of regulating the metallic currency was established in England, as it were, accidentally, and deliberately adopted only in 1816. The practical good results which followed made all English economists of that period warm advocates of the composite system. Thus, M'Culloch and Tooke agree in supporting the English system, as also does J. S. Mill.[1] On the Continent the weight of authority was more divided, and the existence of the French bimetallic system gave support to the advocates of a double standard. The result of the gold discoveries in Australia and California was to greatly increase the supply of that metal, and, under the action of Gresham's law, to change the French currency from silver to gold, while Holland, to avoid the evils which were anticipated from the reduced value of that metal, adopted silver as the standard. The movements in favour of a universal currency described above, combined with the course of events, brought the standard question into greater prominence. The proposal of the Paris conference of 1867 for a single gold standard, and a universal coinage on that basis, raised the question to great prominence. Wolowski and Courcelle Seneuil strongly opposed the recommendation, the former predicting that a disastrous appreciation of gold would follow. This view seems borne out by the result, for, although a universal coinage was not created, yet Germany and the Scandinavian Union both changed from a silver to a gold standard, while Holland and the United States both made movements in the same direction by demonetizing silver and making preparations for adopting gold. The Latin Union at the same time restricted their silver coinage, which had nearly the same effect as the adoption of a gold standard.[2] The result of these extensive changes was to cause much confusion. The more ardent advocates of a double standard, too, attributed most of the continued trade depression to this cause. The altered condition of opinion on the question was seen at the monetary conference held at Paris in 1878, where the universal demonetization of silver was considered to be dangerous. The "Bland Act" of the United States, which theoretically decreed the double standard (1878), was another instance of reaction. The great depreciation of silver, which resulted mainly from its having ceased to be money over a large part of the civilized world, severely affected the Indian finances,[3] and thus the advocates of a double standard were able to command some attention in England. The conference held in Paris in 1881 reflected these changed views. The supporters of the double standard took the initiative and proposed a treaty based on the double standard at a fixed ratio, but no conclusion was arrived at—England, Germany, and the Scandinavian Union upholding the gold standard.

Such, in brief, has been the recent history of the standard question, and it now becomes desirable to examine more closely the conflicting arguments in the various shapes they have taken. The older English advocates of the gold standard have found their best representatives in Lord Liverpool and Tooke. The former of these adopted the argument used by Petty, Locke, and Harris, that only one metal can be the standard of value at a given time, but he held that the advance of England in wealth rendered gold a more suitable material than silver for the principal money. He added that by law the power lay in the sovereign to settle the standard, and, as a matter of fact, he contended that gold was actually at that time (1805) the English standard in common estimation. These arguments were supported by a mass of historical examples.[4] Tooke, who dealt with the subject in his *History of Prices*, severely criticizes the double standard. He points out that it would be impossible to keep both metals in circulation, and that it would be the inferior one which would remain. He also indicates a more refined objection, namely, the difficulty of constituting a bank reserve under the double standard. Thus, if silver were the more valuable, and the reserve consisted mainly of it, there would be an inducement to make a run on the reserve, so as to drain out the small quantity of gold and then get the more valuable silver.[5] The silver standard was preferred by Ricardo, who fully accepted the arguments against the double standard as conclusive; his view was, that silver was steadier in value than gold, and was the standard money in other countries, while the objection to it on account of its greater bulk was, he thought, obviated by the use of paper money for circulation.[6] J. S. Mill pronounces no opinion as to the comparative merits of gold and silver, but he objects to the double standard on the usual ground that the cheaper metal is the only one used in payments, and that therefore the fluctuations are more frequent under a double standard *régime*. The advocates of the concurrent use of the two metals, prominent among whom were Wolowski on the Continent and Seyd in England, contended that these objections were ill-founded, for (1) the double standard, though it produced (*i.e.*, admitting the assumption of their opponents) more frequent fluctuations, still did not vary so widely from the mean, since in each case it was the *cheaper* metal which determined the value,[7] and (2) the action of Gresham's law would produce a compensatory action. Thus, if silver be undervalued in a double-standard system, a drain sets in to other countries where it is more valuable. The quantity of silver is thus reduced and its value raised, while gold is imported, its quantity increased, and its value lowered. Were gold the undervalued metal, the converse process would take place. The soundness of this position is illustrated by the case of the great transformation of the French currency (1849-1860). During the rapid increase of the gold supplies the value of silver only rose about 3 per cent.; in fact the depreciation was spread over the two metals, and not confined to gold.[8] In addition to the above arguments, it was urged by Wolowski that any attempts to establish a universal gold standard as contemplated by the Paris conference of 1867 would cause a great appreciation of gold, which would be disastrous to commercial interests, while silver would lose most of its value. The services which the double-standard countries rendered by acting as intermediaries between gold and silver standard countries was also dwelt on, the ease with which the mass of silver needed for exportation to the East was supplied from France during the years 1853-56 being an instance in point. The monetary difficulties, as indicated above, which followed the adoption of gold by Germany and the Scandinavian Union, as well as the embarrassment of the Indian Government, from the resulting depreciation of silver, revived the double-standard advocates. Cernuschi and De Laveleye came forward as supporters of what the former called *bimetallism*, that is to say, the establishment of a universal, or at all events a large international, currency, based on the concurrent circulation of the two metals gold and silver at a fixed ratio. This plan has gained many supporters, though the tendency among English economists was at first to decline even to consider it; and not even yet does the question appear to have received that careful examination by monometallists which would be desirable.[9]

