ALEXANDER MARCET (1770–1822), PHYSICIAN AND ANIMAL CHEMIST

by

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ALEXANDER John Gaspard Marcet[1] was born in Geneva in the year 1770. His father, who was a merchant of Huguenot descent,[2] wished him to follow the family business, but the young Alexander had no liking for commerce. Instead he decided to train for a career in the law, but before he could complete his studies he became involved in the disturbed political situation which arose in Geneva after the French Revolution.[3] This resulted in his imprisonment, along with his boyhood friend Charles Gaspard de la Rive.[4] After the death of Robespierre in 1794 the two friends were at length successful in obtaining a special dispensation by which they were released from prison but were banished from Switzerland for five years. They then came to Edinburgh, where they took up the study of medicine, both gaining the M.D. on the same day in 1797.

There was a strong chemical tradition in the University of Edinburgh at this time, deriving from the earlier influence of men like William Cullen. Joseph Black was in the chair of medicine and chemistry and the university was also served by Daniel Rutherford, from whom Marcet received instruction. The interest which Marcet was later to show in chemistry became apparent in that he chose to write his doctoral thesis on diabetes,[5] about which several plausible chemical theories were currently under discussion in the university.

Immediately after qualifying in 1797, Marcet moved to London where he was first of all assistant physician to the Public Dispensary in Cary Street. Two years later, in January 1799, he became a Licentiate of the Royal College of Physicians and was appointed physician to the City Dispensary at Finsbury. In the same year he married Jane Hallimand,[6] daughter of a wealthy Swiss merchant who lived in London; their son François was to become a distinguished physicist. So content was Marcet with his life in England that he took out naturalization papers in 1800 and for the next twenty years lived the life of a well-to-do London doctor.

It was natural that Marcet should wish to do all he could to help those who were

[1] Unsigned obituaries; *Lond. med. phys. J.*, 1823, **49**, 85; *Quart. J. for. Med. Surg.*, 1823, **5**, 314; *Med.-chir. Rev.*, 1822–3, **3**, 698; A. Garrod, *Guy's Hosp. Rep.* (iv), 1925, **5**, 373–89; *Dictionary of National Biography*, **36**, 122; W. Munk, *The Roll of the Royal College of Physicians of London*, 3 vols., London, 1878, vol. 2, p. 466.

[2] *La France Protestante*, ed. Eugene and Émile Haag, 10 vols, Paris, 1846–59 (Repr. Geneva, 1966), vol. 7, pp. 217–19; *Biographie Générale*, Paris, 1863, vol. 33, p. 463.

[3] Geneva passed through a period of 'Terror' similar to that in Paris, though less violent. During this time anyone who had spoken against the ruling party or had served in the National Militia was liable to be in trouble. Marcet had done both.

[4] C. G. de la Rive (1770–1834), M.D. Edin., 1797, practised in London 1797–99, then returned to Geneva where he spent his life in the university. J. C. Poggendorf, *Biographisch-Literarisches Handwurterbuch zur Geschichte der Exacten Wissenschaften*, Leipzig, 1863, Bd. 2, p. 658.

[5] A copy of Marcet's thesis 'De Diabete', Edinburgh, 1797, is to be found in the Library of the Royal Society of Medicine, London, where there is also a convenient collection of his papers (1805–1822). The thesis was a compilation from other sources, showing no evidence of clinical experience.

[6] Who, as Mrs. Marcet, became well known for her popular educational books. It is interesting to compare the lengths of the notices to Alexander and to his wife in *Dictionary of National Biography*, **36**, 122–3; see also Armstrong, *J. chem. Educ.*, 1938, **15**, 53.

fighting against Napoleon and he therefore volunteered his services in 1809 to take charge of a temporary Military Hospital set up in Portsmouth. This hospital was needed to care for troops returning from the Antwerp expedition in which Flushing and Walcheren were captured. Many of the soldiers contracted a virulent fever which came to be called the 'Walcheren Fever', and Marcet himself suffered a severe attack which made him seriously ill.[7] It is not impossible that this illness weakened his heart and so shortened his life.

