

The Healing Sea: A Sustainable Coastal Ocean Resource: Thalassotherapy

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ABSTRACT

CHARLIER, R.H. and CHAINEUX, M.-C.P., 2009. The healing sea: a sustainable coastal ocean resource: Thalassotherapy. *Journal of Coastal Research*, 25(4), 838–856. West Palm Beach (Florida), ISSN 0749-0208.



Thalassotherapy is perhaps less an alternative medicine than a treatment for specific ailments. It has witnessed ups and downs. A centuries-old, if not millennia-old, approach, it has gained many adepts in the medical profession and left many a patient delighted with its results. Thalassotherapy has many aspects in common with thermalism that, similarly, gained its *lettres de noblesse* over the centuries. This paper examines the roles that thalassotherapy has played and currently plays and surveys the European centers that have gained a solid reputation for thalassotherapy. It concomitantly considers its parallel therapy—thermalism—and takes a look at other related alternative or complementary treatments. The economic impact of thalassotherapy and its related activities has increased.

ADDITIONAL INDEX WORDS: *Acupuncture, algae, economics, muds, thermalism.*

O mer, toi que je sens frémir
A travers la nuit creuse
Comme le sein d'une amoureuse
Qui ne peut dormir
Paul-Jean Toulet
"Les Contrerimes"

INTRODUCTION

The Geneva, Switzerland, based World Health Organization (*Organisation Mondiale de la Santé*) handled, in its yearly assembly, the matter of so-called traditional medicines. It is true that Western societies, occasionally disappointed by modern medicine, or looking askance at the chemicals in pharmaceutical products, have shown an increasing interest in what are commonly called traditional medicines: acupuncture, homeopathy, Hindu medicine, Chinese medicine. Many native societies never abandoned the ancestral practices; in developing countries 80% of the population turn to them. Furthermore, stated Jonathan Quick, WHO's director of the Department of Essential Medications, "they exist, they are used, and, quite often, they fall within the reach of far more people." He added to the traditional medicines hypnosis, relaxation techniques such as *yoga* and *tai chi*, and drugs extracted from minerals, plants, and animals. It is important that consumers and practitioners use these approaches properly and that their costs remain affordable.

WHO estimates that such methods and products have proved their efficiency when appropriately used. The organization aims at regulating them and at encouraging national evaluation schemes.

Concern for the regulation of the use of, and therapies dealing with, mineral waters, and seawaters goes as far back, in France for instance, as even Louis XIV. Henri Bessé de La Chapelle, addressing the barely 20-year-old French Academy of Sciences in the name of Louis' Minister of State Michel-François Le Tellier, marquess of Louvois (1683–1691), who headed the Academy, admonished that body to study mineral waters and desalinate seawater (on January 30, 1686). From 1823 through 1889, a compulsory inspection by water physician inspectors was in force to police mineral waters. Declared of public utility in 1856 by Royal Decree, mineral waters perimeters were delimited. It took another 100 years for a republican decree to outline the rules for the waters surveillance (1960), though decrees taken by the *Etat Français*—also known as *Gouvernement de Vichy*—in 1942 dealt also in part with thermal waters. The French Imperial Academy of Medicine, at its meeting of February 5, 1856—as reported in its *Procès-Verbal de Séance*—had praised the virtues of treatment based on mineral waters and, subsidiarily, seawaters.

In the framework of a sustainable littoral environment use, coupled with responsible ecotourism, this paper attempts an assessment of the development of thalassotherapy centers. Indeed, medical results claims are increasingly made, and the last decade witnessed the inclusion of thermal, climatic, and thalassotherapeutic medicine in the curricula of some colleges of medicine in European universities, paired with their recognition as a specialization. The conclusions reached herein are based upon visits to centers; participation in programs in France, Germany, Czech Republic, Belgium, Romania, Bulgaria, Japan, and New Zealand; and the perusal of conference proceedings, pertinent professional literature—exclusive of pamphlets and publicity releases—and reports from national health schemes.

Table 1. *Healing from the sea, alternative/complementary therapies.*

Range of therapies
Rheumatism, arthrosis, respiratory ailments, dermatology (psoriasis)
neurology, nervitis, osteoporitis
Thalassotherapy, balneotherapy, and thermalism
Historical background
Greeks, Romans, Gauls, English, French, Scandinavians, Japanese
Medical quality of cures
Academic recognition and acceptance
Internal use of seawater, sea salts, aerosols, baths
Marine muds: Germany, Belgium, France, Romania
Use of algae in thalassotherapy
Mud packs
Cosmetology, pharmacology, food, feed

These official reports and follow-up studies of patients' cohorts, conducted by the Faculty of Medicine of the University of Nancy (France), provided data whose synthesis—based on payments made by the French national health scheme to insureds—showed a lowering of pharmaceutical consumption (thus expenditures for the scheme and for the patients), fewer hospitalizations of patients treated and a decline in ailment recurrence (well-being of patients) when compared with patients who had not followed such therapy.

An Environmental Type of Therapy

Alternative, or parallel, medicine has steadily gained adepts, and its merits have been discussed in conferences held at traditional colleges of medicine. Osteopathy (from the Greek *ὀστέον*, bone; osteopathy is a medical approach based on the manipulation of bones, muscles and nerve centers), chiropractic (from the Greek *χίρo*, hand; chiropractics is a medical approach based on the manipulation of the spine), naturopathy (naturopathy is a drugless medical approach using remedies believed to help nature overcome illnesses), naprapathy (naprapathy is a medical approach based on massages), acupuncture (from Latin *aculeus*, needle; acupuncture is a medical approach based on placing needles on the body on force lines), Chinese traditional medicine, thermalism (from the Greek *θερμος*, heat or warmth; thermalism is a medical approach using thermal [mineral] waters), thalassotherapy (from the Greek *θαλασσα*, sea, and *θηραπεία*, treatment; thalassotherapy is a medical approach based on the systematic use of seawater, sea products, shore climate), aromatherapy (from the Greek *θηραπεία*, perfume; aromatherapy is a medical approach based on use of odors exhaled, particularly by plants), crenotherapy (from the Greek *κρήνη*, source; crenotherapy is a medical approach based on spring waters on the site of the spring itself), balneotherapy (from the Latin *balneum*, bath; balneotherapy is a medical approach based upon the taking of baths), and others have entered the common vocabulary for some time, some celebrating their one hundredth anniversary on the scene (Table 1). The latter two make use of ocean algae in packs, powders, and other forms. Of these thalassotherapy and thermalism have been used for thousands of years and gained access to hospitals, private practitioners' offices, and the hallowed halls of some universities' faculties of medicine, such as the Univer-

sity of Nancy (France) and others (San Martin Bacaicoa, 1995).

Relevant publications air the view that there is far from agreement on the effectiveness, appropriateness, and success of these therapies. However, in view of results claimed by many venues, and backed up by economic studies, it becomes increasingly difficult not to give some credence to the approaches. For one, and based upon five personal direct tests, thalassotherapy and thermalism are beneficial. Whether we are faced by an alternative treatment or a complementary one is far from settled.

Many treatments have received the thalassotherapy label; all do not deserve it. Because of its recent success, the term has been usurped to indicate so-called "spa" treatments. It would be best to limit its use to seaside treatments calling upon climate factors, seawater bathing, impact of waves, marine (e.g., algal) products poultices, seawater medication; the approach is very similar to thermalism, but is geared to the role of the sea and seawater.

Thalassotherapeutics and thermalism (*θερμος*, heat, warmth) got a boost in the nineteenth century with tourism's emergence. The enthusiasm displayed by prestigious visitors to thermal health centers made it possible for cure stations to associate cultural, leisure, and often gambling activities with a treatment program. Napoleon III and his empress Eugénie contributed much, unwittingly, to the new fashion. Cure translates best, in this instance, as treatment. A curist is thus someone following a treatment, usually at a thermal or thalassotherapy/thermal center; by extension it has also been used for a prolonged stay at a climatic resort. A journey to a cure station was one to improve or restore one's health, the avowed aim, and one of tourism and discovery, the hidden aim. Nowadays curist and tourist are commonly both one and the same person.

According to a yarn spun in the nineteenth century, the use of seawater for medical purposes would be due to the Egyptians who observed a constipated ibis using his long beak, loaded with seawater, as a clyster! No lesser writer than Pliny the Elder (23–79) (Breton, 1968; Pliny, 1966) is supposed to have reported the tale.

Both the treatment and the desire to know a region and its cultural traits motivate the visitor. The search for better-being simultaneously with well-being points to a trend to link the medical quality of cures to the tourists' and curists' quality of life. An effort is also directed toward children who may find relief, cure, or improvement of ailments related to breathing, skin problems, and developmental troubles, such as enuresis, growth, and fracture healing. *Mens sana in corpore sano*—a healthy mind in a healthy body, viz., the body will heal better with the mind kept away from the problem—tourism may in some cases become a component of the curative process.

The tourist, increasingly in search of a "return to the sources" and pure clean water, commonly equated with health and well-being (*bien-être*) shows a growing interest in water centers. Seawater therapeutics along the Black Sea coast mainly in Bulgaria, Romania, Russia, and Ukraine have been developed for more than 100 years and the success, in France for instance, of thalassotherapy centers has been heralded by

economists, and tourism officials, but also by many a health practitioner.

If seaside sanatoria remained part of respiratory and pulmonary therapies, seawater therapy was practically abandoned after World War I. It has witnessed both a *risurgimento* and an *aggiornamento*, regained popularity, and attained medical acceptance.

Rebirth

Thalassotherapy, and also thermalism, are thus not new to the panoply of medical approaches. What is new is the updating of the facilities and the introduction of new technological advances. Balneotherapy and exposure to coastal climate have been essentially readaptive and convalescence treatments, but the constantly growing segment of younger and middle aged people seek an effective approach to reshaping, a *remise en forme*, encompassing not only physical reshaping but also a health restorative process (Anonymous, 1989). This requires (besides better trained support personnel) research, retooling, refurbishing, and a fresh outlook on approach and problem solving. Centers endeavor to determine the effects of thalassotherapy cures and even export their therapeutic mud (Italy provides mud to Bourbonne-les-Bains, France and Israel's Dead Sea mud is used in Plombières-les-Bains, France).

If France is the birthplace of modern thalassotherapy, the approach and procedures spread wide beyond its borders, and centers operate in Egypt, Morocco, Tunisia, Spain, Portugal, Italy, Greece, Crete, the Canaries, the Balears, Romania, Bulgaria, Ukraine, Russia, Albania, Turkey, Poland, Jordan, Malaysia, Thailand, and Japan. In fact, the development of thalassotherapy predates its blossoming in France by several centuries: severe burns, wounds, and female genital diseases were treated using seawater by the Egyptians during far-removed classical times; and evidence exists that Herodotus (484–425 BC), Euripides (480–406 BC), and Hippocrates (460–377 BC) praised and recommended its use.

