

TRIBUTE / HOMMAGE

Sir Charles Edward Saunders, Dominion Cerealists

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Abstract: Charles Edward Saunders was born in London, Ontario, in 1867. His father, Sir William Saunders, was the first director of the Dominion Experimental Farms (1886–1911). Charles received his B.A. with honours in science from the University of Toronto in 1888 and his Ph.D. in chemistry from Johns Hopkins University in Baltimore, Maryland, in 1891. He attempted a career in music, his first love, from 1893 to 1902. With his father, Charles attended the 1902 International Conference on Plant Breeding and Hybridization in New York, where he learned of Mendel's theories of inheritance and their applicability to plant breeding. When he began work in 1903 in the Division of Cereal Breeding and Experimentation at the Central Experimental Farm in Ottawa, he used the knowledge he had gained at that conference. It was Charles's goal to achieve "fixity" in the varieties that had been bred and released using phenotypic mass selection, prior to his tenure as Cerealist. He selected four heads from the wheat variety Markham and in the winter of 1904 he performed a "chewing test" to select for gluten elasticity and colour. Seeds from two heads were chosen, and seeds from one went on to produce the variety Marquis after extensive yield trials on the Prairies. Marquis was 7 to 10 days earlier than Red Fife, the standard bread wheat of the Prairies. The earliness and tremendous yield of Marquis wheat resulted in the rapid and successful settlement of the Great Plains and countless billions of dollars in revenue to Canada. By 1923, 90% of the spring wheat in Canada and 70% in the USA was Marquis. Charles continued as Dominion Cerealist until his retirement in 1922. He was knighted in 1934, and died in 1937.

Key words: Marquis wheat, plant breeding, genetics.

Résumé : Charles Edward Saunders est né à London, Ontario en 1867. Son père, Sir William Saunders, a été le premier directeur des Dominion Experimental Farms (1886–1911). Charles a obtenu son B.A. avec mention en sciences de l'Université de Toronto en 1888 et son Ph.D. en chimie de l'Université Johns Hopkins à Baltimore, Maryland en 1891. Il a tenté de faire carrière en musique, son premier amour, de 1893 à 1902. Avec son père, Charles était présent à la Conférence internationale sur l'amélioration génétique et l'hybridation des plantes de 1902 à New York où il a pris connaissance des théories de Mendel sur l'hérédité et leur application en amélioration génétique. Lorsqu'en 1903 il a commencé à travailler au sein de la Division d'amélioration génétique des céréales et d'expérimentation à la Ferme expérimentale centrale à Ottawa, il a employé les connaissances acquises lors de la conférence. Le but de Charles était d'atteindre la fixation génétique au sein des variétés qui avaient été sélectionnées au terme d'une sélection massale phénotypique et mises sur le marché avant son embauche comme sélectionneur de céréales. Il a sélectionné quatre épis au sein du blé Markham et, au cours de l'hiver 1904, il a réalisé un « test de mastication » afin de sélectionner pour l'élasticité du gluten et la couleur. Les grains de deux épis ont été choisis dont l'un a éventuellement donné la variété Marquis après des essais agronomiques exhaustifs dans les Prairies. Marquis était 7 à 10 jours plus hâtif que Red Fife, le blé panifiable standard dans les Prairies. La précocité et l'exceptionnel rendement du blé Marquis a entraîné une colonisation rapide et réussie des Grandes Plaines et rapporté un nombre incalculable de milliards de dollars en revenus pour le Canada. En 1923, Marquis constituait 90% du blé de printemps au Canada et 70% aux Etats-Unis. Charles a continué à titre de Dominion Cerealist jusqu'à sa retraite en 1922. Il a été anobli en 1934 et il est décédé en 1937.

Mots-clés : blé Marquis, amélioration génétique des plantes, génétique, historique.

