

Lessons from a historic example of diving safety rules violation: the case of Greek sponge divers

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ABSTRACT

This study presents a historical example of systematic safety rules violations by professional sponge divers in Greece during the early 20th century. In light of absolute unaccountability in favour of economic competition and in the absence of state oversight, the profession of sponge diving had developed into a deadly undertaking.

The study is based on a report compiled by Professor of Hygiene and Microbiology Konstantinos Savvas, which was addressed to the Ministry of Marine Affairs. Savvas' report rested on data concerning hospitalised divers derived from the medical records of warship 'Kriti' (Crete), which escorted groups of Greek fishing vessels to four of their expedition in the Mediterranean over the period 1900–1903.

Although the events explored herein took place at a time much different from the modern era with its numerous advancements in hyperbaric medicine, enhanced divers' professionalism and the establishment of labour rights and strict safety regulations, we should not overlook the human factor of professional exploitation that leads to the violation of safety rules. On the other hand, supervisory authorities entrusted with the responsibility of overseeing professional activities ought to be vigilant on a constant basis, especially in times of economic crisis that may lead to lax state functioning.

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Key words: decompression sickness, Greece, history, Konstantinos Savvas, sponge diving

INTRODUCTION

A professional diver has to perform a series of underwater tasks using exclusively self-contained breathing apparatuses. These tasks include underwater ship repairs, dock construction, aquaculture, etc. Regardless of the needs or competition in market economies, however, divers' compliance with safety rules while underwater remains a crucial issue.

By examining the records of a Greek warship from the early 20th century, the study illustrates the lasting risk of inadequate or even inexistent safety among professional divers in conditions of economic competition. The pressing need for work amidst the harsh economic crisis that tormented Greece in the late 19th century, coupled with commercial competition, employers' demands for quick profits, and divers' low earnings that forced them to exhaustive dives in order to earn more money, had taken their toll on safety. In addition, the absence of state controls embold-

ened employers to push towards increasing their profits in the name of competition.

ARCHIVAL SOURCES

The study was based on two Greek archival sources: a) the report on decompression sickness (also known as the divers' disease), which was prepared by Konstantinos Savvas, Professor of Microbiology and Hygiene at the Medical School of the University of Athens, on behalf of the Royal Medical Council and addressed to the Ministry of Marine Affairs (1904), and b) the data collected by Dr. Sfinis onboard the warship 'Kriti', which escorted Greek fishing vessels in the Mediterranean.

Professor Konstantinos Savvas (1861–1929) was the founder of Hygiene, Epidemiology and Microbiology in Greece (Fig. 1). Besides infectious diseases, Savvas took up issues of occupational health and safety. The tragic rates of morbidity and mortality among Greek sponge div-

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Figure 1. Professor Konstantinos Savvas (1861–1929) (Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)

ers prompted Savvas to examine the issue. To this end, he started collaborating with the officer Dr. Sfinis, who gave him the data contained in the medical records from four expeditions dated from the period 1900–1903 [1]. In an effort to fully comprehend the physiology of underwater diving, Savvas travelled to the Diving Academy facilities of the Imperial Russian Navy in Kronstadt in 1903, whereas he also studied numerous educational dives on the coasts of Finland [2, 3].

SPONGE DIVING IN GREECE (19TH–20TH CENTURY)

Sponge diving constitutes a legendary chapter of the Greek naval history. Over the centuries, sponge diving techniques evolved from diving without equipment to diving suits. After the establishment of the modern nation state of Greece, the first diving suits were introduced in the Aegean islands – both those that were liberated and the ones that remained under Ottoman control – in the first half of the 19th century. The capability of staying underwater for longer

periods of time soon gave rise to the problem of overfishing. The Ottoman Empire had prohibited sponge diving using diving suits up to three miles off its coast. During summer, the Greek fishing vessels collected sponges on the Tunisian coast, moving to Egypt and Cyprus in the winter. In the early 20th century, more than 500 fishing vessels were actively harvesting sponges around the Greek islands, of which 150 carried oxygen pumps and diving suits. Sponge trade was highly lucrative, while companies had established branches in Western Europe where sponges were sold as a luxury good. In light of protecting them from raids by other countries' ships, fishing vessels grouped into fleets, each of which was escorted by a warship. The coexistence of fishing vessels within the same fleet (200–250 vessels) did not necessarily imply their cooperation, since the islands competed fiercely for the distribution of marine sites of sponge harvesting [4].