From 1804 to 1819 Marcet held an appointment as a physician at Guy's Hospital. He secured this post largely through the good offices of his friend William Saunders,[8] who had been a physician at Guy's since 1770. Here Marcet came into contact with some of the leading physicians of the time, notably Sir Astley Cooper,[9] John Yelloly, and later William Prout.

He attended meetings of the London Medical Society and soon discovered that many of its members were dissatisfied with the manner in which its business was being conducted. Marcet and Yelloly therefore suggested that a new Society should be formed, and with the backing of Astley Cooper and Saunders they called a meeting of physicians and surgeons at the Freemasons' Tavern on 22 May 1805.[10] As a result of this meeting the Medico-Chirurgical Society of London came into being, 'to promote a spirit of harmony among the members of the profession, and to serve as a centre for the communication of papers . . .'[11] Saunders was the first President of the Society, Yelloly was Secretary, Astley Cooper was Treasurer, and Marcet, Foreign Secretary, an office which he held until his death in 1822. Through his acquaintance with foreign physicians and chemists, including Berzelius, Marcet was able to make the Medico-Chirurgical Society more widely known abroad than it otherwise would have been.[12]

William Saunders directed Marcet's attention to the chemical analysis of mineral waters[13] and this led him on to the examination of sea-water from various parts of the world.[14] These researches, carried on throughout much of his life, gave Marcet valuable insight into analytical procedures. He perfected his own methods, aiming to achieve accuracy with very small quantities of material, and he was prepared to

[7] William Allen records Marcet's absence from Guy's in October, 1809, *Life of William Allen with Selections from his Correspondence*, 3 vols, London, 1846, vol. 1, p. 115.

[8] William Saunders (1743–1817), was appointed Physician to the Prince Regent in 1807. *Dictionary of National Biography*, **50**, 330; Munk, *Roll*, 1878, **2**, 399.

[9] B. B. Cooper, *The Life of Sir Astley Cooper, Bart.*, 2 vols., London, 1843, vol. 2, pp. 40, 211, 240, 263, 273, 276, sheds interesting light on the character of Marcet and on his relations with his colleagues.

[10] Marcet is said to have been 'the original founder' of the Society. *Med.-chir. Rev.*, 1822–3, **3**, 698; but see N. Moore and S. Paget, *The Royal Medical and Chirurgical Society of London, Centenary 1805–1905*, Aberdeen, 1905, p. 7.

[11] *Lond. med. phys. J.*, 1805, **14**, 191; see also *Edinb. med. surg. J.*, 1805, **1**, 383–84, 504–5.

[12] Marcet's familiarity with European chemists is evident in his fascinating correspondence with Berzelius. Jac. Berzelius, *Brev*, Stockholm and Uppsala, 6 vols, 1912–1932. (suppl. 1935), vol. 1, pt. iii; see also Maurice Crosland, *The Society of Arcueil*, London, 1967, pp. 101, 120, 139, 360, 413, 468.

[13] To Saunders' *Treatise on Mineral Waters*, London, 1805, Marcet contributed 'A chemical account of the Brighton chalybeate'. This essay was also published separately in 1805.

[14] 'An analysis of the Dead Sea and the River Jordan', *Phil. Trans.*, 1807, **97**, 296–314; 'A chemical account of an aluminous chalybeate spring in the Isle of Wight', *Trans. geol. Soc.*, 1811, **1**, 213–348; 'On the specific gravity and temperature of sea-waters in different parts of the ocean etc.', *Phil. Trans.*, 1819, **109**, 161–208; 'On the water in Lake Ourmia or Urumea in Persia', *Ann. Phil.*, 1819, **14**, 150–51; 'Some experiments and researches on the saline content of sea-water, undertaken with a view to correct and improve its chemical analysis', *Phil. Trans.*, 1822, **112**, 448–56.

defend his work and criticize the methods of others when their results differed from his own.[15] This work was to be invaluable to Marcet in his chemical investigations of animal fluids, urine and urinary calculi. Indeed, it was for his animal chemistry that Marcet was best known and he was amongst those who laid the foundations of this subject in the nineteenth century.