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Charles Edward Saunders was born in London, Ontario, on 2 February, 1867 (Pomeroy 1956). He was the fourth of six children of Sarah and William Saunders. The Saunders home, on Dundas Street, must have been a challenging place

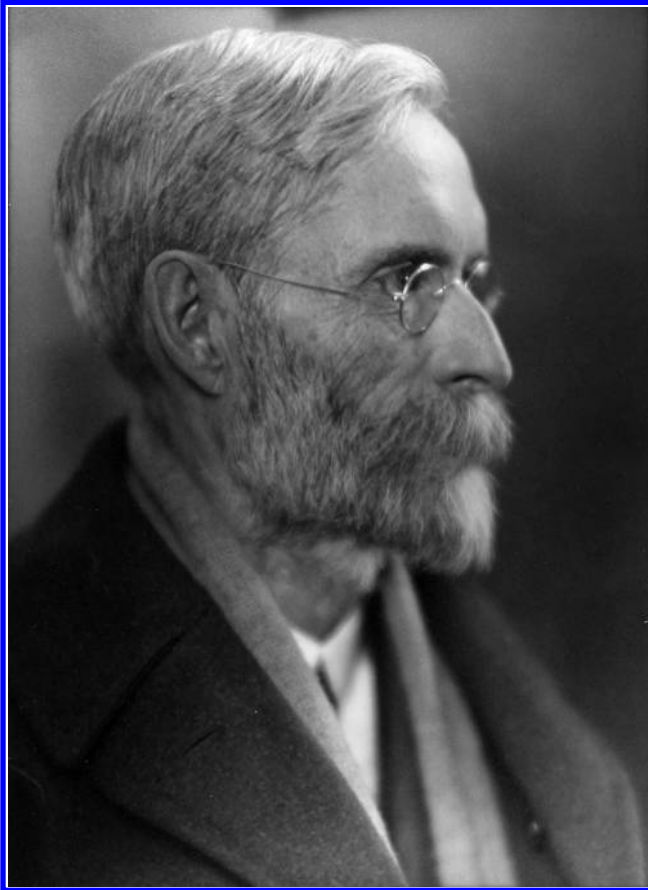
in which to grow up. Grandparents on both sides were preachers in the Methodist Church. Charles's father, William Saunders, was born in England and when the family immigrated to Canada in 1849, William was apprenticed to

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Fig. 1. Sir Charles Edward Saunders, 1934.



a pharmacist at 13, receiving only primary school education. At 19, he opened his first of two pharmacies. In the course of his career this self-educated individual founded a drug wholesale company and was a co-founder of the University of Western Ontario, where he taught *materia medica*. William was an avid horticulturalist, selecting and hybridizing many varieties of grape, berry, and ornamentals. Charles's older brothers, Will and Henry, apprenticed as pharmacists, obtained their certification at the College of Pharmacy in Philadelphia, and then took on the family pharmacy and drug businesses when William, then the foremost authority in Canada on agriculture, was asked to be the first director of the Dominion Experimental Farms in 1886. Charles's younger brothers, Percy and Fred, became professors of chemistry and physics, respectively, at universities in the United States.

All of the Saunders family had musical ability, playing one or more instruments or singing. Charles began with piano and violin but switched to flute and voice. His free time in summer months was spent collecting, cataloging, and preserving insects, and hybridizing all manner of plants at the family's six-acre gardens near Mount Pleasant Cemetery in London. Driving along country roads, his father would often stop the horse, get out, and quiz the family on plants he would pull from the roadside. Charles received his early education at London Collegiate Institute and a Bachelor of Arts with honours in science from the University of Toronto in 1888. He obtained his doctorate in chemistry from Johns Hopkins University in Baltimore, Maryland, in

1891. He married Mary Blackwell in 1892 and was briefly a professor of chemistry at Central University, Danville, Kentucky, until 1893 (Pomeroy 1956).

Citing poor health, Charles returned to Toronto, and from 1893 was involved in music, studying flute and voice in Boston and New York. He taught music at Havergal College and then St. Margaret's Ladies College in Toronto, and opened two private music studios, teaching voice and flute. From 1895 to 1896 Charles reported on musical events in a column in a Toronto paper, *The Week*. During this period, vacations and holidays were spent in Ottawa at the family home on the Central Experimental Farm. William Saunders, who was extremely busy managing the Dominion Experimental Farms, capitalized on the scientific training of both Charles and his brother Percy by having them hybridize plants in the summers.

At some point towards the end of the 1800s, Charles and Mary moved to Ottawa, where Charles became choirmaster of the Dominion Methodist Church. Charles loved music, but he did not make enough money to support himself. In 1901, when Charles wanted to go to Germany to study the flute his father refused to support him, believing that his son's meticulous nature and scientific training should be put to better use.