STUDIES ON DECOMPRESSION SICKNESS

Human efforts to prolong their underwater stay on the seabed gradually led to the creation of new distinct scientific branches of Medicine. Alfred Léroy de Méricourt became interested in decompression sickness and published his relevant thesis titled '*Considérations sur l'hygiène des pêcheurs d'éponges*' in 1868, while Alphonse Gal travelled to Greece in order to complete his own thesis that was published in 1872, where he recorded the symptoms of the disease by himself [5–7]. He gradually became more interested in the supply of compressed air to mines and caissons of underwater constructions, such as the construction of large bridges like the Eads Bridge in St. Louis and the Brooklyn Bridge in New York City, where decompression sickness or '*caisson disease*' was also observed. On account of that observation, Alphonse Jaminet (1871) and Andrew Smith (1873) – the doctors overseeing the construction of Eads Bridge and Brooklyn Bridge respectively – published two studies describing the disease and their experiments [8, 9]. In 1878, Paul Bert laid the foundations of hyperbaric medicine in his monumental work '*La Pression Barométrique recherches de Physiologie Expérimentale*' [10, 11].

Despite widespread dissent, it appears that the dangers of the disease had been known in Greece at least since the 1860s, when the first diving suits were used by the Dodecanesian sponge divers. In 1867, Auguste Denayrouze published a manual on the use of diving suits, which offered clear and specific instructions to those who descended up to 50 metres: 'Ascending very slowly, the diver can avoid abrupt transition to atmospheric pressure. Periodical stops (during ascent) help to make decompression smooth' [4]. Studies on decompression sickness were also conducted in Greece. In 1881, I. Tetsis published his study titled '*L'île*

d'Hydra et les maladies des plongeurs' in Paris, distinguishing between four levels of the disease: temporary cerebral congestion, paraplegia, haemorrhage that may lead to death, and comatose state that always leads to death [4]. Of major importance was the study of K. Katsaras, who studied 62 divers suffering from the disease [12].

THE MEDICAL RECORDS OF WARSHIP 'KRITI'

The warship accompanied the Greek fishing fleets in four expeditions: 7 May – 20 October 1900, 12 May – 20 October 1901, 17 May – 16 October 1902 and 15 May – 24 October 1903. The health records of divers who suffered from the disease between 1900 and 1903 were handed to Savvas and highlighted various aspects and risk factors of the disease.

WORKING CONDITIONS

The problem of decompression sickness lay in the highly problematic business model of the time and started long before the expedition itself. In order to be able to equip their ships, captains were forced to borrow heavily from the banks. They also borrowed capital from the private sector with interests of 24% to 36%, which had to be repaid within 6 months, while their ships or even homes were put up as collateral for those loans. Moreover, it was lenders who provided captains with the necessary equipment, usually at very high prices. As a result, captains were already indebted before they had even set sail and their only hope lay in harvesting large quantities of sponges. Any delays in their departure meant that divers had wasted their salaries, thus they too could only set their hopes on harvesting many sponges since they would accordingly get a share of the profits. Captains were faced with pressing loans that gave rise to irrational demands for more and more dives, a reality that proved to be a major risk factor for accidents. The captains' burden was passed on to the divers who, according to Savvas, *'lost their freedom and became slaves of the captain'*. Similarly, the oral testimonies of captains indicate that they, in turn, were slaves of their lenders: *'When you have borrowed a lot of money and mortgaged your house, you have to earn that money and the time is not enough. Therefore, the people (divers) must ascend quickly'; 'How many hours does the day need to have for me to be able to do my job, to earn the money that is not mine, to pay the bank, to pay the people?'* [4].

THE DIVERS' PROFILE

The profile of the proud diver and tragic hero who boldly confronts real and mythical dangers in the great depths of the sea and thoughtlessly spends all his money while on land, since any of his next trips might be his final one, has

long been inscribed in Greek historical consciousness. On the other hand, the drama of mothers and wives of dead or handicapped divers has been an integral part of island societies [4]. Each ship was manned by 8–12 divers aged 19–45, many of whom came from continental Greece in search of easy profits but lacking familiarity with the marine environment. For instance, the records revealed that numerous divers had formerly worked as farmers, shepherds, carpenters, builders, barbers, railroad employees or in various other professions that were completely unrelated to marine life and the dangers of the sea.

