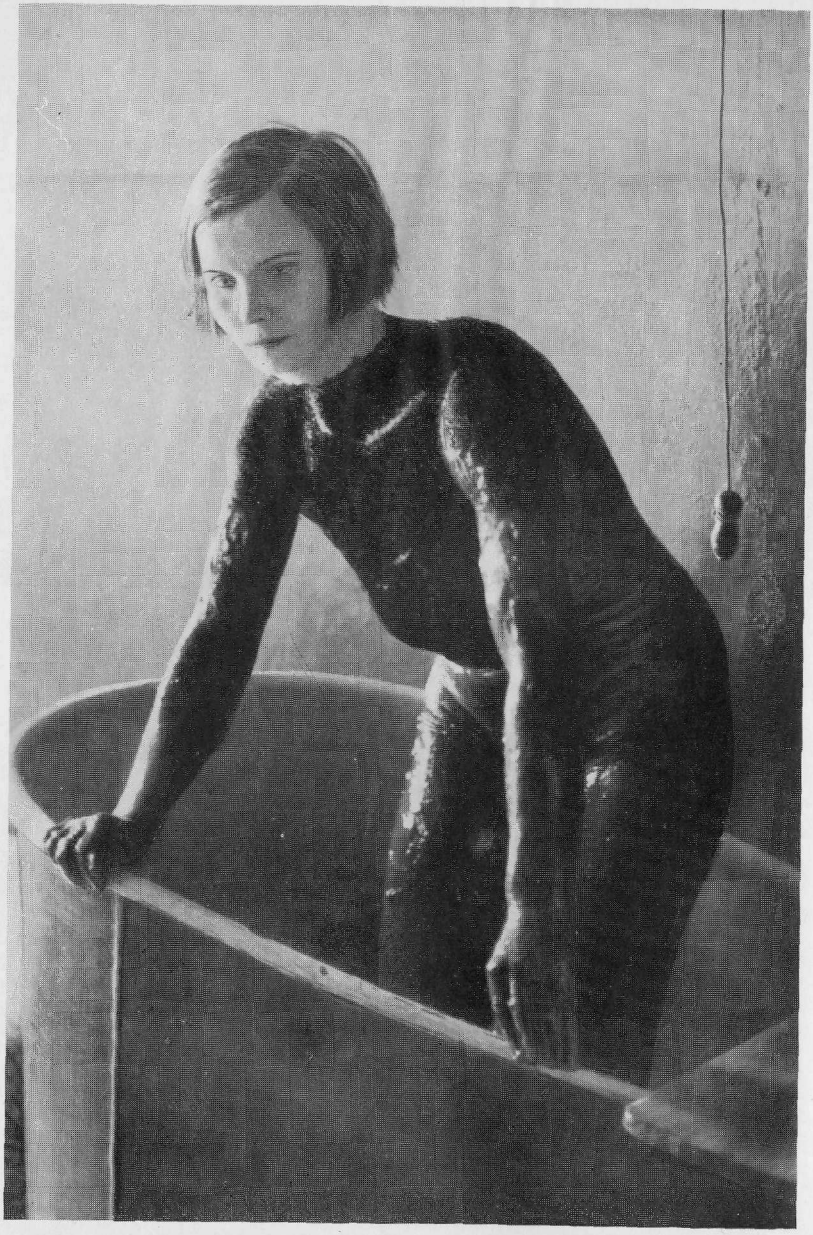
The treatment is guided not only by the character of the disease itself and by the intensity of the local lesions, but also by the reactivity of the patient, by his endurance and the state of his internal organs.

When reactions of a serious nature and unpleasant

PÄRNU: THE REST-ROOM OF THE BATHING ESTABLISHMENT.

PÄRNU: A MUD-BATH ROOM IN THE BATHING ESTABLISHMENT.





PÄRNU: A PATIENT EMERGING FROM THE MUD BATH.

general disturbances such as depression, loss of appetite, insomnia, elevation of body temperature, as well as local symptoms (increase of pain, swelling, redness, heat, etc.) appear, they must be allowed to subside by giving the body rest and extending the intervals between the baths. As is known, excessive irritants produce extreme fatigue, weakness, and exhaustion of the organism, and the disease may grow worse, where an improvement or complete healing might have been achieved if a well-judged method of treatment had been used.

Special attention should be paid to nervous patients with unduly excitable hearts, a labile vascular system, anaemia, and lassitude, and to the convalescent. In these cases mild sea-mud baths are given, preferably combined with local applications of mud packs which do not produce a sudden general reaction.

It is worth noting that in recent years our medical practice favours partial baths and local applications of mud, instead of baths of concentrated mud at high temperature (Falk et al.) which often produced injurious and damaging bath reactions. It has been found [1] that mud baths of lower temperature (38—41° C.) and concentration show a better therapeutic effect than drastic treatment. In cases of allergic conditions cooling mud baths, in which the temperature gradually falls to 33° C., have proved of considerable value. It seems reasonable, however, not to go too far with the

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[1] Marshalkovitz, Odes. med. Zeitschr. No 3, 1928; Arronet, H., Eesti Arst, p. 214, 1922.

dilutions of the sea-mud used for the baths, because the colloidal properties of the mixture containing less than 40 per cent. sea-mud undergo profound changes, and the rate of sedimentation is rapidly increased. It is evident that the addition of insignificant quantities of sea-mud to the water changes but little the physical and therapeutic properties of the water bath, and such a muddy mixture can hardly be called a sea-mud bath.