Seawater bathing, whether in the actual sea or in bathing tubs, had become fashionable in England during the 19th century. Physicians recommend the practice for depressed patients, nervous diseases, asthma, and pulmonary illnesses. Treatments in tubs on wheels placed under tents were subsequently designed in France, along the water's edge in Granville and Royan. By 1820 warm baths were introduced and medical marine hydrotherapy gained *droit de cité*. The beach contraptions disappeared, and actual care centers opened their doors in Dieppe (1822), linked by ferry service to England; La Rochelle; and Cherbourg. And in 1865 the term thalassotherapy was coined by professor Joseph de la Bonnardièrre at the College of Medicine of the University of Montpellier.

The *Revue de biologie (de France)* published a paper in 1894 by René Quinton, in which the author disclosed his theory that since seawater is the first medium in which a living cell appeared, a biological identity exists between seawater and human plasma. To prove his thesis he conducted an experiment at the prestigious Collège de France that would cause animal defenders to raise more than an eyebrow, even if the outcome was positive. He drained the blood from a live dog

Table 2. Procedures and methods of thalassotherapy and of concurrent or parallel care.

Care and Procedures	Concurrent
Aerosols	Lymphatic draining
Algotherapy	Pressotherapy
Algal balneotherapy	Cryotherapy
Bubbling baths	Electrotherapy
Multijet hydromassage	Osteopathy
Thalaxion bathtub	Feet bottom reflexology
Phlebologic bath	Sauna
Marine mud	Hammam
Marine pellets	Tao
Affusion showers	Impedancemetry
Submarine showers	Fasciathrapy
Jet showers	Sophrology
Hydrojet	Do-in
Scottish showers	Qi gong
Wrapping	Tai-chi-chuang
Massages	Yoga
Thai	Endermology
Californian	Cellu M6 Treatment
Aromatic	
Ayurvedic	
Shiatsu	
Reiki	
Amma	
Energetic modeling	
Hot stones modeling	
Reeducation	
Aquagym	

just short of cardiac arrest and then replaced it with an equal amount of seawater. Not only did the dog survive, its blood regained its normal composition and its organic terrain improved.

Quinton's book *L'eau de mer, milieu organique* became the *vademecum* of thalassotherapy, buttressed by the work of Dr. Louis Bagot, who created a center at Roscoff (Brittany). With the 20th century comes the first Rockroum marine medical center, with moving in water as guiding principle. Publicity for kine-balneotherapy (from the Greek *κινειν*, to move) came from a car accident of a champion bicycle racer—Louis Bobet. He was saved by Dr. Bagot and, in 1964, opened the first modern thalassotherapy center at Quiberon (Brittany). Although it was beneficial in bringing this therapy to the attention of the public at large, it carried a damaging impact for the reputation of medical and thermal cures. In the 1980s the term and concepts were misused and some institutes imported seawater, sea mud, and algae at distances far from the ocean, contrary to true therapy, which must be practiced at the shore, preferably in facilities not farther away from the water's edge than a good 100 m. Close to 50 procedures are part of thalassotherapy (Table 2).

Origins

The origins of thermal baths and related treatments can be traced back to remote antiquity. Romans were firm believers in the virtues of thermalism and thalassotherapy. Regulations pertaining to the practice and the facilities have gradually been promulgated to guarantee hygiene and stem quackery. France passed a Royal Ordinance on policing min-

eral waters (*Ordonnance royale sur la police des eaux minérales*) in 1823 that carried a compulsory inspection by water physicians inspectors; these inspections were abolished in 1889. In 1856 a decree was passed declaring mineral waters in France of public utility, and a protection perimeter was delimited. *Procès-verbal de l'Académie Impériale* 1856 (Range, cited in Larivière, 1958). A subsequent decree, more than 100 years later (1960), outlined the rules for water surveillance. French writer Guy de Maupassant (1850–1896) published his pieces on Mont Oriol—near Riom—and Enval-les-Bains in 1887 and “*Sur l’eau*,” in 1888 (Various Bulletins, Bundesarbeitsgemeinschaft für Rehabilitation, 1999; Bundesministerium für Gesundheit und Umweltschutz, 1985; Deutscher Bäderverband e.V. und Deutscher Fremdenverkehrsverband e.V., 1987; Hüfner, 1994).

It is seldom mentioned that Paris used to be a thermalism center. Springs are common in the Ile-de-France region. In Auteuil, famed for horse racing, springs provided treatment to curists, but the facilities were closed when the metro was extended to Passy. The Quartier Combat was approved for the quality of its waters in 1853. Also part of the history of thermalism in the Paris surroundings and Sunday excursion destinations were Belleville, Montmartre, Termes, Batignolles, and La Villette which developed in the 19th century and was closed in the 20th. The existence of the *thermae* of Paris is evidenced by the street names close to their former sites, such as rue de la Source (Spring Street), rue de la Cure (Cure Street), rue des Eaux (Waters Street).

In 1919, France passed a law classifying climate stations (*stations climatiques*), thermalism centers and setting forth tourism in general. Health tourism was on the books. Three years later a professional organization grouped operators in a Federation of Thermalism and Climatism (from the Latin *clima*, derived from the Greek κλίειν, slant, tilt) and a Union of Federations of Initiative Syndicates. Next, on April 3, 1942, World War II notwithstanding, a decree of the Vichy government (*Etat Français-Décret*) added winter sports and Alpinism, and shore stations (*stations balnéaires*) to the thermal stations roster. Vichy, a world-renowned spa in central France, was where the government of France had taken refuge after the May 1940 military debacle. Finally in 1957 another decree set rules and standards for mineral waters. European Union directives are in the making and will buttress weaker national legislations.

Other countries, for instance Germany and Austria, similarly passed legislation and have professional organizations dealing with thalassotherapy and thermalism.

The concern and interest for mineral and seawaters has never been limited to a single area; a cursory look at toponymy in various languages yields a lengthy list of places mentioning springs, baths, and the like: Aachen, Agua, Aqua, Acqui, Aix, Ax, Bad, Bains, Bani, Banya, Bath, Termi, and so on (Falkenbach, 2001). Bath, in Cornwales, praised by doctors Russell (Russell, 1720) and Turner in the 18th century, was rather promptly followed by Brighton (1750), Hastings, Yarmouth, Turnbridge, Wells, and Epsom (which gained fame with its salts). Relevant literature is prolific, with, e.g., essays, as the *Discourse on Baths and Hot Waters . . .*, but many monographs, particularly in the 19th century, fre-

quently authored by physicians, were biased toward self interest and included exaggerated claims on the beneficial use of the waters (François, 1999).

The success of thermal and thalassotherapy centers spurred the opening of such stations throughout Europe: inland for instance at Albano Terme (Italy), Baden-Baden (Germany), Bad Nauheim (Germany), Karlsbad (Karlovy Vary) (Czech Republic), Lomberg (Germany), Luchon (France), Mondorf (Luxembourg), Montecatini (Italy), Oradea (Romania), Salsomaggiore (Italy), Spa (Belgium), and Vichy (France), with some of these tracing their origin to earlier, even remote, times, and on the sea shores in Scandinavia on the Baltic Sea (between 1810 and 1860) and Travemünde near Lübeck (Germany) (1802). There were 20 stations in Pomerania (formerly part of Sweden, then Germany, now Poland) where the first opened in 1820. Thereafter the fashion spread to the North Sea shores and the English Channel: Bremerhaven (Germany), Scheveningen (Netherlands), Ostend, Knokke (Belgium), Zuydcoote, Malo-les-Bains, Wimereux, Dieppe, Trouville, Etretat (a favorite subject of the impressionist painters), Berck (praised for the treatment of osteotuberculosis), Fécamp (all in France), etc. Further to the south, fame came to Biarritz (France), San Sebastian (Donastio) (Spain), Estoril, and Cascais (both in Portugal).

Although far less familiar to West European potential patrons, medicinal mud is also exploited in the Ukraine (Black Sea shores) and Albania (Adriatic Sea). Several limans in these countries are similarly hypersaline lakes paralleling the coast such as on the Kerch Peninsula, entrance (Kerch Strait) to the Azov Sea, where the Kachik, Opukskiy, Tobechik, and Uzunlar limans are hyperhalitic environments. On the Albanian coast several hypersaline lagoons, e.g., Patku, Velipoje, and Karavastase, likewise provide mud that is used for medical purposes. A liman is similar to a haff, an embayment common to the Baltic Sea, but differs in that it is a coastal lake of erosive origin, a recipient of waters, while lagoons and rias have a tectonic origin (Zenkovich, 1950).

The resorts are larger in Albania where their development was not due exclusively to medical reasons (mud, mineral waters) as was the case on the Kerch Peninsula. In some Ukrainian limans mud reserves exceed 14 million metric tons; in the Kujalnik liman, reputed for the highest mud quality, bottom muds represent 24 million metric tons spread over 53.5 million km². The medicinal characteristics of the natural mineral waters found around near-shore lakes in Ukraine and Albania are mainly chloridosodic. However, the implanting of anthropogenic structures changed, in some sites, the liman's barrier entraining a thorough modification of the bottom relief. The link established with the sea influenced hydrochemical and geochemical regimens and increased the degree of pollution destroying the medically valuable mud layers (Malyi Adjalik Liman, Ukraine).

WHAT IS A SPA?

There is actually only one Spa, a thermal water center in the Ardennes region of Belgium. The town, which has remote origins and mineral water use that goes back several centuries, was described in the early 18th century (Eyre, 1733) and

engravings even predate the 18th century. Perhaps the most ferruginous spring of all Europe is located near the town. It is said to have been visited by tsar Peter the Great (1642–1725), and it is indeed named after him (Figures 1 and 2).

Crowned heads, famous people, and well-to-do bourgeoisie patronized the waters. A history of the development of the thermal station was published in the 19th century (Le Drou, 1737; Wolf, 1829), while closer to us its medical properties received academic medicine's attention (Crismer, 1983; Florin, 1954; Juchmes, Lagneaux, and Lecomte, 1980; Lecomte, Colinet-Lagneaux, and Lecomte, 1976). If the word Spa has been much maligned, thalassotherapy has been equally abused. A thermal station in landlocked Austria in the middle of the Alps advertised such cures without even being aware of the origin of the mud it uses and certainly lacking seawaters as much as Valkenburg, in the Netherlands' province of Limburg, where a thalassotherapy cure was the prize of a publicity gimmick organized by the very respectable Kraft company. Obviously spa and thalassotherapy have an undeniable appeal and exert a commercial pull. The designation spa has unfortunately gained lately a "sulfurous" reputation in several countries as it has become a euphemism for a type of massage salons where other than therapeutic treatments are dispensed.