In early fall 1902, the first International Conference on Plant Breeding and Hybridization was held in New York under the auspices of the Horticultural Society of New York. William Saunders presented a paper titled *Results of Hybridization and Plant Breeding in Canada* and Charles presented a short paper titled *Study of the Variations in the Second Generation of Berberis Hybrids* (Horticultural Society of New York 1904). To put the importance of that conference in perspective: Gregor Mendel had published his paper *Experiments in Plant Hybridization* in the *Proceedings of the Natural History Society of Brünn* in 1866 (Mendel 1866). It was cited three times in 35 years until its rediscovery in 1900 by Hugo deVries and Carl Correns. Charles was in the audience when William Bateson, perhaps the strongest proponent of the work of Mendel at the time, delivered the opening address of the conference, entitled *Practical Aspects of the New Discoveries in Heredity* (Horticultural Society of New York 1904). Bateson introduced the terms "genetics", "homozygote", and "heterozygote" and emphasized that "fixity" of parental characteristics was of utmost importance in breeding. Bateson concluded his presentation by stating that "The period of confusion is passing away, and we have at length a basis from which to attack that mystery [heredity] such as we could scarcely have hoped two years ago would be discovered in our time." It was clear from the statements made by William Saunders after Bateson's presentation that he was not aware of Mendel's theories and their application to plant breeding. Evidence that Charles was quick to adopt these new ideas is found in the conclusion of his paper, presented 2 days later: "The reappearance of this 'recessive' character in almost exactly one-fourth of the seedlings is of interest in connection with Mendel's observations on cross-bred peas" (Horticultural Society of New York 1904). Additional evidence that Charles was influenced immensely by the science he witnessed at this particular conference can be found in correspondence Charles wrote to *The Journal of Agricultural*

Science, in which he corrected inaccuracies in a paper written by R.H. Biffen, who had openly criticized Charles's knowledge of the work of Mendel. Charles replied, "Mendel's investigations were well known to me before the year 1903 and all my work since then has been conducted in the light of his valued conclusions" (Saunders 1909).

In addition to his duties as director of the Dominion Experimental Farms, William Saunders was also in charge of the Department of Cereal Breeding and Experimentation. He realized that he was not doing both jobs justice and asked the minister of agriculture to create the position of Dominion Cerealists. When William told his son of the position in late 1902, Charles was averse to accepting it and in later years admitted that he accepted the position in 1903 because he could not make a living from music (Pomeroy 1956). Charles began working as an "Experimentalist" in the new Division of Cereal Breeding and Experimentation on the Central Experimental Farm in the early summer of 1903. He was 36 years old and was paid \$100 per month.

It is impossible to write about Charles Saunders without going into great detail about the wheat variety Marquis. So much has been written about its development and importance that the story has achieved almost mythical proportions. It is interesting to note that the variety description of Marquis was not published until 1928 (Newman and Fraser 1928).

When William Saunders began as director of the Dominion Experimental Farms in 1886, one of his main goals was testing the adaptation of world crops to different regions of Canada (Pomeroy 1956). To that end, William collected seeds from different crop species from many regions of the world. These crop varieties were grown at the Central Experimental Farm in Ottawa and selected for general growth and adaptation. The most promising of these were increased and sent to farmers across the country for testing. In 1889, a 1.4 kg sample of Ladoga, a wheat variety from Northern Russia that matured earlier than Red Fife, the standard bread wheat of the time, was shipped to 667 farmers across the Prairies. While up to 2 weeks earlier in maturity, Ladoga did not yield as well as Red Fife and more important it produced yellow flour with poor baking qualities.

The failure of Ladoga may have convinced William Saunders that hybrids must be created, because he began an ambitious program of crossbreeding at the Central Experimental Farm. At the time, the progeny of a cross was considered a variety and named shortly after the successful growth of the first generation. In succeeding generations, plants of similar appearance were selected from the population and bulked to form the variety. Therefore, varieties were not pure lines but phenotypic mass-selected mixtures, segregating for a great many traits.