In cases of localized processes the patients generally receive local applications of hot mud at 40—52° C. to the affected part for 20—30 minutes, which produce an increased local hyperaemia. Separate regions of the body can stand much longer treatment at greater degrees of warmth, without any damaging irritation of the skin, than the whole body when whole baths are given. High temperatures and prolonged local application of the sea-mud are readily tolerated by the patients, and the local and general reactions are mild or absent. Whole sea-mud baths are often combined with suitable local applications. The patient lies in a sea-mud bath of temperate heat, and a compress of hot mud, up to 52—55° C., is applied to the affected part. When it is injudicious to apply an intensive sea-mud bath (local tuberculosis, general weakness, etc.), the whole bath of a moderate temperature (36—40° C.) is used, and mud of a higher heat (42—45° C.) is added at the foot end. If the consistence of the natural sea-mud is too low, special mud-sacks, mud-compresses, or mud-pants are used for local applications.

According to Reichart [1], the reputation of a health resort is founded upon the special methods of treatment employed and the traditional experience of the place at least as much as upon the qualities of the mud. However, the nature of the cure, the temperature, duration and reactions of all the mud applications should be carefully adapted to each individual case. The beginning of a treatment with sea-mud at the proper time is of great importance, otherwise there is danger of aggravating the disease. In acute cases with fever or any sign of local inflammation it is expedient to wait until the acute stage is over and not to commence the treatment too soon. On the other hand, it should be noted that the difficulty of curing a disease tends to increase with lapse of time and with the chronicity of pathological processes. The more chronic an ailment, the more difficult it generally is to cure. Thus, for instance, cases of inflammation and its results such as exudates, adhesions, compact mass of liquid and cellular elements and cicatrized tissue cannot be easily cured by sea-mud applications if the proper time of treatment has been neglected. The pressure of the contracting tissue on the sensitive nerves causes a continual pain which counteracts all kinds of treatment.

It may be noted here that the cure in Estonian mud-bath establishments differs in some respects from practices followed elsewhere. The term fixed for a sea-mud cure is variable, but it generally lasts from

[1] Reichart, A., Arch. of Medic. Hydrology, IV, 3, p. 179, 1926.

4 to 6 weeks and comprises about 20—30 mud baths. As to the concentration of the mud mass, strong (80—100 per cent. of sea-mud), medium (60—80 per cent.) and diluted (30—60 per cent.) baths are prescribed. If necessary, 3 to 4 preparatory or introductory water or diluted mud baths with rising temperature (35° C., 36° C., 37° C., 38° C.) and sometimes with rising mud concentrations are given. The sea-mud baths are repeated for 15—30 minutes daily, at 38—42° C., if an energetic cure is required. A milder cure comprises from 3 to 5 baths weekly, followed by a rest. After the mud bath the patient gets a cleansing bath with sea water and then retires to a rest-room to lie down well covered for 1—2 hours. In order to increase the effect of the bath, the patient is sometimes wrapped up in warm woollen coverings immediately after the mud bath and is then made to lie down and drink hot weak tea. After 1—2 hours of copious sweating the patient is gradually uncovered and then changes his linen. Sometimes 3—5 terminal water baths with declining temperatures (37°—36°—35°—34° C.) are given, which conclude the cure. In appropriate cases open-air baths in the sea are practised at the end of the treatment (Russow, Alver, etc.).

The loss of weight during the sea-mud cure observed in 51—54 per cent. of cases (Teas) may reach 1,5—2,0 kgs., which obviously depends upon the perspiration, increased diuresis and increased metabolism. On the contrary Alver [1] reports an increase of weight

[1] Alver, H., Eesti Arst, Supplem., 1936.

in 50 per cent. of cases. Exposure to cold should be carefully avoided during the sea-mud cure. Conveyed home from the establishment, the patient retires to bed for 1—2 hours until the body temperature slowly returns to normal. On leaving the spa the patient should be advised not to return to his usual work immediately after the cure, to save his strength and give himself time for the recovery, to avoid everything detrimental to his health, to lead a regular life and to give up alcohol and tobacco.

If competently administered, the sea-mud treatment is usually tolerated very well. Through controlling the reaction produced by the thermal baths it is possible to prevent all deleterious action. According to Reichart [1], in cases of heart weakness the simultaneous energetic cooling of the cardiac region (heart cooling) often brings down the frequency of the pulse by 20—25 beats per minute. An excessively increased flow of blood to the head and the congestion of meninges sometimes accompanied by headache and giddiness may be forestalled by means of a cold wet compress applied to the head.