Between 1807 and 1820 Marcet co-operated with William Babington and William Allen in giving courses of chemical lectures to the medical students at Guy's.[16] These courses were well established before Marcet took part in them; they were intended to familiarize the students with the main facts of general chemistry. From later syllabuses it appears that Marcet simply carried on the established tradition, adding only a few optional lectures on the identification of urinary calculi.[17] The lectures were illustrated by demonstration experiments and the student also had access to a well-equipped laboratory where he could see chemical processes in operation and so become 'familiarly acquainted with every step necessary in the management of such operations . . . without which the demonstrations of a lecture-room will seldom acquire that force which is necessary to fix them in his memory . . .'[18]

This method of illustrating chemical lectures with apposite demonstrations was something of a novelty and although Marcet cannot claim to have introduced it, he was nevertheless instrumental in disseminating it through the work of Berzelius. The latter, remembering his own youthful eagerness to carry out experimental work, was impressed by these demonstrations which he saw on his first visit to England in 1812.[19] The famous Swedish chemist copied Marcet's plan of lectures with their accompanying experiments and went on to elaborate and use it in his own courses, thereby establishing a method which was to become a model for the other chemical schools of Europe.[20]

In the courses given at Guy's there was only limited reference to Animal Chemistry as such. The main substances discussed under this heading included fibrin, gelatin, mucilage, and urea, which was stated to bear 'no resemblance to uric acid, a substance which constitutes the most common species of urinary calculus'. Marcet included some remarks on stones formed in the kidney and in the bladder, containing lithic or uric acid, oxalate of lime (the so-called mulberry calculus) and phosphates. A fusible calculus was described, and cystic oxide, discovered by Wollaston,[21] was also mentioned. Tests were given for each type in terms of their chemical reactions in solution and their behaviour with the blowpipe.

One of the more important aspects of Marcet's work was his insistence on the use of very small quantities in chemical tests, many of which might be regarded as 'semi-micro analysis'. Marcet considered this use of minute quantities as a development of

[15] E.g., 'Observations on Mr. Klaproth's analysis of the water of the Dead Sea', *Ann. Phil.*, 1813, **1**, 132–35.

[16] W. Babington and W. Allen, *A Syllabus of a Course of Chemical Lectures read at Guy's Hospital*, London, 1802. (1811 and 1816 editions ed. by Babington, Marcet, and Allen).

[17] This is made evident in the MS. lecture notes of Thos. E. Bryant (later President of the Medical Society of London), 'Lectures on Chemistry by Allen and Marcet', unpublished MS., 3 vols., 1816. in the Library of the Royal College of Surgeons, London.

[18] *Syllabus*, 1802, preface, p. vii.

[19] Jac. Berzelius, *Autobiographical Notes*, trans. Olof Larsell, Baltimore, 1934, p. 80.

[20] M. P. Louyet, *Edinb. New. phil. J.*, 1849, **47**, 1–12. Berzelius had to devise both the experiments and the apparatus to perform them.

[21] W. H. Wollaston, *Phil. Trans.*, 1810, **100**, 136.

primary importance. Thus he said, 'Amongst the various improvements which have assisted the progress of natural science within the last twenty years, that of carrying out experimental researches upon very small quantities of matter, ought, perhaps, to occupy the first place. The advantages which often result from a minute scale of operations are too obvious to require any comment . . .'[22] Marcet was endeavouring to follow what he had seen of Wollaston's work and it was to him that he ascribed the credit for the development of these small-scale methods. Of Wollaston, Marcet wrote, 'The acuteness with which he discriminates crystalline forms, however minute, the neatness of his chemical manipulations, and the dexterity with which he analyses the smallest quantity of matter, are known only to those who have seen him engaged in experimental researches. The chemistry of microscopical quantities is in a great degree his own.'[23]