Competitive, Concurrent, or Concomitant?

Thermalism, thalassotherapy, and aromatherapy claim scientifically proved curative effects. An abundant literature has been published, but it is often strongly publicity geared. Several treatises were written long ago (Eyre, 1733; Jacob, 1570; Le Drou, 1737; Russell, 1720; Wolf, 1829). Boulangé, of the University of Nancy, and others, like Colin and Constant, recently made important contributions to the field (Boulangé, 1995a, 1995b, 1997; Boulangé, Collin, and Irlinger, 1989; Hérisson, 1989; Jacob, 1570; Lance, 1988; Larivière, 1958; Russell, 1720; Valnet, 1995).

Both thermalism and thalassotherapy use waters, mud, and thermal gasses; thalassotherapy is alone in using algae, seawater, and only the aeration thereof. Techniques, however, appear to be quite similar. They associated occasionally, such as at the *Thermalies* of the 17th *Salon de la Santé* at Versailles in March 1999, a congress paired with MEDEC (*Salon de la Médecine*). Aromatherapy, gaining its niche in the panoply of alternative medicines, uses a variety of oils, extracted from plants; such treatments are not yet eligible for benefits from the social security system in France, though they are included in "putting back into shape" care in some centers (e.g., Thonon-les-Bains) (Lance, 1988). Except for Belgium, medical practitioners prescribed thermal and thalassotherapy cures are reimbursable medical expenses in most countries of the European Union and elsewhere.

Aromatherapy has gained a solid foothold in Great Britain, where 29 centers offer such treatment. In the United States aromatherapy rides a wave of interest in California; in Chicago some 20 spas offer the therapy to patients. A series of U.S. television programs (ABC network, May 2001) presented, commented, and praised the approach. The therapy is concomitantly offered in some thermal and thalassotherapy

centers. If statistics provided by the trade periodical *Spa Magazine* are accurate, there would be more than 1600 facilities for spa treatments in the United States and 35% of the country's population visits a spa each year. A high number, since besides fees that are mostly not modest, tipping a clinician runs \$10 to \$15 or 15% of the cost of the treatment, making it a not commonly affordable expense. Tipping is unthinkable in European centers where clinicians consider themselves health professionals. Some centers in the United States use Dead Sea salts, others marine algal products. It should be stressed at this point that, particularly in the United States, the notion of spa is rather vague, often implying massage, swimming, or merely exercising on/with a variety of machines.

From the more than 100 thermal cure centers of France, over 50 are thalassotherapy centers (Figure 3). Germany places a solid second for numbers (Figure 4). Others are located in Denmark, the Netherlands, and Belgium. Belgium and Luxembourg have famed thermal centers (Spa, Mondorf-les-Bains), and it is the city and thermal care center of Spa that gave its name to the cure centers worldwide. The practice of "taking the waters," far less common in the United States, rather faded away during the period in between World Wars, though Saratoga Spa is still on the map. Thermal centers are numerous in Japan—Hakone, for instance, at the foot of Mount Fuji—in New Zealand at Rotorua, itself reminiscent with its warm open-air pools of Iceland's Reykjavik (Blue Lagoon). It is in Plattsburgh, a Ukrainian thermal center, that Gorbachev became a protégé of Andropov, one of the last leaders of the USSR, who was a frequent visitor there to treat his ailments.

Historical Perspective

On the Mediterranean Sea, Balaruc-les-bains has no less than four thalassotherapy/thermal establishments: two public and two private. Romans were there in the third century BC. The concern for and interest in waters was such that the Gallo-Romans named their basilica Sancta-Maria-de-Acquis, a sanctuary recognized by a papal bull of Pope Urban III (1120–1187) in 1187. What became today's Balaruc's Athena and Hesperides thermae are, however, modern installations, since the antique facilities fell derelict. The still existing rather small pavilion was built by a descendant of French epistolarian-author Marie de Rabutin-Chantal, Marchioness of Sévigné (1626–1696), who revived the practice in 1833.

But high in the Central Massif of France, as in the Pyrénées, the waters were also tapped by the Romans, who established a very sophisticated system of aqueducts and the like. They were very careful not to waste the precious resources, as opposed to our contemporaries! In the region of the Gard (Eastern Languedoc) contemporary thermae are the resurrection of Roman stations built around the beginning of the Christian era; the famed Pont du Gard, which crosses the Gard River, an affluent of the Rhone River, is actually not a bridge but a Roman aqueduct that is still erect. In the Pyrénées, e.g., at Montmaurin, Romans built villas as early as 350 BC, and a thermae system was part of the later Gallo-Roman settlement. Roman Emperor Caligula (AD 12–41)

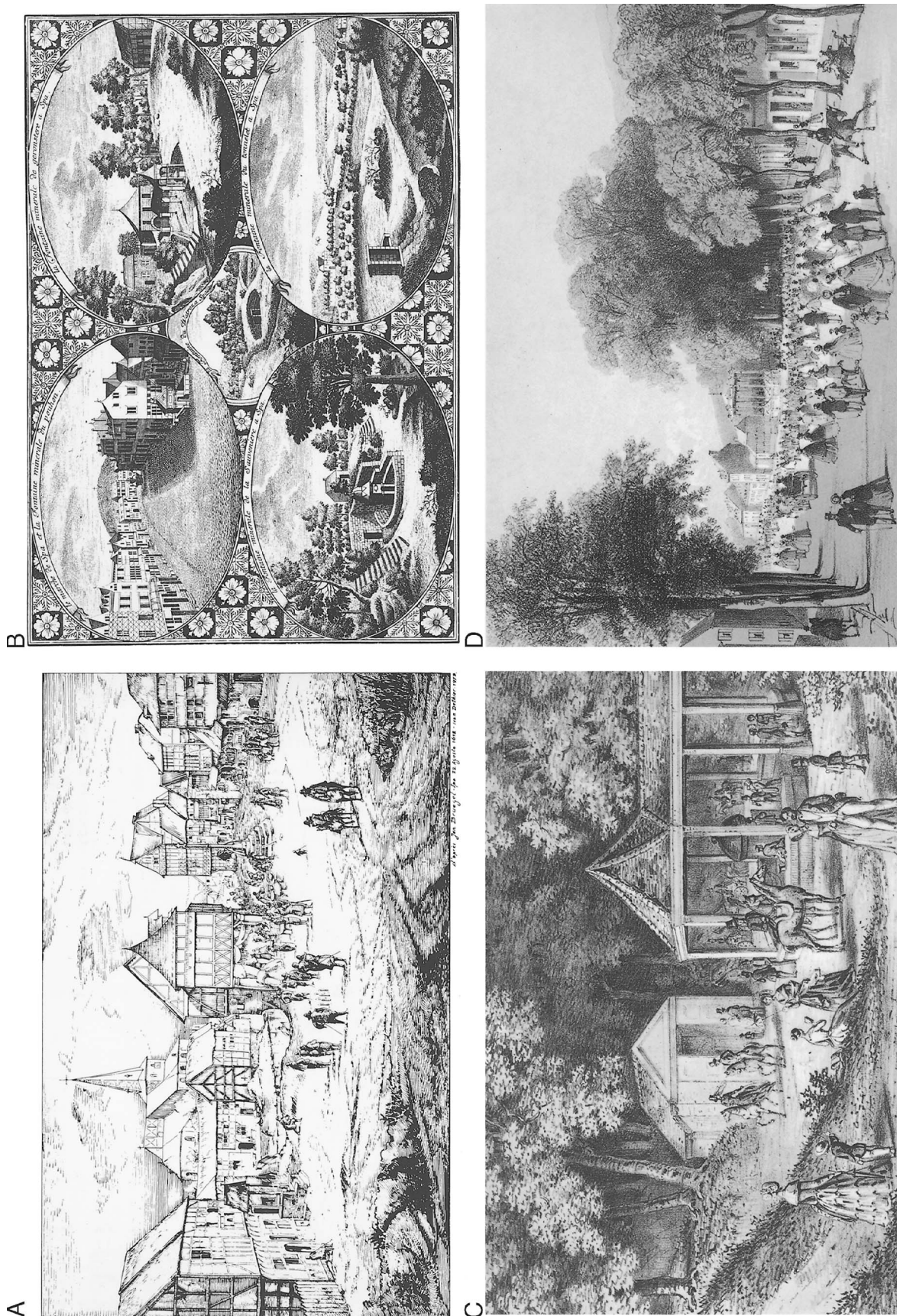


Figure 1. The name of the town of Spa, one of the earliest villes d'eau, viz. "water centers"—visited by numerous crowned heads, became the byword to designate centers of thermalism and thalassotherapy throughout the world. (A) Spa in late medieval times (1612), (B) Spa views in post-medieval times showing the village and springs that were used in the earliest times (1743), (C) spring used by and named after Peter the Great of Russia (1840), (D) early evening stroll in the mid 19th century to and from a major spring (1860).



Figure 2. Post card reproductions of posters published by the two railroads (Belgian State Railroad [link Brussels and Spa], Chemins de Fer du Nord [a French company linking Spa and Paris in a record 7h40min]) that came to Spa. They advertised both health treatments and entertainment (a.o. the Casino). (A) stressed that the waters are ferruginous and that the city is the site of a Royal Residence; (B) advertises an international exhibit of balneology and of “life in thermal resorts” to be held in the Summer of 1907.

sent King Herod (AD first century) and his wife in exile at Comminges; the exiles must not have suffered too harshly from their captivity, since the area reputedly supported 50,000 inhabitants who had a theater, forum, market, temple, and thermae, already then praised for their healing qualities. At Barbazan and Salies-du-Salat, and at Luchon, where Romans lived for six centuries, the old Roman thermae are enjoying a remarkable resurrection. It is at Salies that the most mineralized waters of all Europe were rediscovered in 1850.

Romans tapped thermal waters and built thermae all over Europe (Figures 3, 4, and 5), from Rome's *Baths of Caracalla* to those of Trier (Trêves) (Germany), Lindesina (today's Bourbonne-les-Bains), or Plombières—both in France—predating the year AD 100 (Anonymous, 1997; Boulangé, 1995a, 1995b; Collin, 1997; Guillemin, Constant, and Boulangé, 1994). Roman emperor Augustus—whose statue adorns the center of Plombières—came there, and so did many leading figures of

history, writers, and philosophers, i.e., Diderot (1713–1784), Chateaubriand (1768–1840), and rulers and their relatives Laetitia Bonaparte (Napoleon I's mother), Napoléon III (1808–1872), Louis XV (1715–1774), Wilhelm II (1859–1941), the German Kaiser (WWI). Some contemporary centers were built by the Romans: the Roman baths of Plombières are still in use and remnants of thermal-thalassotherapy thermae are visible in Balaruc-les-Bains (Mediterranean Sea, France). In the latter site all activity ceased before the third century AD, but resumed under the aegis of descendants of French society lady and distinguished author Mme de Sévigné (1626–1696), mentioned earlier, in 1833. Her thermae are still visible in the Pavillon Sévigné, while no less than three extensive up-to-date facilities—Athena, Hespérides and Solehau—make the area the third thermal-thalassotherapeutic center of France.