SAFETY RULES

The records of warship 'Kriti' illustrate that safety rules were essentially absent from diving. The Hellenic Navy employed no divers who would dive to such great depths, since their main mission rested in performing maintenance tasks on the hulls of ships. This was the main reason why no casualties were recorded in the Navy, coupled with the rigorous military standards that were strictly followed by its divers. Civilian divers, on the other hand, experienced a totally different situation. The whole process was outside state regulation and anyone could become a diver, even without training, while basic safety rules were absent from fishing vessels whose equipment was outdated and dangerous.

The inspections of fishing vessels conducted by officers and doctors revealed crucial violations in relation to their equipment, like diving suits lacking maintenance, helmets lacking lanterns or cables of communication with the ship, oxygen pump pistons lubricated with animal fat that contaminated the air inside helmets, or pumps that channelled hot air due to their poor maintenance. A notable effect of these deficiencies was the case of the release and detachment of a diver's helmet while working at a depth of 40 metres. Professional divers dived up to 6 times during their shift and usually worked at a depth of 45–60 metres, sometimes reaching 80 metres. They ascended really fast and would *'hurl at high speed and immediately remove their diving suit in order for the next diver to use it and for them to go to rest'*. Each dive lasted 40–50 minutes: *'On 27 June 1903, a diver of the ship Evangelistria dived to 30 metres and remained on the seabed for 50 minutes, then ascending fast and not smoothly. After one hour and a half, he dived again to the same depth and remained underwater for 45 minutes. One hour later he dived to 30 metres and stayed for 35 minutes. When he ascended, he reported dizziness and lost his consciousness. As soon as he regained consciousness, he felt numbness on his limbs and was unable to stand. Complete paralysis ensued...'*

A regretful finding rests in the testimonies of divers, who secretly entrusted them to the Navy officers. Some captains ignored divers' signals for ascent, not allowing them to

return to the ship or forcing them to dive again when they considered the quantities of sponges they had harvested to be insufficient. On the other hand, some operators of oxygen pumps mentioned that divers themselves often ignored their signals in light of discovering hundreds of sponges, suffering from what they called 'seabed drunkenness' that made them want to collect them all [4].

The divers' diet was satisfactory and included fish, meat and legumes, while they had 2 to 4 meals a day. Pressure and tension, however, led to excessive smoking and alcohol consumption. Savvas considered the usual practice of consuming an alcoholic drink in between dives to be burdensome for the divers' overall health. In a time when the concept of risk factor was unclear, Savvas was able to distinguish alcohol as a significant factor that could cause accidents.

DECOMPRESSION SICKNESS IN NUMBERS

According to Savvas, Paul Bert had been informed that 30 Greek divers died on average every year during the 1870s. The studies conducted by Greek doctors referred to ten deaths per year but indicated equally high rates of disability. Between the years 1878–1900 it was estimated that approximately 100 divers had died while more than 800 were left paralysed. Unfortunately, there is no conclusive and systematic data on the exact number of victims per island. For instance, it has been reported that 'more than 15 died every summer' in the Dodecanese during the 1870s. Russian Professor Karolus Flegel, a renowned and staunch objector of diving using a diving suit, pointed out that at least 800 divers had died from the island of Kalymnos since the introduction of the diving suit, a number that remains to be verified [4].

The records from the period 1900–1903, however, offered a more coherent picture of the prevailing situation. The records of 'Kriti' included the number of patients, the seriousness of their condition, as well as the number of those who did not survive. All patients were grouped into age groups, whereas the doctors also classified symptoms into 'disorders of the central nervous system', 'heart disorders' and 'lung disorders'. Particular attention was paid to paralysis, which was categorised as 'upper limb paresis', 'lower limb paresis', 'hemiplegia', 'upper limb paralysis', 'lower limb paralysis', 'perfect lower limb paralysis' and 'paralysis of the whole body'. Over the 4-year period covered in the records, a total of 936 divers were hospitalised, of whom 152 in serious condition. Twenty one of these 152 patients passed away, while those who survived developed some kind of disability. Ages 21–35, especially 26–30 (46%), represented the age spectrum that was mostly affected by decompression sickness. As far as the type of paralysis is concerned, paralysis of the lower extremities was the most common.

The presence of the warship and the lax controls did not have any effect on captains, since the legislative framework was essentially non-existent and the naval officers were unable to intervene. On the other hand, many captains pulled away from the fleets and resumed their oppressive behaviour towards divers. For instance, 60 divers working on the fishing vessels that had abandoned the fleet in 1901 died outside Benghazi in Libya.