Marcet thought that such methods facilitated analysis, making it more convenient, more economical, and sometimes more accurate. He said that by his small-scale methods he had never found it necessary to include 'a little dirt' amongst his results as some old-school chemists had been in the habit of doing. He was also convinced that the results of the analysis of minute quantities were equally valid for larger amounts. There were those who doubted this, but Marcet declared, 'I have always thought . . . that the chemical properties which belong to a particle of matter were exactly similar to those which would be found to belong to a whole mountain of the same substance.'[24]

In support of this contention he cited a variety of discoveries ranging from the chemical nature of urinary calculi to the discovery of new metals in crude platinum ores.[25] In the case of the alkali metals too, their isolation had involved 'mere atoms' only, yet when larger quantities became available no new discoveries or changes had resulted from quantity alone. Marcet's chemical knowledge displayed breadth, and it was through a common interest in the subject that he and Berzelius became acquainted in 1812. At Marcet's suggestion they worked together in his own laboratory on the preparation and properties of 'alcohol of sulphur' or carbon disulphide.[26] A mutual respect grew up between the two chemists which resulted in a life-long friendship, maintained principally through the exchange of letters. They were destined to meet in person only twice more, once in the autumn of 1818 in Paris and again in the summer of 1819 when Marcet returned to Geneva.

Davy, in his Presidential Address to the Royal Society on 30 November 1822, after Marcet's death, said of him, 'his different papers, published in the [*Philosophical*] *Transactions*, on chemical subjects, show how capable he was of sound reasoning, accurate experiments, and ingenious views, in this department of science . . .'[27] Marcet's personal qualities had also impressed Davy, who was moved to remark on his simple dignity and 'warmth of manner, arising from a warmth of heart, which ensured

[22] A. Marcet, *Ann. Phil.*, 1813, **2**, 99–100.
[23] A Marcet, *Med.-chir. Trans.*, 1811, **2**, 358.
[24] A Marcet, *Phil. Mag.*, 1812, **39**, 124.
[25] The discovery of palladium and rhodium in native platinum was announced by W. H. Wollaston in 1804 (*Phil. Trans.*, 1804, **94**, 419), whilst Smithson Tennant described osmium and iridium about the same time (*Phil. Trans.*, 1804, **94**, 411).
[26] This work was not completed during Berzelius' visit and it remained for Marcet to prepare it for publication. *Phil. Trans.*, 1813, **103**, 171–99.
[27] J. Davy (ed.), *The Collected Works of Sir Humphry Davy, Bart.*, 9 vols., 1839–40, vol. 7, p. 31.

affection'. These were the characteristics which endeared Marcet to his colleagues.

The friendship between Marcet and Berzelius, however, was established largely on their common interest in Animal Chemistry. Berzelius had realized early in his career the need for a more detailed knowledge of the nature of animal fluids and tissues with which, he believed, physiologists would be enabled to make better progress. He had set out to remedy the deficiencies in this branch of chemistry and had published a two-volume work in Swedish entitled *Forelasningar i Djurkemien.*[28] Marcet, who realized how important these researches were, pressed Berzelius to send some of his results for publication in the *Medico-Chirurgical Transactions.*[29] This Berzelius did, submitting a paper in 1812 which contained his original work on the analysis of animal fluids.[30] Marcet had this paper printed as a separate pamphlet and it represents the only part of Berzelius' book on Animal Chemistry to appear in English, although several abortive attempts were made to prepare an English translation of the complete work.

Earlier, Berzelius had sent a copy of his book to Davy who, realizing its novelty, at once suggested to the Animal Chemistry Society that they should undertake to have it translated.[31] The work was begun but never completed and Berzelius formed a poor opinion of the translation when he saw it during his visit to London. He therefore decided to have an English translation made under his own personal supervision and began to cast around for a publisher. Being unsuccessful, he turned to Marcet who continued the search for a long time. The difficulty was that large works on such specialized topics did not find a ready sale. Nevertheless, by April 1814, Marcet was able to persuade Longmans to agree to publish an edition of about five hundred copies, partly at their own risk.[32] The edition was not produced, however, since the translation was never completed.