In suitable cases the mud therapy is combined with the specific and non-specific protein therapy, organotherapy, physiotherapy and pharmacotherapy. Some authors [2] recommend local electro-mud-baths,

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[1] Reichart (Pistany), Arch. of Medic. Hydrology, V, 2, p. 250, 1927.

[2] Tsitovitš, B., Arch. of Medic. Hydrology, IX, 3, p. 479, 1931.

where the local mud bath is combined with the galvanic current, others [1] combine mud baths with diathermy.

The principal indications of the Estonian curative sea-mud were established by the experience acquired during hundreds of years in the past. The best results registered till now have been obtained in the treatment of the group of troubles generally referred to as rheumatic diseases, which are classed among the worst social evils in many countries [2]. The health statistics of the United Kingdom, the Netherlands, Germany, Denmark and many other countries supply us with striking facts which clearly emphasize the importance of the part played by rheumatism in the production of disability or infirmity among the population.

Most authors agree that rheumatism is the symptom of a general failure of vitality affecting the whole constitution of the body and thus calling for adequate methods of general treatment, to which the mud-cure belongs. The sympathetic nervous system (S. N. S.) plays a very important part in the constitution, and recent studies demonstrate a connection between the S. N. S. and rheumatism on the one hand, the effects of balneological treatment on the other. According to Trauner [3], 78% of all the rheumatic cases showed

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[1] Hollmann, W., Eesti Arst, Supplem,, p. 27, 1934; Schotter, A., Eesti Arst, 5, 1933.

[2] Martinson, H., Eesti Arst, Supplem,, p. 11, 1934.

[3] Trauner, Arch. of Medic. Hydrology, XVI, 3, p. 67, 1938.

lability of the S. N. S., viz. 93% in inflammatory and 63% in degenerative forms. During the thermal cure crisis the tonus of the S. N. S. was reduced, whilst the sedimentation rate of the erythrocytes (S. R.) rose. At the end of the cure there was a tendency towards normalization in 82% of the patients with labile S. N. S. Chronic rheumatic trouble is usually attributed to different toxins which may originate from various foci: teeth, tonsils, intestines, gynaecological diseases, gonococcal urethritis and others (Sir William Willcox [1]). As predisposing factors, the following are generally considered: sex, age, race, heredity, trauma, cold and damp dwellings.

In the first place it is necessary to remove all infected foci and then to start with the sea-mud treatment, including mud baths, packs and accessory treatment such as massage, etc. In cases of chronic rheumatic diseases the duration of the cure should be relatively long (4—8 weeks) and ought to be repeated after 6—8 months. Protein therapy and chemotherapy are generally applied during the intervals between the courses, but not during the thermal mud treatment (L. de Pap).

The principal rheumatic disturbances in which sea-mud baths are indicated belong to the diseases of the motor organs, joints, ligaments, muscles, and nerves. Acute and chronic cases of rheumatic joints must be very clearly distinguished. When there are signs of

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[1] Sir William Willcox, Arch. of Medic. Hydrology, IV, 3, p. 182, 1926.

sub-febrile body temperature or some of the joints are distinctly warm, the disease should be regarded as subacute; here particular caution is necessary, because an over-energetic treatment with hot mud baths may cause an excessive and injurious reaction. In these cases the mud treatment begins with moderate temperatures (38—38.5° C.) for 15 to 20 minutes, slowly increasing the intensity of the cure. If the local condition gets worse, rest and intervals of two or more days between the mud baths are indicated. The cure of chronic articular diseases without visible modifications of the joint generally begins with mild, almost indifferent baths and is finished up with more or less energetic baths. Strong mud baths, which are supported well by young subjects with a healthy heart and normal blood vessels, are suitable in cases of chronic joint diseases accompanied by visible functional disturbances and inconsiderable objective modifications of the joint. Massage and gymnastics are generally prescribed in those cases as accessory treatment. In grave cases of chronic joint diseases, however, with important anatomic lesions and functional disorders such as thickening of the joint capsule, exudation in the articulation, limited movement, incomplete anchylosis and contracture, an intensive mud cure is prescribed, and different accessory measures such as intensive thermal irritation, massage, gymnastics, and physiotherapy are applied. Disorders of the motor system caused by infections and toxins, or associated with morbid alterations of metabolism and internal secretion, are also successfully treated with thermal mud baths and packs.

Trousseau and Garrods are the first to have noticed the frequency of arthritis in middle-aged women, especially at the climacteric period, and to have regarded it as endocrine arthropathy. Fox (1895) described these joint diseases and called them the "climacteric arthritis". Later on many authorities (Munk, Umber, Weil, etc.) reported different forms of arthritis induced by the disturbances of ovarian and endocrine functions. It is not, however, held that these disturbances are the primary cause; they rather bring to the front latent tendencies, or speed up an existing joint disease. The experience in the practice of thermal baths supports the view of the connection between ovarian function and arthritis.