The bimetallists start with a discussion as to the causes which determine the value of money. They point out that there are two extreme theories: one that the value of money depends on the will of the sovereign (the *fiat* theory); the other that the value of money is entirely independent of state control, and determined by economic conditions (the *free trade* theory). Neither of these is accepted by the bimetallists. They take up a middle ground and hold that, by its power of deciding what substance shall be deemed legal tender and discharge all obligations, the state is able to determine, *within limits*, what substances shall be money and what the value of those substances shall be. They argue from history that several metals have been successively demonetized, that different ratios have been fixed between metals circulating together, that inconvertible paper currencies have been kept in circulation by the will of the state.[1] The doctrine of cost of production as determining the value of money is also assailed by them. They hold that it is the quantity of money which governs its value,[2] and that cost of production has little or no influence in the matter. The next step in the bimetallic argument is to contend that their proposed ratio for gold to silver (1 to 15½) can be maintained by the legal regulations to that effect. The common objection to bimetallism is, that whichever metal was undervalued would be exported. They answer that the same ratio existing over all, or a great part of, the world, there would be no inducement to export either metal, and in support of their argument they appeal to the passage from Newton quoted above, and claim him as the inventor of modern bimetallism.[3] Thirdly, a greater stability as regards value is claimed for the two metals combined than for either singly, since the fluctuations are distributed over a wider field, and, the conditions of production of gold and silver being somewhat different, fluctuations in them tend to counterbalance each other. A fourth point consists in the greater facilities which would exist for trade, since the fluctuations of the exchanges which arise from the existence of gold and silver currencies, and the variations of relative value of these metals, would under a bimetallic system disappear. The fifth argument for bimetallism is the advantages which would result from the increased prices caused by the greater abundance of money, or at all events from the check to any fall in prices which might arise from a diminution in the production of gold. The final argument is that a universal currency is desirable, and that, a single gold currency being by general consent practically impossible, this advantageous reform can be realized in no other way than by adopting a plan which permits the concurrent circulation of two metals. Most of these positions are contested by the monometallists, and even where any concession is made the value of the advantage to be reaped is estimated at a much smaller amount. The contention that the value of money is largely influenced by state demand is met by the assertion that cost of production is the ultimate regulator of value, and that any artificial regulation would stimulate the production of the cheaper metal, and thus flood the world with it. The fixing of a ratio different from the market one is derided by them as absurd, and an extreme case is instanced for this purpose. Is it possible, they ask, to make the value of silver equal to that of gold? If not, how can it be possible to alter the market ratio in even the slightest degree? Is there not a great demand for the precious metals in the various trades? And would not the ratio of this demand be affected by the fixing of a new ratio? The argument of bimetallists that their system would produce greater stability in the value of money is met by the answer that there is no proof of this. It is quite possible that a single metal may be steadier in value than two combined, and the evidence of history shows that silver is more liable to depreciation than gold. The argument derived from the advantages to exchange transactions is to a slight extent admitted, but it is pointed out that the factors which affect the foreign exchanges are so numerous, and are so rapidly eliminated in the course of trade, that a radical currency change need not be adopted for this purpose. It is also shown that, even when most European countries were bimetallic, fluctuations in the exchange price of silver took place; and still more that, where it is the less valuable metal that is in course of depreciation, bimetallism can afford no aid. The assumed tendency of the bimetallic scheme to produce a higher scale of prices than would otherwise prevail is dwelt on by opponents as a proof of its inherently vicious character. The claim to benefit the world by adding to its stock of money places bimetallists in the same class with the advocates of inconvertible paper money, and shows the absence of reason in their views. Their position becomes the same as that of the Birmingham currency school. The proposition that the quantity of money is of no consequence since prices vary in proportion to it is cited as conclusive, and the contempt so frequently expressed for bimetallists is accounted for by their advocacy of this principle of the beneficial effects of an increased amount of money. To the contention that bimetallism is the necessary condition for a universal coinage system the answer is, that the idea of universal coinage is premature, and that the *gradual* introduction of the gold standard is desirable as preparing the way for a future universal coinage based on gold monometallism. On the practical question as to the actual introduction of the system, the monometallists deny the possibility of forming a universal bimetallic league which would not be liable to be broken up by war, or impaired by some of the states which composed it issuing inconvertible paper. On the other hand, the various international conventions for postal purposes, extradition, commercial arrangements, and other matters of interest, are considered by bimetallists as evidences of the feasibility of their plan.[4]