William Brande once claimed that the members of the Animal Chemistry Society were the first to bring Berzelius into notice in this country,[33] but it would seem that Marcet has at least an equal claim to this distinction, both on account of his correspondence with Berzelius and his attempts to make his work better known in chemical circles in England.[34]

Inspired by Astley Cooper, Marcet made a number of chemical analyses of animal fluids in 1811, with the object of characterizing the fluid secreted in dropsical conditions such as spina bifida, for the treatment of which Cooper had been developing new techniques.[35] In an effort to identify the alkali present in such fluids Marcet

[28] Jac. Berzelius, *Forelasningar i Djurkemien*, 2 vols., Stockholm, 1806–8.

[29] The Journal of the newly formed Medico-Chirurgical Society. The first volume appeared in 1809. See Jac. Berzelius, *Brev.*, 1, pt. iii, p. 19.

[30] Jac. Berzelius, 'General views of the composition of Animal Fluids', *Med.-chir. Trans.*, 1812, **3**, 198–276; *Ann. Phil.*, 1813, **2**, 19, 195, 377, 415.

[31] See my article, 'The Animal Chemistry Club, Assistant Society to the Royal Society', *Notes Rec. R. Soc. Lond.*, 1967, **22**, 173–85 (177 ff). Marcet was not a member of this Society despite the fact that he knew Babington and would have met Everard Home socially at the 'Pow-wow' Club. B. B. Cooper, *Life of Sir Astley Cooper, Bart.*, vol. 2, p. 239. Both Babington and Home were founder members of the Animal Chemistry Club.

[32] Jac. Berzelius, *Brev*, 1, pt. iii, p. 91.

[33] C. R. Weld, *A History of the Royal Society*, 2 vols., London, 1848, vol. 2, p. 240.

[34] See J. Erik Jorpes, *Jac. Berzelius; His Life and Work*, trans. B. Steele, Stockholm, 1966, p. 83.

[35] A Marcet, *Med.-chir. Trans.*, 1811, **2**, 340–81. This work of Marcet, together with that of Berzelius, already mentioned and some analyses of animal fluids made by Bostock about the same time, may be said to have laid the foundations of our knowledge in this field. See J. Bostock, *Edinb. med. surg. J.*, 1805, **1**, 257; 1806, **4**, 37. *Med.-chir. Trans.*, 1813, **4**, 53.

combined it with nitric acid, crystallized the salts formed, and then carefully examined the crystals in the manner adopted by Wollaston. From the rhomboidal shapes obtained he concluded that they were formed of sodium nitrate (potassium nitrate would have given hexagonal prisms). Marcet therefore stated with confidence that the alkali present in these fluids was soda—a view which coincided with that of Berzelius.

There followed a controversy between Marcet and George Pearson, who considered that the alkali present in animal fluids was principally potash.[36] Bostock at first agreed with Pearson but later changed his mind and accepted the view proposed by Marcet.[37] Brande too, had found soda both in blood serum and in other animal fluids.[38] Since he was so certain of his results, Marcet was incensed at Pearson's criticism of his methods and pointed out that much of it was trifling and could easily be dismissed with 'half a grain of salt, a few drops of alcohol and a watch glass'. After restating his results, Marcet firmly refused to enter into an acrimonious quarrel and made it clear that he had little time for those who were prepared to do so.

In his private life Marcet was as meticulous as he was in his chemical work. He was punctilious in dress and behaviour and seems to have found it difficult to unbend.[39] All his thoughts seemed to turn about his work and so keenly interested was he in chemical experiments that he would carry about with him a small portable laboratory with which he could pursue his hobby at any convenient moment.[40]

Marcet was always seeking practical ways in which to improve the lot of his patients. One of the things he considered most worthwhile in his life was his success in bringing about an improvement in the diet of the patients at Guy's. This was not put into effect until after he had resigned his post at the hospital, but it was due to Marcet's strenuous efforts that the authorities were at length brought to see the need for a more interesting and better balanced diet. He was also successful in persuading Sir Samuel Romilly and the Hon. H. G. Bennett to press for a grant of money from Parliament for the support of the London Fever Hospital (called at that time the Institution for the Cure and Prevention of Contagious Fevers).