From 1886 to 1892 cereal crosses were made by William, his sons Charles and Percy, and W.T. Macoun (Buller 1919). In 1892, during his summer holidays, Percy Saunders made crosses at Brandon, Manitoba, Indian Head, Saskatchewan, and Agassiz, British Columbia. It was thought at the time that the environment where a cross was made influenced the progeny. There is some debate as to where the original cross of the wheat varieties Hard Red Calcutta and Red Fife that produced the variety Marquis originated. Charles did not seem to know its origin, reporting that "The

cross was made on one of the branch experimental farms and the cross-bred seeds, or their progeny, were subsequently transferred to Ottawa" (Saunders 1913). Brandon can be eliminated as the source of the cross because there was a crop failure there that year (Sirett 1912). Years later, Charles told Reginald Buller that he believed the cross originated at Agassiz (Buller 1919); however, in the annual report from Agassiz the superintendent reported that crosses were attempted between spring and winter wheats, while the superintendent from Indian Head specifically stated that crosses were made between the Indian wheat varieties and Red Fife (Morrison 1960).

In the original cross, Percy used Hard Red Calcutta as the female parent and Red Fife as the male. Hard Red Calcutta was a trade name for a wheat variety sent to William Saunders years earlier by Lord Dufferin, a former viceroy of India. Hard Red Calcutta likely originated from the area around the Himalayan Mountains (Pomeroy 1956). It ripened 2 to 3 weeks earlier than Red Fife, had poor yield, was bearded, and shattered (Buller 1919). Evidence of Red Fife's origin comes from a letter written to the *Canadian Agriculturalist* in 1861 by George Essen. In this letter Essen describes how his neighbour David Fife, a Scottish immigrant who had settled near Ontonabee, Ontario, was sent a sample of wheat from a friend in Glasgow who had procured it from a cargo of wheat sent from Danzig. Fife planted half of the seed and only one plant produced heads, the rest being winter types. Three heads were saved from that plant and replanted in the following years to build the population (Buller 1919). Charles later demonstrated, using side by side comparisons, that Red Fife was actually a central European variety known at the time as Galician but later identified as the Ukrainian wheat Halychanka. Charles later said, "It always seemed to me probable that the kernel which Mr. Fife obtained was merely a seed of some common European variety which found its way, into the wheat from Danzig" (Buller 1919).

The seeds, or progeny of the original crosses made by Percy Saunders in 1892, were returned to Ottawa, where they were grown and plants resembling Red Fife were selected and bulked until the population was large enough to produce the variety Markham, first mentioned in the annual report of 1902 (Morrison 1960). It is interesting to note that prior to Markham, the Indian Head research station released the varieties Clyde and Cassel, which were sister lines from the same cross of Hard Red Calcutta and Red Fife. Neither of these varieties was grown extensively.

In early August 1903, Charles began his career as Experimentalist by selecting individual plants from populations of nearly 100 varieties that had been produced in preceding years by phenotypic mass selection. He was practicing his newly acquired knowledge of Mendelian genetics and trying to achieve "fixity" in these populations. He selected four heads from the Markham population. During the fall and winter of 1903–1904, Charles selected a few seeds from each head to perform a "chewing test". By chewing the kernels slowly he developed a small gluten pellet that was examined for colour, elasticity, and size. The process, he said, "requires some patience and a fairly good set of teeth, but these two attributes may be considered essential to all breeders of wheat" (Saunders 1913). Sirett (1912) remarked

that “Saunders must have had sound teeth and a regular constitution from all of the starch and bran he would have ingested during a day of selection.” Charles’s notebook from 1904 showed how he practiced rigid selection: “Markham is not to be retained at all unless it is earlier or stronger than Red Fife” (Morrison 1960). Of the four heads of Markham selected, two were rejected based on the chewing test and the others were designated Markham A and B.