Buchet, describing medicine and surgery in the first century in Gaul, focuses on the role of thermal waters (Buchet,

1. AIX-EN-PROVENCE
2. AIX-LES-BAINS
3. AIX-LES-BAINS-MARLIOZ
4. ALET-LES-BAINS
5. ALLEVARD-LES-BAINS
6. AMÉLIE-LES-BAINS
7. AMNÉVILLE-LES-THERMES
8. ARGÈS-GAZOST
9. AULUS-LES-BAINS
10. AURENSAN
11. AVÈNE-LES-BAINS
12. AX-LES-THERMES
13. BAGNÈRES-DE-BIGORRE
14. BAGNOLES-DE-L'ORNE
15. BAGNOLES-LES-BAINS
16. BAINS-LES-BAINS
17. BALARUC-LES-BAINS
18. BARBAZAN
19. BARBOTAN-LES-THERMES
20. BARÈGES-SERS-BARZUN
21. BEAUCENS-LES-BAINS
22. BERTHEMONT-LES-BAINS
23. BOULOU (LE)
24. BOURBON-LANCY
25. BOURBON-L'ARCHAMBAULT
26. BOURBONNE-LES-BAINS
27. BOURBOULE (LA)
28. BRIDES-LES-BAINS
29. CAMBO-LES-BAINS
30. CAMOINS-LES-BAINS
31. CAPVERN-LES-BAINS
32. CASTÈRA-VERDUZAN
33. CAUTERETS
34. CHALDETTE (LA)
35. CHALLES-LES-EAUX
37. CHÂTEAUNEUF-LES-BAINS
38. CHÂTEL GUYON
39. CHAUDOS-AIGUES
40. CILAUOS (ÎLE DE LA RÉUNION)
41. CONTREXÉVILLE
42. CRANSAC
43. DAX
44. DIGNE-LES-BAINS
45. DIVONNE-LES-BAINS
46. EAUX-BONNES
47. EAUX-CHAUDES (LES)
48. ENGHEN-LES-BAINS
49. EUGÉNIE-LES-BAINS
50. ÉVAUX-LES-BAINS
51. ÉVIAN-LES-BAINS
52. FUMADES-LES-BAINS (LES)
53. GRÈOUX-LES-BAINS
54. GUAGNO-LES-BAINS
55. PIETRAPOLA
56. JONZAC
57. LAMALOU-LES-BAINS
58. LÈCHÈRE-LES-BAINS (LA)
59. LONS-LE-SAUNIER
60. LUCHON
61. LUXEUIL-LES-BAINS
62. LUZ-SAINT-SAUVEUR
64. MOUTG-LES-BAINS
65. MONTRUN-LES-BAINS
66. MONT-DORE (LE)
67. MONTROND-LES-BAINS
68. MORSBRONN-LES-BAINS
69. NÉRIS-LES-BAINS
70. NEYRAC-LES-BAINS
71. NIEDERBRONN-LES-BAINS
73. PLOMBIÈRES-LES-BAINS
74. PRÉCHACQ-LES-BAINS
75. PRESTE (LA) PRAIS-DE-MOLLO
77. RENNES-LES-BAINS
78. ROCHEFORT-SUR-MER
79. ROCHE-POSAY (LA)
80. ROYAT-CHAMALIÈRES
81. SAIL-LES-BAINS
82. SAINT-AMAND-LES-EAUX
83. SAINT-CHRISTAU
84. SAINT-CLAUDE-MATOUBA-PAPAYE
85. SAINT-GÉRAIS-LE-FAYET
86. SAINT-HONORÉ-LES-BAINS
87. SAINT-LARY-SOULAN
88. SAINT-LAURENT-LES-BAINS
89. SAINT-NECTAIRE
90. SAINT-PAUL-LES-DAX
91. SALIES-DE-BÉARN
92. SALIES-DU-SALAT
93. SALINS-LES-BAINS
95. SAUBUSSE-LES-BAINS
96. SAUJON
97. TERCIS-LES-BAINS
98. THONON-LES-BAINS
99. URIAGE-LES-BAINS
100. USSAT-LES-BAINS
101. VALS-LES-BAINS
102. VERNET-LES-BAINS
103. VICHY
104. VITTEL
105. ZIGUARA-BAINS D'URBALACONE

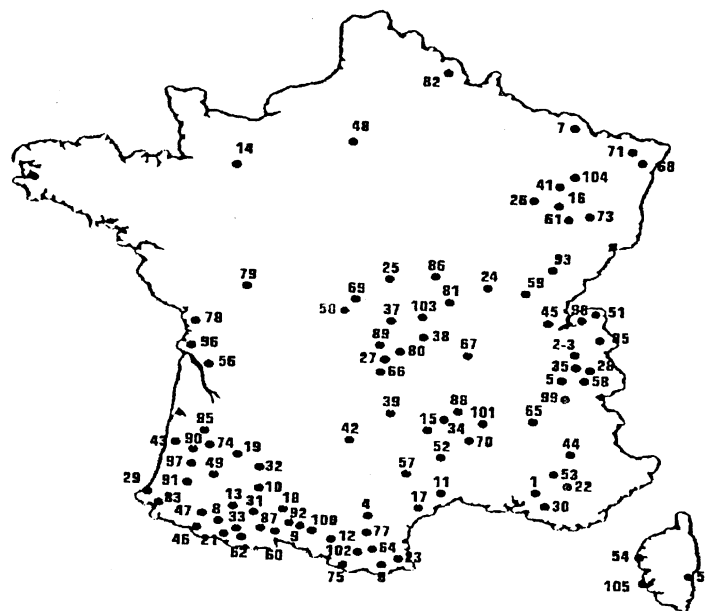


Figure 3. Thermal centres in France, exclusive of Guadelupe and La Réunion.

1985), but use of seawater for therapeutic aims was known in what are contemporary Egypt, France, Italy, and Greece as far back as 3000 BC. Nor was thalassotherapy a stranger in the medical arsenal of classical times. Its knowledge and practice were spread by Celts, Gauls, and especially Romans (Buchet, 1985). Bath, in England (*Aquae Sulis* in Roman times), got its name from the Romans' custom. Greeks put considerable faith in the healing power of the sea. Greek poet Euripides (480–460 BC) wrote "The sea restores man's health." Greek philosopher Plato (428–437) held that "The sea washes all man's ailments." And twenty centuries later French historian Jules Michelet (1798–1874) opined "*La terre vous supplie de vivre; elle vous offre ce qu'elle a de meilleur, la mer, pour vous relever. . .*" Thalassotherapy faded away in the Western world when philosophers embraced Aristotelian logic, which was then nurtured by Galileo (1568–1642) and Descartes (1596–1650), then more recently by Pasteur (1822–1895) and physiologist Claude Bernard (1813–1878). The decline may thus well be due to the adoption by the great minds of the time of stricter scientific viewpoints, and rational reasoning by the Renaissance researchers and thinkers (Boksha,

1982; Boulangé, 1995a, 1995b, 1997; Boulangé, Collin, and Irlinger, 1989; Hérisson, 1989; Lance, 1988; Valnet, 1995).

Springer traces it back in modern times to the Margate Royal Sea-Bathing Hospital, located in famed Blackpool, England, which has its spot in seawater therapy history (Charlier, 1975; Springer, 1935). Russell of England, Barellai of Italy, Pérochaud and, closer to the present, Larivière (1958) of France, and Benecke of Germany are credited as founders of the contemporary seawater therapy, while Boulangé (University of Nancy, France) and his coauthors act as contemporary spokesmen for French thermal therapy. Thalassotherapy no longer limits itself to use of the maritime climate but involves administration of seawater orally and by injection, use of the spray of water, use of the pounding effects of waves, use of heated seawater baths, and use of newer approaches such as combining electroacupuncture and seawater therapy. The 400 seashore sanatoria and preventoria that existed in 1935 along the coasts of Europe have multiplied during the second half of the 20th century but have somewhat lost their public social work *cachet* due in part of the retreat of tuberculosis and the improvements in living

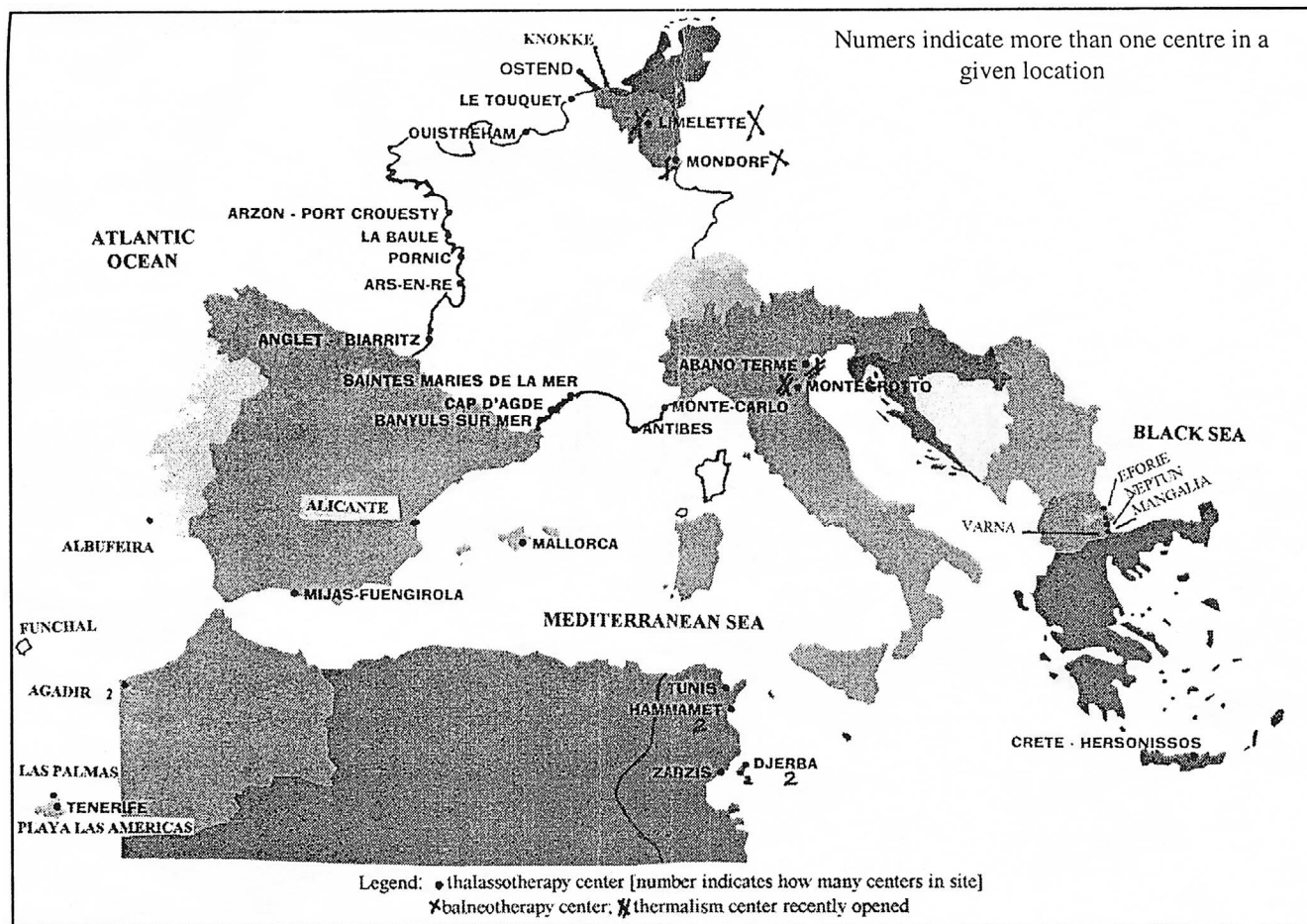


Figure 5. Centres of thalassotherapy in Europe south of the Belgian-French border. For France only a few recently opened or refurbished centres are shown.