There can be little doubt too, that Marcet was anxious to help the physician to relieve the sufferings of those afflicted with calculous disorders when he published his book on this subject.[41] In the introduction Marcet said that it was whilst he was lecturing to the medical students at Guy's Hospital that he came to realize how little was known about the chemical properties of urinary calculi. The students were eager to secure all the information they could regarding the nature and possible methods of treatment of this disease.[42] Marcet continued the work of Wollaston, to whom he

[36] G. Pearson, *Phil. Mag.*, 1812, **39**, 64–72; A Marcet, *Phil. Mag.*, 1812, **39**, 122–27; *Nich. J.*, 1812, **31**, 230.

[37] Correspondence between J. Bostock and A. Marcet, *Phil. Mag.* 1812, **40**, 176–9; *Nich. J.*, 1812, **33**, 147, 288; *Med.-chir. Trans.*, 1813, **4**, 53.

[38] W. Brande, *Phil. Trans.*, 1812, **102**, 90–114 (98); *Phil. Mag.*, 1812, **40**, 109–17 (114).

[39] See B. B. Cooper, *The Life of Sir Astley Cooper, Bart.*, vol. 2, p. 273.

[40] Such portable laboratories had been known and used by mineralogists for a long time. See W. A. Smeaton, *Ambix*, 1965–6, **13**, 84–91.

[41] A. Marcet, *An Essay on the Chemical History and Medical Treatment of Calculous Disorders*, London, 1817 (2nd ed. 1819).

[42] In an interleaved copy of the 1802 *Syllabus* in the Library of the Royal College of Surgeons, there are MS. notes relating to calculi, and simple methods of identifying uric acid, phosphate and oxalate of lime calculi are also given.

acknowledged his indebtedness. He set out to describe calculi by means of their chemical composition rather than their position in the body.[43] He both described and illustrated by means of coloured line drawings, nine types of calculi of common occurrence, adding two more which he was the first to recognize. He was attempting, he said, 'to indicate the easiest analytical methods by which their chemical nature may be ascertained; and to point out the modes of medical treatment which afford the best prospect of success.'

Marcet's book was said to be superior to any other from a chemical point of view and perhaps its main interest was for the chemical pathologist.[44] As for medical treatment in these cases, Marcet doubted whether much could be done apart from surgery, once the disease had become established, though it might be possible to avoid or correct the conditions leading to the disorder if they were recognized early enough. He seems to have had in mind the average medical practitioner, into whose hands he wished to place a reliable method of diagnosis. 'I have thus pointed out the summary modes of analysis by which, with very little chemical skill or knowledge, and with an extremely simple apparatus, the various kinds of urinary calculi may be easily distinguished.'[45]

The tests given by Marcet involved the use of solutions such as the dilute mineral acids, acetic acid, the caustic alkalies and the alkali carbonates, ammonium hydroxide, ammonium oxalate and potassium cyanide. The blowpipe too, used in conjunction with a small spirit lamp, was found to yield valuable information about each type of calculus.[46] All the tests were to be carried out on a very small scale, using only a few drops of solution and pieces of calculi the size of a pinhead. Marcet included an illustration of a set of chemical apparatus amongst the plates at the end of his book. This was designed so as to be convenient for the physician to carry about with him and so enable him to make his tests on the spot.

A knowledge of the chemical nature of the different kinds of urinary deposits would clearly be useful in suggesting ways in which the condition might be prevented, but it would seem reasonable to suppose that the analysis of the urine itself would have been more readily available to the general practitioner. Indeed, in view of Marcet's interest in the analysis of mineral waters, it is surprising that he did not pay more attention to urine analysis in his book.[47]

[43] In this Marcet was following the lines laid down by Fourcroy, Pearson, and Brande as well as Wollaston. Fourcroy and Vauquelin, *Ann. Chim.*, 1800, **32**, 213; G. Pearson, *Phil. Trans.*, 1798, **88**, 15–46; Brande, *Phil. Trans.*, 1808, **98**, 223–43.

[44] Reviews of Marcet's book: *Med.-chir. Rev.*, 1817–18, **4–5**, 401, 493; *Lond. med. phys. J.*, 1818, **39**, 313.