According to Neuwirth and Weiss [1], arthritic cases for which local mud packs are usually applied show better results if the pelvic region is also treated, even when there is no evidence of trouble in the pelvic organs. The application of mud packs (at 46—52° C.) now used by them for all women patients extends from the umbilicus to nearly the middle of the thigh for 20—30 minutes, and is followed by a tub bath at 30° C. After the pack, the patient is wrapped up in waterproof and blankets for 30 minutes and then retires to bed. The authors suggest that the action of the mud packs is probably complex; the whole organism is affected by the absorption of proteins (shock), which stimulate endocrine activity. The best results

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[1] Neuwirth and Weiss (Bad Pistany), Arch. of Medic. Hydrology, XI, 3, p. 196, 1933.

were generally obtained when ovarian functions had not ceased yet.

The Estonian sea-mud cure is known to produce remarkable results in gynaecological disturbances, both chronic and inflammatory, such as perimetritis, parametritis, perioophoritis, salpyngo-oophoritis, sterility, chronic exudates of the pelvis, endometritis, vaginitis, amenorrhoea and dismenorrhoea, especially of young girls, excepting diseases which are accompanied by bleeding [1]. In subacute cases caution is necessary, but in chronic cases very intensive thermal mud treatment may be administered. Sea-mud application shows beneficial results especially in different gynaecological disturbances following gonorrhoea; very extensive exudates often entirely disappear. Long intervals of rest between the baths are necessary in cases where any exacerbations accompanied by an increase of pain and temperature occur. New applications are possible only after all symptoms of exacerbation have disappeared. At some spas [2] vulvo-vaginitis, cervicitis, vaginismus and other superficial inflammatory processes are successfully treated with intravaginal mud tampons, at 55° C. in case of chronic diseases, and at lower temperatures in case of acute and subacute processes. Better results were, however,

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[1] Miländer, J., Eesti Arst, p. 169—172, 1925; Mieržejevski, W. and G., Putevoditel na grjazi i morskija kupanja v Arensburge, Warsaw, 1912.

[2] Solonowitsch, Z. für Gynek. und Geburtshilfe, No 2—3, 1935.

obtained by the combined treatment with general mud baths and tampons.

Sea-mud baths and packs are of particular value in the treatment of different conditions resulting from t r a u m a, and many surgical affections, such as stiffening of the joints resulting from fracture and dislocation of bones, proliferation of callus, periostitis, lacerations, bruises, sprains, and different troublesome sequelae, especially intraperitoneal adhesions [1] occurring after a surgical operation or disease (appendicitis etc.). The solution of the adhesions as well as resorption of the exudates can often be brought about by properly applied sea-mud treatment. Of course, the mud-bath treatment must not be used while febrile temperature and signs of acute irritation are observed.

Patients with various d i s t u r b a n c e s o f m e t a b o l i c o r i g i n or uncertain etiology, such as acute and chronic gout with nodosity and other affections, lymphatic diathesis, rickets, deforming arthritis, anchylosing spondylitis and neurogenous arthropathies, are often relieved of pains and troubles by treatment with sea-mud.

There are many forms of s u r g i c a l t u b e r c u l o s i s in which treatment with sea-mud baths is beneficial, as, for instance, tuberculosis of the joints and periosteum, tuberculosis of the lymphatic glands and bones with slowly suppurating abscesses and fistulous passages. In all these cases treatment must be very carefully proceeded with: the fistula must be

[1] K o r c h o v, J., Vestnik chirurgii, 1935.

covered with gauze, all signs of reaction (increase of pain, redness, higher temperature, falling of the general health) must be carefully observed and a rest of several days given to the patient if there appear signs of excessive reaction. In the application of mud the chief object should be to effect an increase of the blood and lymph circulation without causing too sudden a reabsorption of the tuberculous products from the diseased foci. The treatment must be regularly controlled by the sedimentation test. The thermal treatment of tuberculous processes often induces an improvement of enormous infiltration and decreases the swelling in the joints, but there are, of course, refractory cases, which it would be better to leave alone if the results are unfavourable after several applications of mud.

Unnaturally d i l a t e d v e i n s (varices), caused by enforced standing as well as repeated pregnancy. and eventually i n f l a m e d b l o o d v e s s e l s (phlebitis, periphlebitis, thrombosis) may be effectively treated with sea-mud applications. The absorbing power of the hot sea-mud brings about an objective and subjective improvement.

The mud cure in the Estonian mud-bath establishments, as well as abroad, has proved very beneficial in various primary and secondary chronic diseases affecting the p e r i p h e r a l n e r v o u s s y s t e m, as, for instance, neuralgia, neuritis (sciatica), peripheral paralysis, spasmophilia, hypertonia, neuritis, and paralysis following chronic poisoning with mercury,

arsenic and lead [1]. In some cases of hemiplegia, residues of encephalitis, chronic myelitis and poliomyelitis accompanied by pain, the thermal mud cure, as well as hydrotherapy, often relieves the pain and sometimes improves the mobility. According to Schmidt and Weiss, in cases of hemiplegia treatment with mud applications may be commenced after three months have elapsed. It is to be noted, however, that the treatment of different organic diseases of the central nervous system with sea-mud applications is very limited. In cases of syphilitic affections of the central nervous system, the results hitherto obtained have proved more or less disappointing.