In 1904, the remaining seeds from Markham A and B were grown in a single-row nursery and single plants were again selected, tested, and carried forward to 1905. By 1906, Markham A and B had been renamed Marquis A and B, and there was enough seed to sow a plot at Ottawa in the summer. During the winter of 1906–1907, Charles conducted replicated baking tests. He ground his own flour with a small mill and baked bread in uniform loaf pans. Each loaf was carefully examined and notes were taken on its height, shape, form of the crust, texture, and colour of the bread (Morrison 1960). In 1907, a portion of the remaining seed of Marquis B was sent to Indian Head for testing and it yielded 2150 kg ha⁻¹, whereas Red Fife yielded only 806 kg ha⁻¹ (Sirett 1912). In 1908, Marquis was grown at Brandon and Indian Head, again yielding more than Red Fife. From 1907 to 1911 Marquis produced average yields of 2822 kg ha⁻¹, while Red Fife produced 1881 kg ha⁻¹ (Sirett 1912). Marquis ripened 6 to 10 days earlier than Red Fife, was relatively short-strawed for the time, with a uniform shape and colour to the plump grain, and was tolerant of or escaped some forms of rust. The flour had excellent colour and possessed high baking strength.

During the years of testing on the Prairies, Marquis was increased in Ottawa and 1.4 kg lots of seed were distributed to farmers as early as 1908. The adoption of Marquis by Canadian farmers can be seen in the figures of seed distribution from the Central Experimental Farm. In 1909, 4024 samples of Red Fife were distributed, while only 407 samples of Marquis were sent to farmers. By 1911, 5343 samples of Marquis were requested, compared with 327 of Red Fife (Morrison 1960). By 1912, the supply of Marquis seed was assured and acreage began to increase logarithmically (Sirett 1912).

The availability of Marquis wheat was one of the factors that encouraged the settlement and development of western Canada. In 1910, there were approximately 3.2 million ha of wheat grown in Canada. By 1923, there were 6.9 million ha, 90% of which were sown with Marquis wheat (Pomeroy 1956). In 1917 and 1918, the yield of Marquis was 15 and 18 million metric tons with a value of \$0.5 and \$0.6 billion, respectively. The steady supply of wheat during WWI was one of the factors that tipped the scales in favour of the Allies (Buller 1919).

Charles was successful because he followed a strict methodology, capitalizing on his knowledge of plant breeding and evaluating material on a scientific basis, using the best technical means at his disposal (Morrison 1960). He kept exact records of his progress and had clear goals to produce a wheat variety that was better adapted than Red Fife with equal or better quality. Charles Saunders became the Cerealist in 1905, and the title changed to Dominion Cerealist in 1910 (Anstey 1986).

Charles continued plant breeding at a vigorous pace. He

applied his single-line selection method to reselecting the best heads or plants from plots of the mass-selected varieties that had been developed prior to his tenure. From each plant or head a separate strain of each variety was grown and studied, and the inferior ones were discarded. The chief results were the release of two earlier ripening strains of Red Fife as well as pure lines of the wheat varieties Huron, Preston, and Stanley and Banner oat, Manchurian barley, and Arthur and MacKay field pea (Saunders 1913).

Charles’s goal was to develop a wheat variety for the northern regions of the Prairies that was earlier than Marquis but had the same baking potential. Prelude, released in 1913, was a cross between Fraser, a variety obtained by pure-line selection, and Gehun, another wheat variety from India. Fraser had Hard Red Calcutta, Ladoga, and White Fife in its background. Prelude matured 2 weeks earlier than Marquis and had a small bearded head and short stiff straw. It was a hard wheat with good baking quality but it lacked the yield of Marquis. Ruby, released in 1915, was a cross between Red Fife and Downy Riga that was developed for regions intermediate between those suitable for Marquis and Prelude. Farmers did not grow Ruby because it was very susceptible to rust. Garnet wheat, released by Newman and Whiteside in 1926, after Charles’s retirement, was from a cross made in 1905 from pure-line selections of Preston and Riga. Reward, released in 1935, was from a cross made by Charles in 1912 between Prelude and Marquis. It too was developed for the cool-season areas of the Prairies (Anonymous 1939).

Charles applied his skills in hybridization not only to wheat but also to developing Albert barley, a very early, high-yielding short-season variety. He bred Liberty and Laurel hullless oats “to make possible”, Charles stated, “the realization of the dream... of a porridge free from husks” (Saunders 1913).

Charles often seemed apologetic that his work was of a “practical” nature rather than “scientific”. In his report to the Royal Society of Canada in 1913 he stated, “While contributing so enormously to the immediate prosperity of the country, the work that has been done has added comparatively little to our knowledge of the fundamental principles which underlie the breeding of cereals” (Saunders 1913). That he felt immense pride in his contribution to the nation can be seen in the last line of his address: “We are much nearer the beginning than the end of this work, and he would be a wise and daring prophet who could predict within even a few hundreds of millions of dollars what will be the net profits to Canada, during the first half of this century, from the modest sums spent on researches in cereals.”