The above summary gives the main arguments on each side of the discussion as given by the advocates of the contending principles. A short consideration will show that the controversy may be suitably divided into three heads, viz.—(1) the possibility of constructing a universal bimetallic system which shall be in accordance with sound economic principle; (2), if the first question be answered in the affirmative, the comparative merits of this system as opposed to the present variety of systems, or a future universal gold-standard system; and (3) the expediency under present circumstances of nations in general, and England in particular, joining in the proposed convention. Each of these topics calls for some remark. (1) The possibility of a bimetallic system can hardly be denied. Under all the difficulties attending its existence in a single country, it was retained in practical working in France during the early part of the 18th century, and it is plain that a widely-extended league would afford a better field for its action. It is quite possible that national preferences for one metal or the other would be displayed, but this would be no hindrance, since the exchanges would be regulated by the legal rate, and prices would depend on the total quantity of both metals (the amount of gold being multiplied by the legal ratio, and added to the amount of silver).[5] The objection which denies the power of Governments to fix the relative values of gold and silver, and which is supported by the instance of the extreme case of silver being made equal in value to gold, may be set aside by the consideration that the use of the precious metals takes two forms—(*a*) their use as commodities, (*b*) their use as money. Since the state can influence the demand for these metals as money, and since therefore it can raise the value of either of them by this increased demand, it follows that, within assignable limits, it can fix the ratios between them, and that these limits are "the ratio which would subsist between their values if gold were demonetized, and that which would subsist if silver were demonetized."[6] The possibility of bimetallism, if all nations were agreed, is allowed by some monometallists (*e.g.*, Professor Jevons), and an unconscious argument to this effect was given by the proposal of Chevalier, at the time of the Australian gold discoveries, to adopt silver as the standard and demonetize gold, which is a clear recognition of the force of law in monetary questions. It is therefore reasonable to answer in the bimetallists' favour the question first raised. (2) The considerations to be taken into account under the second head are far more complex, and do not admit of accurate determination. The present currency systems of England and the Scandinavian Union are based on the composite system, and afford the greatest satisfaction to the inhabitants of those countries. The bimetallic system of the Latin Union has been suspended, the introduction of silver as the principal money not being desired by the various peoples concerned. Germany has lost considerably by the sales of depreciated silver, and, were a gold standard once firmly established, it is not likely that any wish for change would be manifested. With silver countries the case is different. They have to receive masses of depreciated silver and to give commodities in exchange, while their purchasing power is reduced owing to the greater relative value of gold to silver. It would therefore be clearly advantageous for silver-using countries that a system should be adopted which would raise the value of their money, and save them from the necessity of importing large quantities of silver to produce a proper adjustment. The ultimate consequences of the complete demonetization of silver as regards silver-using countries are not so clear. The supply of gold might suffice for all wants, and might furnish a better currency than the heavier silver. The preservation of two separate monometallic systems, of gold for the more advanced countries of Europe and the United States, of silver for Russia and India, would, when the superfluous stock of silver had passed to the East, present little difficulty after equilibrium was attained. The new ratio between silver and gold would become established, and silver prices in silver-using countries would be higher in proportion to the fall in the value of silver. It is therefore plain that a suitable adjustment would be reached under any variety of currency systems, and it may therefore be concluded that the comparative merits of the competing standards are not capable of

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[1] Lord Ashburton was the only person of influence who advocated the double standard.