[45] A. Marcet, *Essay*, 1817, p. 122. It was not unusual for large hospitals to keep collections of stones which formed the basis on which estimates of the relative frequency of occurrence of the different types of calculi were made. Thus Marcet examined the collection at Guy's whilst Yelloly examined that kept in Norwich. *Phil. Trans.*, 1829, **119**, 55–81; 1830, **120**, 514–28. Prout compared the results of several such statistical studies in his *Inquiry* of 1821 (see note 47, below).

[46] Wollaston had earlier used the blowpipe to analyse calculi. *Phil. Trans.*, 1797, **87**, 386–400. Berzelius too, was an expert in its use. Jac. Berzelius, *The Use of the Blowpipe in Chemical Analysis and in the Examination of Minerals*, trans. from the French of Fresnel by J. G. Children, London, 1822 (1st Swedish ed., 1819). This work contained a brief chapter on the analysis of calculi by means of the blowpipe.

[47] Marcet's omissions in this respect were to be rectified by William Prout, a junior colleague at Guy's. Prout added ammonium urate to the list of substances found in calculi by Marcet. *Med.-chir. Trans.*, 1819, **10**, 389. See also W. Prout, *An Inquiry into the Nature and Treatment of Gravel, Calculous and Other Diseases connected with a Deranged Operation of the Urinary Organs*, London, 1821.

Diabetes, the other common disorder readily detected by the examination of the urine, also interested Marcet. In his thesis of 1797 he had followed the views of Cruickshank in thinking that sugar was to be found in the blood of diabetics; but by 1811 there was considerable doubt about this. In an open letter to Wollaston, Marcet acknowledged that he did not wish to perpetuate his original views any longer; he agreed that sugar was not to be found in diabetic blood.[48] Wollaston had set out to test a theory of Charles Darwin that there was a passage from the digestive organs to the kidneys without involving the bloodstream.[49] In order to test this Darwin had administered massive doses of nitre, but Wollaston chose to experiment with potassium cyanide which, if carefully controlled, could be given without harm and for which the prussian blue test is exceedingly delicate. If cyanide were present in the blood of patients dosed with it, then it would certainly be detected. Both Wollaston and Marcet carried out these tests, applying them to the serum of the blood as well as to the urine, but in no case was cyanide found in the blood even when it was present in considerable amounts in the urine. This result seemed to confirm the observations concerning diabetes.

The fact that Wollaston directed his remarks to Marcet again indicates the respect in which the latter was held as a chemical analyst. His ability in this field is also clearly shown in his discussion of the use of silver nitrate for the detection of arsenic in animal fluids.[50] Marcet was able to show that arsenic could be detected by silver nitrate, even in the presence of other metals such as zinc, iron, copper, mercury and lead. The test was capable of an accuracy of the order of 4×10^{-6} of a grain, which was a considerable improvement on any other contemporary method.[51]

It was objected that Marcet's arsenic test was unsatisfactory in the presence of chlorides, since the silver chloride precipitate would mask that of silver arsenite, and sodium chloride would always be present in animal fluids.[52] Marcet, however, pointed out that the yellow silver arsenite was distinctive in several respects. The washed precipitate turned brown rather than black on exposure to the air and it was soluble in both nitric acid and ammonium hydroxide solutions. If the precipitate were heated on a strip of platinum foil the arsenic sublimed forming a white smoke of arsenious oxide; but by far the easiest way to identify silver arsenite in the presence of silver chloride would be to add dilute nitric acid with the silver nitrate, followed by the addition of ammonium hydroxide. In this way any white precipitate first produced would then be dissolved and the yellow colour of silver arsenite would become apparent.

A more serious objection to the silver nitrate test for arsenic was that if phosphates were present they would interfere by producing a yellow precipitate similar in appearance to silver arsenite.[53] Since it would also be common to find phosphates in animal

[48] W. H. Wollaston, *Phil. Trans.*, 1811, **101**, 96–105. A Marcet, loc. cit., pp. 106–9.