bodying aerosol therapy and heliotherapy. For some practitioners, climate remains an important part of a seashore treatment (Woodcock and Blanchard, 1957). The tiny salt particles contained in sea air (aerosols) work their way into the deepest parts of pulmonary alveoles and settle on their walls with a probably not negligible physiological effect (Charlier, 1975; Larivière, 1958; Springer, 1935). The high proportion of ultraviolet seaside sun rays favorably influences calcium metabolism. The natural oligoelements and others such as magnesium, manganese, and cobalt, which buttress the organism's natural defenses, are also absorbed through warm seawater baths. Its biochemical properties make it a successful side-effect free substitute for comfort medications.

Heated seawater causes a dilatation of cutaneous vessels, and under water jet streams have the same beneficial effects as the pounding of the waves against the body and its spraying by sea foam. The initial shock of cold water in swimming pools has been looked at as a potential negative factor, particularly for older persons. However most centers' swimming pools are now adequately heated, and wave machines provide the beneficial pounding.

Physiological effects of marine climates are reflected in a slowing down of the rates of breathing and heartbeat. The amplitude of the respiratory movement and pulmonary ventilation are increased, and so are the hematies in the blood and hemoglobin ratio, while heart contraction is reinforced; the body is thus better prepared for the beneficial impact of seawater baths due to an increase of cutaneous exchanges. Many physicians recognize such additional symptoms as neuroendocrinic and growth stimulation, and an increase of diuresis and of basic metabolism.

Heated seawater baths have been recommended because they stimulate a dilatation of cutaneous vessels: baths at temperatures below 27°C stimulate the individual, between 28°C and 32°C they also have such effect, but never should exceed 38°C, except under medical control. Warm seawater baths bring about a 24% increase of the amount of blood evacuated from the heart to the large vessels, decongest and smoothen articulation, and have been prescribed for the treatment of chronic evolutive polyarthritis.

Showers prior and after baths, overall or localized, exert a dual thermal and mechanical action on vessels and nerve

endings; alternation of short cold and warm water sprays may well have the same tonifying effect as the Finnish sauna. Gynecological irrigations favor seawater's hypertonic action upon mucous tissues and penetrative ability. Nasal irrigations, aerosols, and gargles help with sinus problems and ear, nose, and throat ailments (Schmidt, 1989a, 1989b).

Black Sea centers ring its shores; originally catering especially to their own nationals, they have increasingly drawn foreign visitors. Mangalia, the southernmost resort, has attracted seamen since classical times; it forms with Eforie and Neptun, artificial creations, the Romanian cure complex. Blessed with a balmy climate, the center offers a therapy based on seawater and sapropelic (from the Greek *σαπρος*, rotten) mud use, sulfurous mesothermal springs, mud baths, and application of mud poultices; it acquired some international reputation. The black, pasty sapropelic mud comes from Lake Techirghiol, with a mineralization of 80 g/l. Concentrated mud extracts have been shipped to distant locations. At 150 m from the sea, the beach facilities follow the Egyptian method of open-air treatment. An air rich in iodine, magnesium, bromine, and sodium chloride creates an ambience particularly favorable for aeroionization and insolation.

As in Germany, pelotherapy is also practiced with peat mud found in Lake Mangalia (Romania) (from the Greek *μυρμιδερός*, blackish and *πηλός*, lime, clay). Bicarbonated, hypotonic, mesothermal (26°C), radioactive, sulfurous water sprouts from springs on or near the Mangalia and Neptun beaches. The sapropelic mud rich in carbonaceous or bituminous matter has a plasticity value of 250 g and a thermal metric capacity index of 20.99. It is enhanced by bacteriostatic, bactericidal, and antiallergic qualities due to its high vitamin (C, E, B₂, and B₁₂), nicotonic acid, hormones, and organic content.

The Romanian Mangalia-Neptun-Eforie complex handled as many as 1000 patients a day during the seventies and eighties; the vetust character of the facilities, the lack of funds, and the underpaid personnel have caused a decline in the number of participants in an otherwise imaginative therapy based upon seawater, sapropelic mud, sulfurous mesothermal springs, and a spring/summer balmy climate (Pricajan and Opran, 1970). Treatments have resulted in some remarkable cures of psoriasis, similar to those confirmed in a Dead Sea Israeli center (Schmidt, 1989a, 1989b; Schulze, 1978). Besides use in dermatology, mud poultices have also found their way into osteoarthritis therapy (Zvieven-Paz, 1996). In the latter site a settlement has practically sprung up around and near a thalassotherapy center. Ein Bokek is actually a cluster of hotels, while a small town is located at some distance. Many of the customers are American. The center has acquired renown for the combination heliotherapeutic/thalassotherapeutic treatment of (arthritic) psoriasis. Because of the negative elevation, solar rays are filtered by an extra 300 m of atmosphere, a situation found nowhere else on Earth. Furthermore, seawater here has a salt content ten times higher than normal. Successful cures, remarkable relief, and in general very encouraging results have been regularly reported in the *Journal of the American Academy of Dermatology* (1985) and the *International Journal of Derma-*

tology (1995 and 1997) (Elkayam *et al.*, 1991; Sukenik, 1996; Sukenik, *et al.*, 1990).

Thalassotherapy has been used for some 50 years in German North Sea centers (Pahl and Pürschel, 1973). Thermal-thalassotherapy has also been used in Israeli centers for rheumatic and arthritic ailments (Werner, no date), as well as in Bulgarian facilities (Bojkinoff, 2000). Chronic back pain relief has been attributed to spa treatment (Constant, Collin, and Boulangé, 1995).

Causes of the beneficial effects of the therapy have not been fully elucidated and affirmations that have not been backed up are numerous. As with other alternative therapies, much research needs to be done, and at present empirical observations are common currency. However, the action of temperature, the mechanical action (waves for instance), buoyancy, viscosity, chemical action, and carbon dioxide effects are all potential causes.

Economic Aspects

Besides leading to savings in hospital days and in pharmaceuticals consumption which benefit insurance systems and the individual, and tourism income, thalassotherapy and thermalism are large earners and big employers. Recent figures were made available by French sources; thermal centers in France, in 1998, hosted 548,003 curists representing 9,864,054 visitor days for insured parties and 527,629 days for other curists, for a year's total of 10,391,683. Many did not come by themselves but were accompanied by noncurists, representing an additional 300,000 persons.

A low-priced cure costs an average FRF 1000 (\$143) for a 6-day stay, with a per person FRF 2200 (\$315) expenditure for food and accommodations (thus exclusive of such additional expenses as beverages, entertainment, sundry purchases). United States dollar values given here are those in effect at the time of the introduction of the Euro. At the time of writing, the cost in U.S. dollars was roughly double due to the *de facto* devaluation of the dollar since 2006.

Costs are considerably higher in some luxury resorts. The income for the French centers, besides payment for medical services, exceeds 13,400,000 days × FRF 2200 = FRF 29,480,000,000, or approximately US\$ 4,211,500,000. It is furthermore estimated that the 100-plus thermal centers provide employment to at least 100,000 people.

One hundredth of this is 1000 jobs and an income of US\$ 42,115,000 for a single low-priced center. Thermae income amounts to, using the same formula, FRF 104,000,000 or about US\$ 14,857,000, making them a significant economic player.¹ This should not be interpreted that some 1000 persons are on the payroll in some centers; but there are an estimated 1000 workers in related positions that are employed, ranging from maintenance, catering, laundering, outside nurses, nurses aids, physicians, and kinetherapists to hotel workers.

Revenues may also be generated by pharmaceuticals and cosmetics: the University of California has received in royalties for patented pseudopterosins over US\$ 1,200,000, and the cosmetics firms have collected several millions more. Algae and muds can thus be earners.

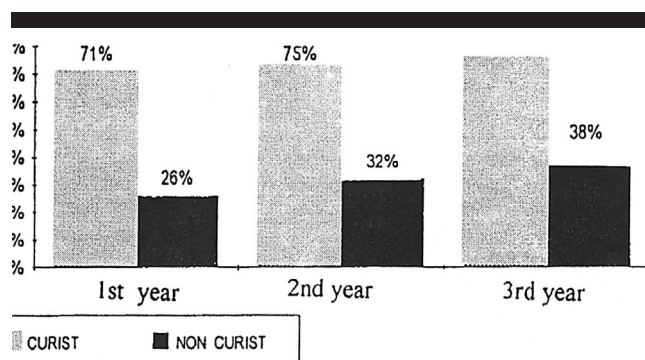


Figure 6. Comparison between patients' health condition (respiratory ailments).

Treatment Centers

Thalassotherapy stations have a long history; the largest number are located in Germany and France. Most of the 22 German stations grew in importance during the last half century as they fast attracted a large clientele. Homeopathy and alternative therapy have a large following in Germany.

The introduction of new technologies such as the combination of electroacupuncture with thalassotherapy won over a new clientele. Thalassotherapy/electrotherapy/acupuncture, brought back from China, rapidly gained *droit de cité* and garnered enthusiasts in French centers. The development of a therapy *de pointe*, free from extravagant claims, in up-to-date facilities can nurture a sustainable and rational growth of resorts.