Many chronic skin diseases, such as pruritus, prurigo, psoriasis, various forms of eczema, lichen acuminatus, strophulus infantum, etc., may be successfully treated with sea-mud application [2]. Chronic cutaneous disorders require a treatment with medium temperature for a very long period (Fraile, Paldrock, Schmidt and Weiss, etc.). Some patients with intractable prurigo have experienced a powerfully tranquillizing and sedative effect. It seems possible that the sea-mud is characterized by a kerato-plastic action.

Congestion of the liver and chronic inflammations of the gall-bladder and biliary passages can sometimes be eased by sea-mud cure. In cases of obstructions of the liver it is some-

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[1] Rives, J., Eesti Arst, Supplem., p. 20, 1934; Falk, A., Eesti Arst, p. 235, 1922.

[2] Paldrock, A., Eesti Arst, p. 172, 1925.

times possible to reduce the swelling before irreparable degeneration has taken place. In these cases a local treatment or a combined method of baths and packs is to be preferred.

Many patients, particularly those of the male sex, who frequent the Estonian mud-bath establishments for different kinds of infirmities are afflicted with arterial hypertension as an accessory disease. As previously pointed out, arterial blood-pressure is generally lowered during the course of the mud baths. According to Reichart, the lowering is gradual, often with oscillations, the minimum being reached in the middle of the mud course; it rises again towards the end, but never attains the initial height. In no cases was the lowering of blood-pressure a sign of circulatory insufficiency. Hypertonic patients, particularly plethoric persons, feel exceedingly well in hot mud baths, if supplied with cold compresses to the head. The presumptive danger which threatens hypertonic patients during the course is apoplexy. No patient affected by arterial hypertension should start with hot applications; always moderate temperatures should be indicated, because at the moment of putting on a pack of hot mud, or plunging into a hot mud bath, there is the danger of a strong thermic excitement of the sensory nerves, which may induce a reflex elevation of blood-pressure. It is recommended to rub the skin gently with a small quantity of cool mud before plunging into the bath of hot mud and proceed to a higher temperature when the patient gets accustomed to the thermic irritation and the blood-pressure is already

lowered. It seems that there is some danger of heart failure, but hardly any of apoplexy. In cases of hypertension the heart must be very carefully examined during the mud applications; energetic cooling of the cardiac region is necessary and sometimes heart-tonics are prescribed.

In localized diseases preference should be given to localized applications of the hot mud, focussing all effects directly upon the centre of the disease. Whole baths may be given now and again to aid the partial baths and local packs. Local applications of natural sea-mud are indicated [1]: 1) in conditions resulting from mechanical trauma where the application of hot mud (42—50° C. for 1—2 hours) may be started from the first in order to stimulate the absorption of exudates; 2) in cases of chronic articular rheumatism, starting the course with 42° C. for about 30 minutes, increasing the temperature every third or fourth day by 1—2° and 5—10 minutes up to 48—50° C. for 1—1½ hours; 3) in cases of arthritis connected with gonorrhoea; 4) in cases of painful fatigue and weakness of certain groups of muscles caused by over-exertion; 5) in defects of circulation produced by obliterating endarteritis; 6) in cases of muscular rheumatism (lumbago etc.) which requires the highest degree of warmth, in order to cause a greater influx of blood; 7) diseases of the liver and biliary passages; 8) in gouty, rheumatic and other toxic cases of the

[1] Schmidt, L. and Weiss, E., Arch. of Med. Hydrology, No. 3, p. 89, 1923; Falk, A., Eesti Arst, p. 235, 1922 etc.

eye and ear; 9) in cases of infiltration of the back of the head and the neck; 10) in some cases of gastric ulcer where the application of hot sea-mud to the gastric region stimulates the gastric function and decreases the gastric acidity (Leube, Peserico, Pinali, etc.).

Sea-mud baths and energetic local applications of hot sea-mud are c o n t r a i n d i c a t e d in all cases of acute feverish and infective processes, active pulmonary tuberculosis, purulent pleuritis, early syphilis, pregnancy (following the sixth month), fibroma of the uterus with a tendency to haemorrhage, malignant tumours, marasmus, diabetes, parenchymatous and interstitial nephritis, amyloid degeneration, cerebral and medullar lesions, advanced hysteria and neurasthenia, epilepsy, anaemia, aortic and arterial aneurism, arteriosclerosis, non-compensated organic diseases of the heart, grave cardiopathy and Basedow's disease.

It is very difficult to compare the beneficial results of the thermal mud cure obtained at different spas, because the selection of patients admitted to treatment with mud and the appreciation of improvement depend upon the individual judgment of the respective physicians. It has been stated that on the average over 80 per cent. of the cases treated with liman muds at Odessa have shown more or less favourable results (Alexandrov). The marine mud or *Schlick* of Wilhelmshaven used by Schultze-Heubach [1] produced very satisfactory

[1] S c h u l t z e - H e u b a c h, Der Balneologe, I, 4, 1934, and II, 2, 1935.

results in chronic arthritis with 79% complete cures, acute rheumatism of the muscles, and acute sciatica — 90% complete cures, chronic sciatica — 83%, acute myalgias — 100%, chronic myalgias — 77%, and gynaecological diseases a variable percentage of complete cures. Although the Estonian mud-bath establishments have not yet elaborated the statistics of recovery for a sufficiently long period and on the basis of exact investigations of the different diseases, it seems, nevertheless, from the data hitherto obtained, that about 80 per cent. of the cases with rheumatic diseases treated in all Estonian mud-bath establishments have given complete cures or very satisfactory results. In gynaecological diseases 22 per cent, complete cures have been effected, and 78 per cent, more or less favourable results obtained (Miländer). According to Alver [1], about 85 per cent, of all cases treated at Haapsalu have given complete cures or variable degrees of improvement; in 15 per cent of cases the results of the treatment proved negative.