[49] Charles Darwin, *Experiments Establishing a Criterion between Mucilaginous and Purulent Matter, And an Account of the Retrograde Motions of the Absorbent Vessels of Animal Bodies in Some Diseases*, ed. by Erasmus Darwin the elder, Lichfield, 1780. (Later included in E. Darwin, *Zoonomia*, vol. 1, eds. of 1794, 1796, and 1801).

[50] A. Marcet, *Phil. Mag.*, 1813, **41**, 121–4; *Med.-chir. Trans.*, 1812, **3**, 342–47.

[51] Bostock, who preferred the use of copper arsenite, had claimed to be able to detect 1 part of arsenic in 2400 parts of the animal fluid. *Edinb. med. surg. J.*, 1809, **5**, 166.

[52] C. Sylvester, *Nich. J.*, 1812, **33**, 306.

[53] Jac. Berzelius, *Brev*, 1, pt. iii, 141.

fluids and in solutions prepared from animal matter, Marcet had to suggest how it might be possible to distinguish between these and the arsenic compounds. He indicated the possibility of using copper sulphate in alkaline solution to obtain a precipitate of Scheele's green and also appealed to the fact that an arsenic mirror could be formed by heating the animal matter with potash and powdered carbon.[54] The arsenic mirror test was introduced by Berzelius in 1826.[55]

After the declaration of independence of Geneva in 1814 Marcet had revisited his birthplace. Though he was received with acclaim and was able to renew his friendship with De la Rive, he nevertheless returned to London after only a short stay. In 1815 Marcet's scientific reputation was recognized by his election to the Fellowship of the Royal Society. Four years later, in 1819, he inherited a large fortune on the death of his father-in-law and gradually his enthusiasm for medical practice declined until he ultimately resigned his post at Guy's on 10 March 1819, though he continued to give his chemical lectures for another year after this. The desire to establish himself in Geneva grew, and in 1820–21 he paid a longer visit there during which he was offered a chair of chemistry, made a member of the Representative Council and shared a course of chemical lectures with his friend De la Rive. Marcet was rapidly absorbed into the life of the city and determined to remove himself there with his family. Thus it was with the intention of clearing up his affairs in England that Marcet returned in 1822, and whilst he was visiting Edinburgh he was seized by an attack of gout in the stomach. He was attended by both Babington and Astley Cooper, but despite all their efforts the attack proved fatal and Marcet died on 18 October 1822, at the age of 52. He was buried at Battersea.

In any attempt to assess Marcet's chemical work it must be admitted that he made few fundamental discoveries.[56] Nevertheless he showed by his work that it was possible to apply chemical analysis to animal substances and use the results to make diagnosis and medical treatment more reliable. This approach was developed and extended by William Prout,[57] partly as a result of Marcet's influence during the years when they were colleagues at Guy's. Prout continued to insist upon the benefits to be derived from the application of chemistry to physiology and medicine. There were vitalists who wished to deny that chemistry had much part to play in physiology,[58] but this attitude diminished as the nineteenth century advanced. Marcet can claim to have been amongst those chemists who saw that physiological processes would ultimately be explained in chemical terms. He was one of the founders of Animal Chemistry.

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[54] A. Marcet, *Med.-chir. Trans.*, 1815, **6**, 663–64; *Ann. Phil.*, 1816, **7**, 236; Jac. Berzelius, *Brev*, **1**, pt. iii, 146.

[55] Jac. Berzelius, *Ann. Phys.*, 1826, **6**, 71–78; *Phil. Mag.*, 1826, **67**, 150.

[56] Marcet's description of the xanthic oxide calculus is an exception to this statement, and his recognition of the condition later called alkaptonuria must be considered an important clinical advance. *Med.-chir. Trans.*, 1823, **12**, 37–45.

[57] See W. H. Brock, 'The life and work of William Prout', *Med. Hist.*, 1965, **9**, 101–26.

[58] E.g. A. P. Wilson Philip sharply criticized Prout's call for physiologists to become chemists. *Lond. med. Gaz.*, 1831, **8**, 641, 705, 737, 769–770, 802, 843; 1831–2, **9**, 38, 69, 73.