Is a risk of quackery conceivable with thalassotherapy and its sister cure thermalism? At the onset of the so-called social medicine programs, physicians routinely prescribed a two or three weeks cure. The abuse was particularly notorious in Germany. The gag was that when a beneficiary of such a cure would leave, he or she would be said to have taken his/her paid government-sponsored free vacation. The distress flag was eventually raised and these cures were accused of being quackery. The accusation seems unfair, though the social benefits' abuse was in many cases flagrant. Were the cures actually helping those among the curists who had a real ailment?

Development must be considered on a long-range scale. Comparisons have been made among European centers and a critical analysis of the recent relevant bibliography published (Collin, 1995; Constant, Collin, and Boulangé, 1995; Graber-Duvernay, 1999). It might be well to look at conclusions reached by a neutral party, or, better, a party who must bear the cost of thermal cures and thalassotherapy cures. A study conducted by the French National Health Insurance System (*Caisse Nationale d'Assurance Maladie*) observed a cohort of 3000 persons who took a thermal cure during a span of three years and found a health improvement dealing with various ailments, *e.g.*, rheumatism, back pain, arterial problems, respiratory problems, in two-thirds of the group (Figure 6), and a concomitant decrease in the length and frequency of hospital stays. Furthermore, the use of medicines stopped or was reduced for 72.4% of the patients, while the disburse-

ments of the National Health System for thermal care represent barely 0.22% to 0.43% and cures, stays at thermal centers, represent 0.89% to 1% of the total medical consumption. These observations may be extrapolated to thalassotherapy (Collin, 1995; Constant, Collin, and Boulangé, 1995; Graber-Duvernay, 1999).

Quite similar conclusions were reached apparently in recent German studies on the same topic (Anonymous, 1999a, 1999b; Falkenbach, 2000; Pratzel and Schnitzer, 1992; Rosenkranz, 1997; Sulinek and Schoenfeld, 1996; Tink *et al.*, 2000).

The strictly economic studies are appropriately checked against an unbiased and disinterested academic study (Meggender, 1999; Stoyke, 1997). A thorough scientific project has been conducted by the department of hydrological and climatological medicine of the University of Nancy's medical faculty and results made public in July 1999. Conclusions are positive and doubts as to the value of thermal cures strongly challenged. The *assises* (congress) of thermalism held in Toulouse, France, in May 1999 (whose *Proceedings* were published in June 1999) confirm the medical dimension of thermalism. Positions held since 1996 seem thus appropriate (Anonymous, 1997; Boulangé, 1995a, 1995b; Collin, 1997). Furthermore, statistics show a substantial sustained drop in the frequency of hospital stays of patients having taken a cure, and, as mentioned, in the consumption of medicines by these same patients.

Already in the sixties, the *Bulletin de l'Hôpital de Trouville* had added to the ailments (rheumatism, arthritis, obesity, back pain, *etc.*) (Guillemin, Constant, and Boulangé, 1994) susceptible to be treated by a thalassic therapy lumbago, sciatica, neuralgia, insomnia, palpitation, cellulitis, dyspepsia, and chronic colitis. Effects of thalassotherapeutic treatments were reconfirmed recently in a study of Guillemin *et al.* (Guillemin, Constant, and Boulangé, 1994). Heart diseases and lung conditions have also been listed as showing improvement after thalassotherapeutic treatment (Bogutskiy *et al.*, 1977; Schütze, 1976).

Boulangé's 1989 and 1995 papers examined the scenario, both in the perspective of European unification and of the 21st century, for French thermalism—views which may be extrapolated to thalassotherapy—and predicted a bright future. If imitations are proofs of success, then it must be attained: indeed several spas located at hundreds of kilometers from any sea, as mentioned before, *e.g.*, in the Netherlands (Valkenburg) and in Austria, refer to their program as thalassotherapy, which it is of course not.

A critical review of the literature, up to 1995, has been published by Constant, Collin, and Boulangé (1995). One would be remiss in this study if contributions to climatological medicine were not mentioned; indeed it is, like balneotherapy, strictly a use of the coastal environment (Falkenbach, 2001; Hock, 1995; Jordan, 1996; Leistner, Schultze, and Wyk auf Föhr, 1974; Leupold, 1973; Schmidt 1989a, 1989b). The department of thermal medicine, at Nancy, includes in its designation climatic medicine.

A MEDICAL PANACEA?

There is always the risk, when finding a new medical technique or pharmaceutical, to believe it is a universal panacea,

and, naturally, commercial centers are apt to downplay, or not mention counterindications. There are. The approach is not to be considered for persons allergic to iodine, or suffering from infectious, evolutive, and contagious illnesses, nor is it indicated in cases of oozing dermatitis; the same is true for individuals suffering from incontinence, arterial hypertension, or having had recently an infarct. Also on the list of abstainers are patients with inflammatory rheumatism, certain cardiac problems, decompensated kidney ailments, or suffering from certain hyperthyroid conditions.

Thalassotherapy Pharmacology: An Oceanic Drug Chest

Already during classical times physicians and drug makers looked at the sea as a source of remedies. The ocean's drug chest contains many plants and animals that provide ingredients usable in medical treatments (Gruber, 1968). Fish, oysters, and mussels provide iron in the human diet. Cod liver oil and salmon oil possess important medicinal uses. Numerous other animals, which place lower on the evolutionary ladder, are sources of pharmaceuticals. Didemnins-B, diazomide-A, dolastin-10, and discodermolide are all potential cancer-fighting compounds derived from marine organisms that live within coral reef ecosystems.

The medical and pharmaceutical value of marine products has of course been proved (Charlier, 2002; Gruber, 1968). Marine organisms produce chemical compounds—and over 6000 unique compounds have been isolated with hundreds providing drug leads—with antiviral, antibacterial, and antifungal properties. The bryozoan *Bugula neritina* produces bryostatin-1, a potential anticancer agent, *Pseudopterogorgia elisabethae*, a soft bodied coral known popularly as the Caribbean sea whip, produces anti-inflammatory pseudopterosins (Arehart, 1969). The compounds found in this soft coral accentuate human skin healing processes and are used in skin care products (Bologa *et al.*, 1999; Charlier, 1990; Charlier and Lonhienne, 1996; Woodcock and Blanchard, 1957). French and German pharmaceutical firms market vials of seawater tapped at 50 km offshore depths of up to 20 m. It is claimed that such waters when purified provide cures for gastric troubles. With a reduced salinity, the water remains nevertheless rich in magnesium and other oligoelements, free of chlorides, and closely resembles blood plasma. Bread, crackers, and pasta made using seawater are marketed in France, Germany, and the Netherlands.

Some enthusiastic researchers ventured in 1998 that “marine sources could be the major source of new drugs for the next decade.” Coral reefs supply the structural components necessary to repair human bone. Unlike allograft bone, originating from a cadaver, grafts manufactured from coral do not carry the risk of implant rejection or of transmission of infectious agents such as HIV or hepatitis. Here, however, only marine macro algae will be discussed.

MARINE MACROALGAE IN PHARMACY, THALASSOTHERAPY, AND BIOTECHNOLOGY

Use and consumption of algae is far more common in Asia than in the Western World (Morand, Charlier, and Mazé,

1990; Pricajan and Opran, 1970; Anonymous, 1999, 1–3). This has been so and still is (Charlier, 1999). As an example: Chinese immigrants put kelp on the California market (*Macrocystis pirifera*) in 1880, although Indians had gathered iodine-containing food prior to that. They started kelp farming in 1890. Chinese women and children collected algae before 1857, particularly on the Monterey Peninsula. They used Moss Beach in Southern California as a base of operations and shipped their products to San Francisco, where it was either exported to China itself, used as fertilizer, or agar extracted (Chen, 1980).

Algae have been gathered for millennia and occupy a place in symbolism. The practice has followed, in Japan, Shintoist rites, not so much because of their role in nutrition, but because they are believed to have protective virtues: they are said to ensure the safety of mariners and to facilitate child birth (Herbert, 1964). The first document dealing with algotherapy, evidently a branch of phytotherapy, a venerable therapeutic approach, was written on clay tablets. This record of therapies in cuneiform characters was produced by the Sumerians around 3000 BC. Perhaps this paper should be retitled 5000 years of healing sea.

Phytomedications

Plant-based medications are in particular used for the prevention of several ailments and also in the treatment of such chronic illnesses as arthrosis (Blunden and Gordon, 1986). Contemporary prescribers praise their in-depth effects as well as the absence of aggressive properties and secondary effects. Phytotherapy, and its component algotherapy, were officially recognized, in 1986, by the French Ministry of Health as a “full fledged medical approach.” This makes them reimbursable by that country's National Health Scheme (*Sécurité Sociale*), gives them undeniable pharmacomedical respectability, and makes them attractive to patients.

Lithothamnium calcareum is a calcareous marine alga whose thallium is used in the treatment of decalcification, osteoporosis, painful joints, chronic tiredness, painful stages of rheumatism, gingivitis, stomach pains, and in antiacid cures. *Lithothamnium* and *Fucus* enter frequently in the composition of sacks used in thalassotherapy. Among other marine macroalgae, rockweed (*Fucus vesiculosus*) has also proved effective against excess weight for individuals with a normal appetite. Rockweeds have furthermore an antiseborrheic effect on greasy hair. *Spirulina maxima*, a freshwater alga that adapts easily to brackish and even salty environments, enters in the treatment of anemia and muscular tiredness. *Spirulina platensis* provides high levels of linoleic acid. *Spirulina* and *Ascophyllum* are reputed for slimming action (Blunden and Gordon, 1986). *Spirulina* has recently been added to the Italian tagliatelle, and colors them a deep green (Bologa *et al.*, 1999; Charlier, 1990; Charlier and Lonhienne, 1996; Morand, Charlier, and Mazé, 1990).

Several species of red algae are used in medicine and bacteriology and some as food, *i.e.*, Irish moss (*Chondrus crispus*), dulce (*Palmaria palmata*), laver (*Porphyra* ssp.), and slack, or to extract galactans (agar-agar) or chemicals (*e.g.*, *Gigartina* and Irish moss). Sea lettuce (*Ulva lactuca*, a green alga),

dulse, and laver are used as seasoning salts. Irish moss has also antingivitis and antiscarring properties (De Roeck-Holtzhauer, 1986). Hawaiians have used since times immemorial *Porphyra atropurpurea* to treat wounds and particularly burns. *Palmaria palmata* has an antiperspirant potential.

Brown algae are also used in medicine and as sources of iodine, potash, and algin. Kelps, which include *Alaria*, *Agarum*, *Laminaria*, *Nereocystis*, and *Macrocystis*, are rich in iodine and widely used in the chemical industry. Iodine combats endemic goiter; kelp (*haidai*) as a diet iodine source finds its most widespread use in the People's Republic of China. The green alga *Chlorella* is rich in antibiotic and antifungal agents. *Hypnea* and *Durvillea* could be used as anticoagulants.