This situation changed during the last expedition of 'Kriti' in 1903, when the naval officers acquired extended powers that allowed them to conduct sworn interrogations. This tactic scared the captains, who began to adhere to the newly-established safety rules of the Ministry of Marine Affairs. The interrogations carried out in 1903 revealed that – besides the three divers hospitalised aboard 'Kriti' who passed away – another 24 divers had also died in that same year. On the other hand, the officers were unable to verify the worrying allegations of another 40 dead divers. In any case, contemporary estimates placed the total number of Greek divers onboard the Greek shipping vessels during the last expedition of 'Kriti' at 900, of whom 100–150 either died or acquired some kind of disability. It should be clarified that the failure to record the total number of deaths may have been due to the fact that some islands remained under Ottoman control and thus the Greek ships still carried the Ottoman flag. As a result, the Greek authorities were informed of accidents only when a captain contacted the Greek consulates in the Greek islands controlled by the Ottomans.

MEDICAL FINDINGS FROM THE RECORDS

Savvas' report confirmed the aggravating factors for decompression sickness that were already mentioned in contemporary bibliography, namely diving depth, duration of stay on the seabed and number of consecutive dives. The disease was linked to the three stages of diving: increasing pressure during descent, high atmospheric pressure while on the seabed and abrupt divers' ascent. According to the records, decompression sickness appeared shortly after ascent and removal of the helmet of the diving suit. Divers suddenly felt malaise, dizziness and imbalance, pain in the precordium that extended to the left shoulder and nape, headache, tinnitus, aphasia, thirst and burning in the epigastrium.

Divers presented shortness of breath for 30 minutes, followed by faint and anaesthesia for 15 minutes. By the time a diver regained consciousness, all symptoms had disappeared only to be replaced by symptoms of paralysis. Over the next 4–8 hours, the unfortunate diver felt numbness throughout his body, losing his ability to move and experiencing paraesthesia in the upper and lower limbs. This situation resulted in hemiplegia, monoplegia or cervical

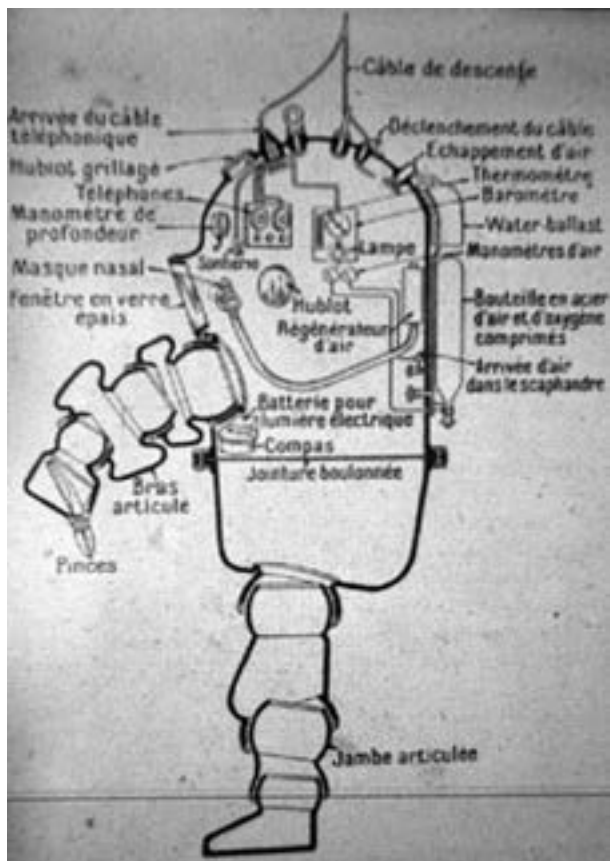


Figure 2. Metal suit P-7 Neufeldt and Kuhnk in section. Glass-slide from the lectures of Prof. Savvas on Divers' Hygiene. (Prof. K. Savvas Collection, Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)



Figure 3. Test of P-7 Neufeldt and Kuhnk (France 1926). Glass-slide from the lectures of Prof. Savvas on Divers' Hygiene. (Prof. K. Savvas Collection, Historical Archive of the Department of Microbiology, Medical School, National and Kapodistrian University of Athens)

and head movement ability only. Over the next 3–5 days, the diver experienced urinary retention that was followed by urinary incontinence. Upon his recovery, the patient was able to walk only with the help of a walking cane.