From the above-mentioned observations we may draw the conclusion that among the considerable varieties of curative muds to be found on the surface of the globe there are obviously some that are characterized by a pronounced therapeutic action. The curative effect of the mud depends not only on its composition and physical properties, but also to a great extent on the methods of application. In a mud-bath establishment as well as in every hospital it is

[1] Alver, H., Eesti Arst, p. 168, 1925.

necessary to observe, and to observe according to Bordeu who says: "Il serait à souhaiter que tous ceux qui prennent à tâche de vanter un remède distinguent toujours avec soin ce qu'ils ont observé de ce qu'ils croient possible."

CHAPTER VII

POTENTIAL SCOPE OF FURTHER SCIENTIFIC STUDIES

The modern period of balneotherapy is characterized by the painstaking efforts of the spa physicians to analyze and explain the empirically established action of curative muds in a scientific manner. It is obvious that researches made at the spa bath establishments can only be taken seriously and will lead to progress if they are carried out on a strictly scientific basis. Care must be exercised therefore to avoid all preconceived notions and prejudiced attitudes which may eventually be turned to account in advertising campaigns playing off one spa against another.

Real progress in pelotherapy can be made and valuable practical results obtained only through close co-operation between different branches of science. Discoveries made in chemistry and physics during recent decades as well as the steadily improving co-operation between physicians, chemists and physicists have opened up many new important fields to medical investigators at spa bath establishments. Thus, the development of scientific balneotherapy has been given a considerable impetus by the dicovery of ionization or dissociation of substances (Arrhénius), of

radioactivity (Curie) and of surface tension (Raoult), and it is probable that the near future will see many further advances in this direction.

The facts about the remarkable effects produced by infinitesimal quantities of different substances (Gautier) as well as the discovery of rare metals (lithium, rubium, caesium, etc.) by means of the spectroscope and the methods of physical chemistry have supplied balneotherapy with ample opportunity for interesting investigations of the effects produced by substances which are present in curative waters and muds in extremely diluted concentrations. It has come to be recognized of late years that the kind and the energy of action of metals depend to a great extent upon the conditions and the form (colloidal or in solution) in which they are acting. Interchanges of electrolytes between the organism and curative sea-mud would produce various modifications of the biological properties of living cells, proteins and lipoids. Thus it is necessary to consider the possibility that treatment with curative sea-muds may have to be directed not only towards the cure of various chronic diseases often accompanied by humoral disturbances, but to a great extent to serve the purposes of prophylaxis.

The discovery of rare gases, such as argon, neon, krypton, xenon and helium (Sir Wm. Ramsay), and the fact of their occurrence in conjunction with radioactive emanations in the springs of curative waters (Moreu and Lepape) urge the question whether these gases might be carriers of a specific therapeutic action.

Various studies made of late years (Linke [1], Piéry and Milhaud [2], etc.) have shown that it is of great importance and practical value to health resorts to study their climatic conditions from the biological and therapeutic point of view. The spa physicians should take into consideration the joint therapeutic effects of certain combinations of meteorological factors. Through close co-operation between physicians and meteorologists a new and important science — medical meteorology, climatology or b i o c l i m a t o l o g y — has been originated, which is concerned with the action of weather and climate on organic life. As is known, the therapeutic effects of climate depend to a great extent upon various factors, such as atmospheric pressure, temperature, humidity, wind, atmospheric electricity, ionization, and radioactivity. The fundamental task of the spa physicians is to discover what climatic elements or which of their combinations exert the most favourable influence on the individual patient treated in a spa establishment. The practical inferences drawn from such observations will make it possible to differentiate between the spas according to each individual case requiring treatment with sea-mud.

The journey of an invalid to a health resort nearly always involves a change of climate. Corresponding investigations at spa establishments as well as treatment of various diseases with artificial (i. e., artificially modified) climate, practised in recent years (1932 and 1933) in America and the Netherlands,

[1] L i n k e, F., Arch. of Med. Hydrology, XV, 4, p. 292, 1937.
[2] P i é r y, M., and M i l h a u d, M., ibid. p. 297.

have shown that a change of climate is beneficial to many diseases. On the other hand, a favourable climate not only makes for the cure of a given disease, but also strengthens the powers of resistance and serves the purposes of prophylaxis.