Algae in Pharmacy, Parapharmacy, and Biotechnology

Algae have been alternatively, and concurrently, praised and damned along coasts (Bologa *et al.*, 1999; Charlier, 1990; Charlier and Lonhienne, 1996). The European Union under its COST-48 program encouraged research both into their use and their eradication (Morand, Charlier, and Mazé, 1990). They play a role among others in food and feed, in cosmetology, in methane and fertilizer production, and in therapy (Charlier, 1999; De Roeck-Holtzhauer, 1986). As discussed later, algae are among the numerous products of marine origin that play a significant role in pharmacology.

The passage of algae components such as iron and cobalt through the skin is controversial for several physiologists. On the other hand, biomedical applications of *Lyngbya majuscula* are recognized by oncologists; this reef dwelling blue-green alga produces curacin-A, which functions as an antiproliferative that inhibits cell division and thus blocks cancer growth and spreading. Algae powder has been added to seawater baths, and algae creams are available in pharmacies and cosmetology stores.

They are present in some marine mud, and in some treatment centers their proportion is increased. German physicians had already in 1929 collected mud in a remote corner of Wilhelmshafen harbor. French marine cures use an alga jelly mixed with wet sand heated in a double boiler. The mixture applied to the body slowly releases its heat. The ionic displacement of marine electrolytes and algal constituents through the skin is, however, not universally agreed upon. Challenged 15 years ago, the practice is continued both in centers and on shores. German centers provide pelotherapy using silt packs rich in vegetal and mineral substances, rather similar to the moor silt.

A mineral spring discovered in the royal residence of Ostend (Belgium) led to the development of a thalassotherapy center (1856) that once catered to as many as 80,000 curists, with an adjoining Grand Hôtel des Thermes and a bottled water plant. The marine vegetal mud, also in use here, is principally made up of compacted peat carried at strong high tides to the beach area. Dried, it is turned into a powder and mixed with a marine clay powder. For use in local applications the peloid is mixed with seawater and heated in a double boiler. The once luxurious thermae became a financial

hardship for the hotel and were turned over to a mutual health organization, supposedly controlled by the Ostend municipality. They were neglected, though used, fell in disrepair, and ultimately totally razed. The bottling of Ostend thermal spring water was also discontinued. Other facilities tried to fill in the void, but only recently was one able to maintain its financial stability. A super deluxe center, in the wealthy seaside resort of Knokke-Heist, some 30 km up north, and a somewhat more financially accessible facility in Blankenberge, also a shore resort, 15 km eastward of Ostend, cater to well-heeled patients.

Depending on the season, the water of some Romanian Black Sea coast hypersaline lakes has temperatures that may reach 27°C with an alkaline pH. Lake levels may drop to within 14 cm of the adjoining Black Sea. Some 30 species of algae have been identified in their abundant microfauna. The bottom mud, rich in amino acids and carcyonoids, has a high rate of natural radioactivity. Some muds are sapropelic, with phytoremainds particularly of algae that putrefied in an anaerobic environment (Pricajan and Opran, 1970). Radon therapy has been credited with favorable effects in Bulgaria and Germany (Falkenbach, 2000; Pratzel and Schnitzer, 1992). Mud can be collected in limans as well.

Algae in Clinical Thalassotherapy

A rather wide range of marine algae enter in the packs used in thalassotherapy, and algal flours or algal salts are sold for use in home bath therapy. Poultices of *Fucus*, *Laminaria*, *Ulva*, and *Ascophyllum* (with or without *Lithothamnium* powder) are heated to 40°C or even 50°C and applied, at thalassotherapy clinics, to limbs to relieve pains due to rheumatism and arthritis, but also to shoulders, shoulder blades, and lumbar regions to treat chronic back pains.

Of the more than 20,000 identified species of algae, some 60 are in use in pharmacy, food, and in cosmetology. Most commonly used in these areas are *Porphyra*, *Euclima* (red algae), *Laminaria*, and *Undaria* (brown algae).

VITAMINS

Algae are rich in vitamins. Reported in the *ad hoc* literature are, e.g., vitamin C (*Chlorella*, *Sargassum muticum*), vitamin D (*Fucus vesiculosus*), vitamin E (*Laminariae*), vitamin K (*Sargassum muticum*, *Delesseria sanguinea*, *Chlorella*).

Phycocolloids

Seaweed phycocolloids are used worldwide in pharmacology and in food. In pharmacy their principal role is as thickening or binding agents, rarely as an active therapeutic agent. Specifically, agar is a suspending agent in barium sulfate, commonly used in radiology; it is an emulsifier used in lubricating jellies and in some ointments. With liquid paraffin it has, for ages, been prescribed to treat constipation.

Alginates

Alginates are used as binders, dissolvants, antirefluxants, and suspension agents, in hemodialysis, hemostasis, and as wound healer but also as excipients absorbable by the epi-

dermis and thus in creams, gels, and pomades. They facilitate transepidermal absorption of hormones. Alginates have multiple applications in cosmetics and toiletry manufacture. In dentistry they may serve as plugging material. They give toothpastes softness and malleability. Woven alginates (calcium alginate) have lately been used in the manufacture of medical dressings; these dressings are particularly appreciated with burns, sores, and leg ulcers (Dixon, 1986).

In cases of poisoning by ingestion of heavy metals, such as strontium, and/or radionuclides, alginates block the effects; the therapeutic effects are a function of presence in the gastrointestinal tract, *ipso facto* of time elapsed since ingestion. It has been held, however, that algal polysaccharides must be taken simultaneously with the contaminant to be effective (Tanaka *et al.* 1972).

Carrageenans

Carrageenans, extracted from several algae, *i.e.*, *Chondrus crispus*, *Mastocarpus stellatus*, *Euclima*, Gigartinaceae, and Phyllophoraceae, enter cough medicines, toothpastes, lotions, sun ray filterers, shaving creams, shampoos, hair conditioners, and deodorants. More than 20% of carrageenan production is used in pharmacy and cosmetology. They are said to be invaluable for the manufacture of wash-removable creams and ointments. Excipients of algal origin are used in vanishing creams: the rapid evaporation of the emulsion's aqueous phase on the skin leaves a thin protective medicated oily microfilm. Dried and pulverized *Lithothamnium* and *Phymatolithon* are used to make absorbent face and/or beauty masks.

Agar, agarose, carrageenan, and alginates can be used as (cell) immobilization materials. Some algal polysaccharides are thus used in biotechnology. Alginate immobilized cells have been obtained from a blue-green alga, *Synechococcus* sp., to produce glutamate. The biotechnology industry has shown considerable interest for possible biomedical applications of immobilized systems, specifically antibiotics and production of monoclonal antibodies and proteins, *e.g.*, interferons. Entrapped cells have entered the manufacture of antibiotics, alkaloids, and steroids.

Polysaccharides

Polysaccharides, including those of algal origin, have entered, or undoubtedly will enter, production of vaccines; drug delivery; anticancer, antithrombogenic, and antiadhesive drugs; and diagnostics (Colwell, 1985).

Sponges

Bacteria living cosymbiotically with sponges could be at the base of new pharmaceuticals. Such bacteria make up over one half of the body weight of sponges. "Marine sponges are the most prolific and important source of new compounds discovered in the last two to three decades. Compounds (are not made by the sponges but) by the bacteria inside their bodies." (Dr. Detmer Sipkema, Univ. of California, Berkeley). Because the environment prevailing in a sponge differs substantially from the conditions in the seawater around the sponges, re-

creating it in the laboratory is very difficult, only about 1% to 0.1% of the bacteria can be currently grown in the laboratory.

Stimulating the microenvironment in the sponge where the bacteria live is an avenue being explored to reach the 99% of the other bacteria. Then of course will come the important steps of identifying those bacteria containing the most valuable medical compounds and setting up large-scale production. Since marine sponges were the first multicellular animals on Earth that are still alive, a corollary benefit of the study is an insight into evolution and reciprocal relationships (symbiosis).

The sea-squid *Diazona angulata*, discovered attached to rocks in the Philippine waters in 1990, seems to repel aggressors by expelling a toxin—diazonamide A—that kills cancer cells. Unlike the commonly used anticancer drugs that attack tubulin, a major constituent of the mitotic spindle (the mitotic spindle is a structure involved in normal cell division; it pulls apart chromosomes before cell splitting), this sea-animal derived toxin does not have chemotherapy side effects such as bone marrow depletion, white cells destruction, and/or nerve damage. Further information can be obtained from the Southwestern Medical Center, University of Texas. The toxin has been synthetically produced *in vitro*.

Oceanic drug discovery is actively pursued at the University of Texas but equally at Harbor Branch Oceanographic Institution (Fort Pierce, Texas). Thus it has been discovered that manzamine A found in some sponges cuts down on the ability of pancreatic cancer cells to spread. The batzellines compounds family, found in a marine sponge, kill pancreatic cancer cells. Other organisms and other cancers (even Alzheimer's Disease) have retained researchers' attention at Harbor Branch: gorgonians, corals, bacteria, fungi. Some have reached commercialization: discodermolide has been extracted from a sponge and proved valuable in breast cancer treatment. Further details available from Novartis (Basel, Switzerland). Scientists have been on an intense search, for a quarter of a century—according to press releases—to discover marine organisms that hold potential to fight human diseases. It has taken an equal length of time for the U.S. Food and Drug Administration (U.S. FDA) to give its seal of approval to new treatments, to the greater distress of physicians who recognized, decades ago, the value of the oceans as a trove of medical products.

In fact, papers have been published, and recommendations made, on the topic of the oceans as a drug chest half a century ago (Charlier, 2002; Gruber, 1968) and that is if wisdom of traditional medicine is ignored. Taking the discoveries to market against the braking effect of the FDA proved an uphill battle, as admitted by the FDA itself and publicized by the Harbor Branch Oceanographic Institution (HBOI).

It is thus not easy to determine whether thalassotherapy biotechnology is a newly born science or the emergence of an ignored branch of scientific endeavor. The HBOI media laboratory has for a year chronicled the medical-pharmaceutical aspects of the new science and concurrently attempted to apply, among others, genomic technology to develop devices and methods to monitor and improve ocean environmental health.

Thalassotherapy biotechnology is thus a relatively new actor on the environmental scene.

Since 2003, the National Sea Grant program has provided a \$300,000 grant to buttress the efforts and reach a large audience. Rather than create still another (expensive and audience limited) learned journal, a web site offers now information on experiments, scientists, aspects of such marine research, equipment, and even online tutorials. Most useful for the public at large and the medical profession, the web site lists marine-generated compounds in use and potential drugs, some still in the developmental phase (Harbor Branch Media Lab, 2008).