STATE INTERVENTION IN RESPONSE TO SAVVAS' REPORT

Following the tragic conditions that came to light from the data, the Ministry of Marine Affairs was called upon to take immediate action at various levels. At that point, the influence of Professor Savvas' prestige came into play, definitely corroborated by his relationship with the royal family. Numerous of his proposals were eventually taken into account and largely influenced the nature of the divers' profession.

The first measure provided for keeping a book where captains recorded all dives performed by the divers onboard their ships. Each entry had to include the site, depth and duration of a dive, along with the name of the diver and the signatures of the captain and two representatives of

the divers who oversaw the whole process. Upon returning from an expedition, the captain handed over the book to the port authorities for inspection.

In turn, divers had to be healthy, that is, not suffer from cardiac, haematologic, urinary or nervous system diseases (or rheumatic diseases, based on contemporary medical perceptions), whereas dives had to be performed 3–4 hours after consuming a meal. In addition, professional divers had to be aged 21–35, while the establishment of the School of Divers was decided, where prospective divers would obtain a diploma and basic first aid knowledge.

The safety rules that were introduced were designed in line with those of the German Navy in 1898. This should not come as a surprise, given that Prof. Savvas had received further training in the Institute of Public Health of Berlin and was generally familiar with the German scientific way of thinking. Based on those criteria, the duration of under-

water stay was defined as follows: 1 hour at 9–10 metres, 15 minutes at 23–25 metres, 10 minutes at 35–42 metres, 5 minutes at 42–47 metres, 3 minutes at 47–50 metres and 1 minute at 50–55 metres. As far as the other technical parameters were concerned, the rate of ascent was set at 2 metres per minute, while oxygen pressure should not exceed 5 atmospheres (atm). It was also determined that 3 months after their therapy, divers could start diving again on the following terms: no more than 3 times a day, at depths of 8–10 metres, remaining underwater for 15–30 minutes.

A key development that originated from Savvas' report was the fact that divers were no longer unprotected, as employers were to be held accountable and subject to punishment. Firstly, captains were now prohibited from coercing divers to multiple dives, whereas they had no right to ask a diver to dive when the latter suffered from any disease. Moreover, in the event of an accident, interrogations were carried out and those deemed responsible were brought to justice. In this context too, Savvas proposed that the laws of the German Criminal Code were put in place. Although a diver's death would be regarded as negligent homicide, the sentences ranged from heavy fines and seizure of the ship to imprisonment for 3 months to 3 years. But Savvas left nothing to chance, as he took another aspect of the problem into account and provided for the establishment of a pension fund for divers, which was maintained through employers' contributions and offered financial assistance to the widows and orphans of deceased divers. Additionally, a special framework was established that prevented lenders from imposing interest rates of more than 10%, thereby relieving captains from the strain of repayment and fear of their ships being confiscated. As a result, captains' behaviour towards the divers changed altogether.

In spite of scientific work, decrees, legislative efforts and public complaints, the concept of work-related accidents and the identification of the causes of death in sponge diving remained controversial until the whole sector became obsolete in the aftermath of World War II. Even in the 1970s, divers demanded that their whole salaries were paid in advance, on the grounds that they would likely never return from the upcoming expedition [4].

Being the most relevant experts, the doctors of the Hellenic Navy continued their research unabated. Two doctors who had been trained in Kronstadt promoted the adaptation of the diving tactics of Greek sponge divers to new standards, suggesting that they stayed on the seabed for a brief period of time and ascended slowly [13, 14]. After tackling the problem of decompression sickness, Professor Savvas became involved in other sectors of public health and focused on the major infectious diseases of the time. Nevertheless, he continued to reflect on issues pertaining

to the health of professional divers from an educational perspective, incorporating them in the lectures on hygiene that he offered to his students at the Medical School (Figs. 2, 3).

CONCLUSIONS

The history of Greek sponge divers in the early 20th century represents a classic and timeless example of safety rules violation arising from economic competition and hardship. Lacking regulation and any form of state oversight, professional sponge diving proved to be extremely deadly. Of course, that era was completely different from modern times in relation to divers' professionalism, safety rules and labour rights, since nowadays a strict legal framework has been put in place to protect professional divers. The prospect of exploitation, however, which leads to violations of the safety rules governing this high-risk profession under the pressure of competition, coupled with voluntary or involuntary acceptance of such situations by the divers themselves, poses a serious risk factor for accidents. On the other hand, the institutions entrusted with overseeing the profession must always be alert and prepared, especially in times of financial crisis when working conditions are subject to changes and pressures.

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