In his almost 20 years working for the nation, Charles laboured unceasingly, often handicapped by the lack of proper equipment or trained technical assistants. In January 1922, Charles was awarded for his work on Marquis wheat at the Manitoba Association of Agricultural Societies convention in Winnipeg. He was forbidden to go to the convention and that was likely the straw that broke the camel’s back, in his eyes, and forced his resignation in the spring. In his paper, read at the convention in his absence, he wrote, “I have decided to give-up Agricultural Research work altogether on account of the profound discouragements of recent years which have at last exhausted my buoyancy and enthusiasm

and have begun to affect my health” (Saunders 1922). Charles observed that science by its very nature was not understood by the general population and the ones in the best position to comment, the scientists, were not listened to. While research was appreciated by the farmers, the government was not enthusiastic about it. “In a democracy”, Charles wrote, “the people govern. Waters cannot rise above their source; governments dare not.” Charles was “personally familiar with the blighting effects of the touch of the efficiency expert’s hand”, and told his audience, “Do not fear lest your research specialist may waste his time. A long and arduous university training is not taken by indolent people.”

Complaining without offering solution was not in Charles’s nature. He offered four simple rules to encourage research: (1) engage the best, most highly trained people obtainable; (2) pay them well; (3) provide them with proper laboratories, facilities, and trained assistants; and (4) trust them and leave them in peace (Saunders 1922). Charles closed his address by saying, “I shall leave my work with regret and yet I am happy in the thought that I shall be relieved of the unfairly heavy burdens which I have carried too long.”

Charles and Mary never had children. In autumn 1922, they retired to Paris, where for the next two and a half years Charles studied French literature at the Sorbonne, enjoying the music and culture of France. His annual pension was \$900 per year, but the Canadian public, recognizing Charles’s great service to the nation and the accomplishment of Marquis wheat, began pressuring Parliament to reward him appropriately. Parliament responded with a one-time gratuity of a mere \$2000. In 1923, 90% of the spring wheat acreage in Canada and 70% in the USA were occupied by Marquis wheat. Farmers still felt that the government had not appropriately awarded one whose “genius had brought much benefit to humanity and untold wealth to his native country” (Pomeroy 1956). Finally, in February 1925, Charles’s pension was raised to \$5000 annually.

Charles, who was made a Fellow of the Royal Society of Canada in 1921, was presented with the Flavelle Medal for Science by the Society in 1925. He was awarded the honorary degrees L.L.D. from the University of Western Ontario in 1921 and D.Sc. from Queens University in 1925 (Pomeroy 1956). Charles and Mary moved from Ottawa to Toronto in 1928, where Charles occupied himself with the study and promotion of the French language, his gramophone record collection, and various speaking engagements on the development of Marquis wheat. He published a collection of his French essays and poems in Quebec in 1928 entitled *Essais et Vers*. In 1934, he was appointed a Knight Bachelor by King George V.

Sir Charles claimed only to have discovered Marquis wheat and that “God Almighty had been its creator” (Pomeroy 1956). In later lectures he admitted to being rather thrilled upon seeing a little mass of grayish gluten on his fingertip that would eventually become so important to a nation and ultimately the world. The huge popularity of Mar-

quis wheat on the Great Plains likely resulted in its massive destruction by rust in 1935. It was rapidly replaced by Thatcher, a rust-resistant variety from Minnesota, which had Marquis in its pedigree.

On 25 July, 1937, one year to the day after the death of his wife, Sir Charles Saunders died. Leading papers around the world published his obituary on the front page. *The Manchester Guardian* wrote, “Canada has lost a scientist who probably contributed more than any other person to make the Dominion what it is today” (Pomeroy 1956). In November 1946 a bust of Sir Charles Saunders was unveiled at the William Saunders building on the Central Experimental Farm. Dr. L.H. Newman, who succeeded Sir Charles as Dominion Cerealist, commented that “...it is impossible to evaluate the magnitude of his contribution to agricultural science in this country. It was a fine work and a great job well done.”

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