Bioclimatic studies should be made at every spa because nowadays the climatic factors are held in much higher esteem than they were a few years ago. In addition to the external application of the sea-mud, the action of the air (climate elements) and the soil (radioactivity, humidity and soil gases) can have a considerable share in the success of the sea-mud treatment at bath establishments. Realizing this, The Committee for Bioclimatology [1] of The International Society of Medical Hydrology proposes that at all the more important spas a bioclimatic observatory ought to be set up to collect the relevant local data. It is desirable that the various countries should carry out their observations according to uniform methods as suggested by the Committee and arrange their results in a comparable manner. The necessary information concerning the instruments for bioclimatic observations, the staffing and the expenses of an observation station is given in the report of the Committee.

The physicians of the sea-mud establishments should never lose sight of the fact that the regulation of the diet must go hand in hand with the sea-mud applications as is customary in hospital treatment. It

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[1] Climatic Research at the Health Resort: Importance and Possibilities, Arch. of Medic. Hydrology, XVI, 4, p. 70, 1938.

seems that too great a liberality in diet prevails at many spa establishments nowadays, and sometimes even the fundamental principles of dietetics are violated. According to modern dietetics, the food should be chosen not only for each particular disease but also for each individual patient. A routine diet, however, should not be allowed. It is, of course, necessary that the spa physicians should indicate special diets for different diseases, as, for example, the gouty diet, the rheumatic diet, the rachitic diet, or that for diseases accompanied by disturbances of metabolism, but even in these cases individualization is sometimes of great value.

The success of sea-mud treatment depends to a great extent upon the patient's digestion. It is often difficult to secure recovery in a rheumatic patient who suffers from persistent digestive troubles. It is remarkable how rapidly sometimes the appetite and digestion improve with treatment in bath establishments if the patients themselves exactly follow the advice given by an experienced spa physician.

The treatment at the sea-mud bath establishments should be supplemented by sufficient sound sleep which plays an important part in the physical and intellectual regeneration of the patient. Sleep is no longer regarded as a passive phase of life originated by physical and chemical modifications of the central nervous system [1]. It is an active phase of personal life which ushers in the physical and mental activity of the following state of vigilance. It is necessary, therefore, to bear in mind

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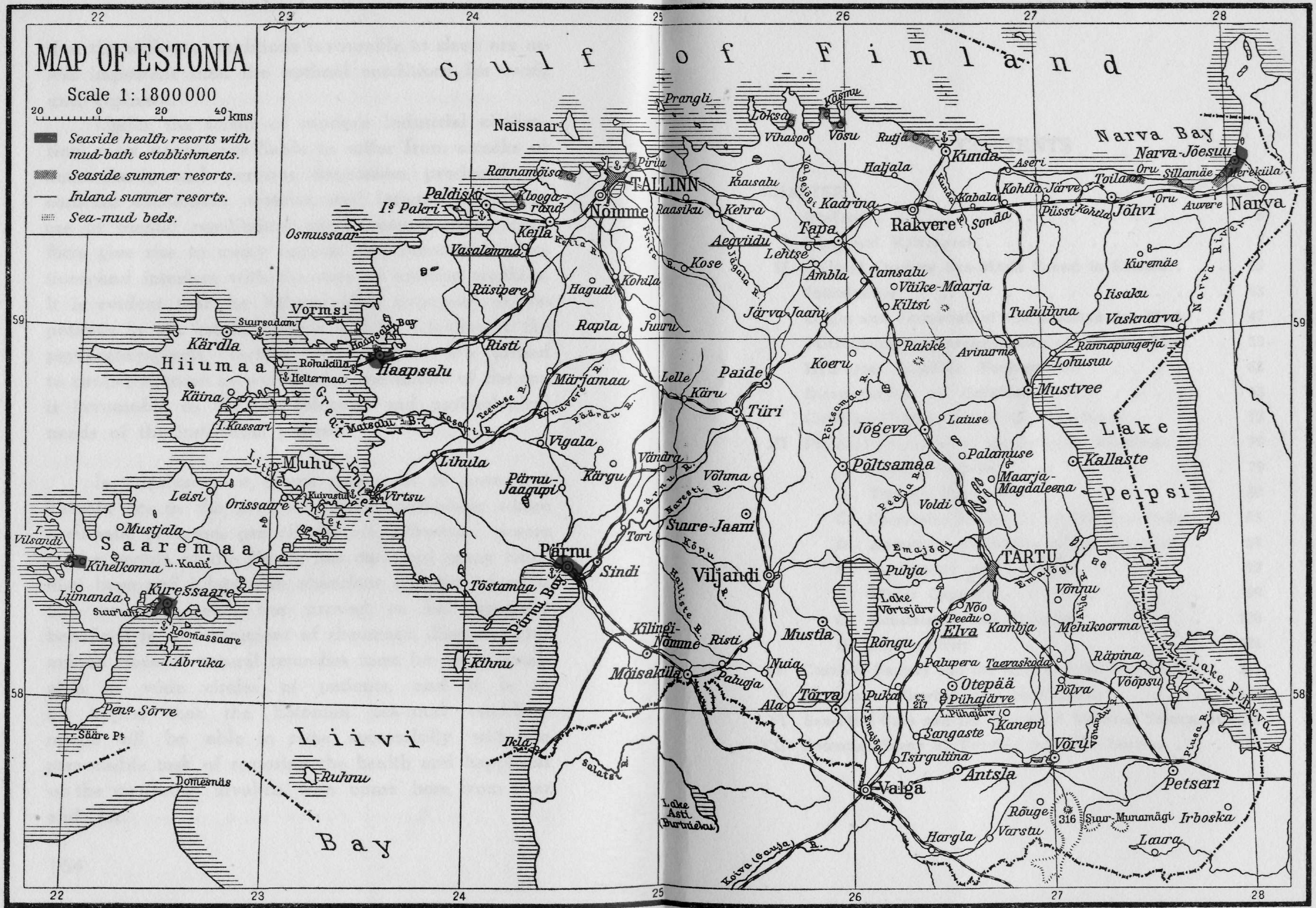
[1] Missenard, A., L'homme et le climat. Paris, 1937.