Thalassotherapy or Delphinotherapy

A recent development in thalassotherapy is the use, one might perhaps more accurately say collaboration, of dolphins (*Delphinus sp.*). Not only do they have the reputation of being particularly friendly and highly intelligent, it is held that the dolphins seek out the company of humans and that in turn humans experience contact with these sea mammals as a very special experience. Results of therapeutic interaction with them vary and so does the group to whom this sort of therapy is aimed. Apparently mentally handicapped and children with physical problems have been found to progress positively when exposed to dolphin company. Listed among the problems that show positive response in relation to dolphin contact are ailments related to speech, mortricity, and social emotional deficiencies.

As other alternative curative processes, this approach is challenged. Marine zootherapy was part of a series of four debate-conferences the Free University of Brussels (Vrije Universiteit Brussel-Brussels, Belgium) set up in May 2009. The specific topic was presented, and the therapeutic approach defended, by practitioners E. Van Neste and H. Straetman, from the Flemish Association for the Handicapped-Sympathizers of Dolfintherapy (Vlaamse Vereniging voor Gehandicapt-Sympathizanten van dolfjnthérapie).

A CONCLUDING REMARK

Taking into consideration the observations spanning the last 70 years—and deliberately, though perhaps wrongly—setting aside all earlier studies, even going back to the Romans, Greeks, Sumerians, and others (Charlier, 2002)—the therapy has provided relief for several ailments. And so have numerous sea-derived pharmaceuticals. No longer exclusively based on solar and seawater precepts—whose validity is not challenged here (Falkenbach, 2001; Hock, 1995; Jordan, 1996; Leistner, Schultze, and Wyk auf Föhr, 1974; Leupold, 1973; Schmidt, 1989a, 1989b; Urbanovich, Chubar, and Zarechnaja, 1989)—it has been combined in some treatment centers with other approaches (e.g., acupuncture), often given the label traditional medicine—and recognized by the World Health Organization (Charlier and Chaineux, 2003).

A contrario from the ailments treatable by thalassotherapy by the scientific authors, many centers appeal to the problems of the day and advertise in addition to thalassotherapy, reshaping, beauty, well-being, golf pain cures, antistress, slimming, dietetics, backaches, heavy legs, antismoking,

postchildbirth, chronic headaches, or insomnia. The current fascination with native medication has led some centers to associate thalassotherapy with the Indian techniques of ayurveda. Ayurveda claims to disintoxicate the body taking into consideration the physical or physiological type of the individual. It involves massages with warmed-up oils in a setting of candles, décor, and petals. To the serious thalassotherapeut this is far removed from the true base of the therapy.

Although it may be viewed in some instances as maintenance and/or palliative therapy—or therapies—the treatments, fallen rather in desuetude for decades during the two world wars, have regained considerable appeal among today's patients. The return of the sea therapy causes no harm to the environment and provides an economic stimulus for regions in the coastal zone, and it is free from the unfavorable side effects common to traditional tourism and recreation (Collin, 1995; Constant, Collin, and Boulangé, 1995; Graber-Duvernay, 1999).

ACKNOWLEDGMENTS

Logistic support and travel grants for this study have been provided by the Institute for the Development of Riverine and Estuarine Studies and IDRECS. The good offices of Dr. Patrick Vanouplines, director of the Main Library of the Vrije Universiteit Brussel, are gratefully acknowledged here.

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□ RÉSUMÉ □

L'utilisation des eaux marines, de leurs mouvements et de produits d'origine marine remonte à la plus haute antiquité. Thermalisme et thalassothérapie sont intimement liés. Après avoir connu une nouvelle vogue depuis la mi-XIX^e siècle, la thalassothérapie tomba pratiquement en désuétude. Le centres de thermalisme, et plus tard ceux de thalassothérapie, ont donc connu une grande vogue, au cours des 19^e et 20^e siècles. La mode de « prendre les eaux » est due en partie à la présence de têtes couronnées qui les fréquentèrent plutôt assidûment. On cite souvent Pierre le Grand, tsar de Russie, mais on peut compter plus près de nous parmi les visiteurs, Napoléon III et son épouse l'impératrice Eugénie. Le dernier empereur allemand Guillaume II, quitta en hâte Spa lorsque la débâcle de ses armées se profila. De nombreux philosophes et savants se portèrent garants de bénéfices que pouvaient apporter l'eau des thermes. Les Anciens les avaient vantés bien avant eux. Les eaux de mer furent louées avant la fin de la Belle Époque, mais la pratique des bains de mer et traitements y associés se perdit plutôt dans l'entre-deux-guerres. Un regain de vigueur s'est manifesté depuis une cinquantaine d'années, probablement dans le sillon de l'intérêt qu'ont reçu les médecines dites alternatives ou encore traditionnelles. Si un certain commercialisme a envahi en partie le domaine, il n'en reste pas moins que de très nombreux centres de soins, voire de cures, traitent plusieurs maladies par des méthodes thalassothérapeutiques et des produits extraits de plantes et d'animaux marins qui ont gagné droit de cité en pharmacologie. La thalassothérapie a refait surface dans l'arsenal médical des praticiens après la deuxième guerre mondiale. Des études scientifiques et des statistiques de systèmes de sécurité sociale font état d'une baisse des hospitalisations parmi les patients ayant suivi des cures. Des études sérieuses ont établi une diminution importante dans la consommation de médicaments et l'hospitalisation de patients ayant suivi une cure marine. Dans plusieurs pays ces cures donnent d'ailleurs droit à une intervention des assurances sociales. Il convient toutefois de se méfier des publicités d'ordre strictement commercial. Par contre les centres de thalassothérapie ont des retombées économiques importantes pour les sites où ils sont établis. Aujourd'hui la thalassothérapie est répandue de par le monde entier. Le tourisme médical s'est assuré une place importante sur le marché du voyage et le touriste associe aisément cure et découverte d'une région. Le nombre de centres de soins a considérablement augmenté, mais il convient de différencier entre ceux qui offrent de véritables traitements médicaux et ceux qui suggèrent des cures de remise en forme, ou de bien être. La thalassothérapie—et le thermalisme—ont trouvé, comme les médecines alternatives, reconnaissance comme spécialité dans des facultés de médecine. La pratique, bien établie en France et en Allemagne, a gagné droit de cité dans plusieurs pays européens et extra-européens. Les centres de soins ont contribué au tourisme côtier. De nombreux emplois ont été créés dans les secteurs médicaux, para-médicaux, hôteliers, touristiques et domaines y associés. La littérature scientifique *ad hoc* est principalement rédigée en allemand et en français. Ceci explique peut-être, en partie, le peu d'extension que connaît la thalassothérapie aux États-Unis où les publications de date récente traitant du sujet sont assez peu fréquentes et où par ailleurs, le terme de “spa”—du nom de la célèbre station thermale belge—a été utilisé fort abusivement.

□ SAMENVATTING □

Al dan niet bewegend (zee)water en de producten die er uit kunnen gewonnen worden, kent de mens sedert de Oudheid. Recenter zijn thermalisme en thalassotherapie, twee nauw met elkaar verbonden begrippen. Thalassotherapie kende een piek in het midden van de 19^e eeuw om daarna meer en meer uit de publieke belangstelling te verdwijnen. Centra voor thermalisme, en later ook die voor thalassotherapie, waren dus in de mode in de 19^e en 20^{ste} eeuw. Het enthousiasme van gekroonde hoofden die vaak naar de “water-steden” trokken, denk aan al de oorden die in Duitsland de naam Bad dragen, droeg veel toe aan het succes van talrijke steden. Onder hen worden regelmatig de keizer van Rusland, Peter de Grote, maar ook de Keizer der Fransen Napoleon III en zijn keizerin Eugénie vermeld. Er is een anekdote die houdt dat de laatste duitse keizer, Willem II, in allerhaast Spa, waar hij dolgraag vertoefde, verliet, toen het hem duidelijk werd dat de oorlog in zijn nadeel uitdraaide. Ook filosofen en wetenschappers uit die tijd loofden de weldaden van thermalisme. Romeinen en Grieken, onder anderen, hadden de voordelen van water therapieën gewaardeerd. Gedurende de Belle Époque werden de zeewaters geloofd, maar de praktijk van zeebaden en daartoe geassocieerde behandelingen geraakte wel in onbruik in de periode tussen de twee wereldoorlogen. Gedurende de voorbije halve eeuw was er terug iets meer belangstelling voor thalassotherapie, in het kielzog van alternatieve en klassieke geneesmethoden. Thalassotherapie genoot opnieuw belangstelling bij artsen na het einde van de tweede wereldoorlog. Wetenschappelijk onderzoek en statistieken van sociale zekerheid organismen maakten het duidelijk dat patiënten die een kuur gevolgd hadden niet even vaak als anderen opgenomen moesten worden in ziekenhuizen. Hoewel winstbejag zeker aan de orde is, kan niet naast de talrijke zorgen- en kuurcentra

gekeken worden waar aandoeningen met thassotherapeutische middelen worden behandeld of waar extracten van uit de zee afkomstige planten of dieren—die inmiddels een plaats hebben gekregen in farmacologie—worden toegepast. Studies hebben aangetoond dat de consumptie van geneesmiddelen aanzienlijk daalt als de patiënt een mariene kuur volgde. In verschillende landen komen dergelijke behandelingen in aanmerking voor terugbetaling door ziekenfondsen. Men moet echter steeds waakzaam zijn voor strikt commerciële reclame. Centra voor thalassotherapie hebben een grote economische invloed op het gebied waar ze zich bevinden. Thalassotherapie is tegenwoordig verspreid over de ganse wereld. Medicinaal toerisme heeft een belangrijke plaats verworven in de toeristische sector en de vakantieganger zal een gezondheidskuur meer gaan combineren met het bezoek aan een streek. Op de arbeidsmarkt worden zo veel plaatsen gecreëerd in de (para)medische sector, het hotelwezen, toerisme en aanverwante economische sectoren. Wetenschappelijke literatuur *ad hoc* is meestal in het Duits of het Frans. Dit verklaart wellicht waarom thalassotherapie weinig doordringt in de USA waar recente wetenschappelijke literatuur over dat onderwerp nauwelijks voorkomt en waar de term “spa”—genoemd naar het bekende Belgische thermaal kuuroord—verkeerdelijk wordt gebruikt. Het aantal zorgcentra is sterk gestegen, maar een onderscheid hoeft gemaakt tussen diegene die werkelijke medische zorg verlenen en andere die slechts aansturen op welzijn of terug-in-vorm stellen. Thalassotherapie—en thermalisme—worden nu (zoals trouwens alternatieve therapeutische aanpakken) erkend als volwaardige specialiteiten in geneeskundige faculteiten. De praktijk, goed ingesteld in Frankrijk en Duitsland, heeft voet in huis in talrijke Europese en buiten-Europese landen. Er hoeft vermeld te worden dat zorgverlenende centra toegebracht hebben aan kusttoerisme.