that the ambient conditions favourable to sleep are no less important than the optimal conditions for work and vigilance.

Under the strain of modern industrial civilization, most people are liable to suffer from attacks of neurasthenia and nervous depression produced by constant excitement, worries, and fatigue. Disturbances of mental equilibrium and incessant minor conflicts give rise to many organic and functional affections and interfere with the cure of existing troubles. It is evident that the balneological treatment of the patients in spa establishments will be effective if the psychotherapeutic factors of the cure are turned to proper account as well, and if the milieu of the spa is favourable to the physiological and psychological needs of the individual patient.

In conclusion, it seems important to note that Estonia lies in the zone of Nordic pathology where rheumatic processes prevail. Nature, otherwise severe to the people of the North, has endowed many Estonian bays and inlets with abundant deposits of curative sea-mud, which has proved to be especially beneficial in the treatment of rheumatic diseases. This unique store of natural remedies must be made available to wide circles of patients, and it is to be hoped that the Estonian sea-mud establishments will be able to cope successfully with the responsible task of restoring the health and happiness of the numerous invalids who come here from near and far.


MAP OF ESTONIA
Scale 1:1800000
20 0 20 40 kms
Seaside health resorts with mud-bath establishments.
Seaside summer resorts.
Inland summer resorts.
Sea-mud beds.
Gulf of Finland
Narva Bay
Liivi Bay
Lake Peipsi
Lake Pihkva
Lake Võrtsjärv
Hiiumaa
Saaremaa
Muhu
Vormsi
Naissaar
Prangli
Osmussaar
Ruhnu
Kihnu
I. Vilsandi
I. Abruka
I. Kassari
L. Kaali
Is Pakri
Pena Sõrve
Sääre Pt
Domesnäs
Tallinn
Nõmme
Paldiski
Keila
Haapsalu
Kärdla
Käina
Kuressaare
Kihelkonna
Mustjala
Leisi
Orissaare
Kuivastu
Virtsu
Lihula
Pärnu
Sindi
Pärnu Bay
Tõstamaa
Vigala
Märjamaa
Rapla
Risti
Kohila
Hagudi
Juuru
Kose
Aegviidu
Tapa
Rakvere
Kunda
Võsu
Käsmu
Lõksa
Haljala
Kadrina
Aseri
Kohtla-Järve
Jõhvi
Toila
Oru
Sillamäe
Narva-Jõesuu
Merekülla
Narva
Auvere
Kuremäe
Iisaku
Vasknarva
Tudulinna
Avinurme
Mustvee
Kallaste
Paide
Türi
Lelle
Käru
Järva-Jaani
Ambla
Tamsalu
Väike-Maarja
Rakke
Koeru
Jõgeva
Põltsamaa
Laiuse
Palamuse
Maarja-Magdaleena
Voldi
Tartu
Emajõgi
Nõo
Elva
Kambja
Võnnu
Mehikoorma
Räpina
Võõpsu
Põlva
Otepää
Pühajärve
Kanepi
Võru
Antsla
Valga
Petseri
Irboska
Rõuge
Varstu
Hargla
Suur-Munamägi
Viljandi
Suure-Jaani
Võhma
Vändra
Pärnu-Jaagupi
Kilingi-Nõmme
Mõisaküla
Abja-Paluoja
Tõrva
Mustla
Rõngu
Puhja
Ikla
Tori
Kärgu
Rannamõisa
Klooga-rand
Vasalemma
Risipere
Suursadam
Rohuküla
Heltermaa
Roomassaare
Lümanda
Koiva (Gauja) R.
Narva River
Lake Asti (Burtnieks)

CONTENTS

KARL SCHLOSSMANN

CURATIVE SEA-MUDS

tries. It is natural that the Estonian sea-mud establishments should play an increasingly important part in combating the troubles and disabilities produced by rheumatic processes among the populations of these countries.

The purpose of the book is to present a comprehensive survey of recent studies relating to curative sea-muds and to give the reader a general idea of the prevailing practices of sea-mud treatment in Estonian seaside health resorts. The value of the book is enhanced by a number of experimental studies contributed by the author and his colleagues.