[2] The amounts decreed to be coined each year were as follows:—

	Frs.	
1874 =	120,000,000	
1875 =	150,000,000	
1876 =	120,000,000	
1877 =	65,000,000	
1878 =	9,000,000	For Italy only.
1879 =	20,000,000	

[3] See, for a full discussion, W. Bagehot, *Depreciation of Silver*.

[4] *Coins of the Realm*, pp. 128-165.

[5] This objection to the double standard is also urged by Prof. Thorold Rogers and by Bagehot. Actual instances of the difficulty occurred in 1860, and again in 1876, with the Bank of France.

[6] "Proposals for an Economical and Secure Currency," *Works* (ed. M'Culloch), p. 403.

[7] The superposition of two curves, each representing the variations of one metal, and the formation of a third curve representing the lowest concurrent points of each, will make this clear. See Jevons, *Money*, p. 138.

[8] See J. E. Cairnes, *Essays in Pol. Econ.*, pp. 140-143.

[9] Mr A. J. Wilson has collected a series of articles on Reciprocity, Bimetallism, and Land Tenure Reform, and Prof. Bonamy Price dealt with Bimetallism and Fair Trade in his address to the Social Science Congress in 1882. But there is no fair reason for placing E. de Laveleye, Luzzati, Cernuschi, Dana Horton, and other supporters of bimetallism—and we may add Prof. F. A. Walker—in the same category with the advocates of (so-called) "Reciprocity."

[1] See Dana Horton's paper on the *Position of Law in the Doctrine of Money*, presented to the monetary conference of 1881 (Appendix ix. C).

[2] On p. 721, above, the theory of money value has been stated, and the objections to the cost of production theory given. It is strange to find Jevons arguing (in common with Bagehot and Prof. Price) that the value of money ultimately depends on cost of production, when his examination of that doctrine in general is considered. Compare *Contemp. Rev.* (May 1881) with Jevons's *Theory of Pol. Econ.*, p. 201 *sq.*

[3] Modern bimetallists freely admit that two different bimetallic systems—*i.e.*, having different ratios—could not exist, for each would drain the other of one metal.

[4] The principal sources for the above summary, besides works before cited, are the pamphlets of Seyd, Cernuschi, and De Laveleye, on the bimetallist side, as well as the articles of the latter in the *Fort.* and *Contemp. Reviews*. The monometallist arguments are given by Prof. Jevons (*Contemp.*, May 1881), Mr R. Giffen (*Essays in Finance*, pp. 286-310), and Lord Sherbrooke (*Nineteenth Century*, April 1882). See also the *Report* of the Paris conference, 1881, and Mr T. H. Farrer, *The State in its Relation to Trade*, pp. 49-52.

[5] It is assumed that the other factors which influence the value of money (see p. 722, above) remain constant.

[6] Mr J. J. Murphy in *Dublin Statistical Journal*, vol. viii. p. 282. See also M. Walras, *Journal des Economistes*, May 1881, "Théorie Mathématique du bimétallisme."

being decided at present. The immediate introduction of a universal gold currency is by the admission of all parties eminently undesirable, and this is the only settled point in the controversy. (3) The last head which the bimetallic question embraces is the practical expediency of joining in a bimetallic league with a ratio of 1 to 15½. With regard to this aspect of the question the answer, for England at least, ought to be a negative one. The present English monetary system has worked well. It is firmly rooted in English habits, and is not therefore to be lightly abandoned. Again, the interests of English creditors are plainly opposed to any movement calculated to raise the value of silver relatively to gold, and to depreciate prices in general. The threat of some bimetallists, that all nations will be driven to adopt a gold standard, and thus produce a crisis in the English money market by the resulting gold drain, is of no weight; any drain of English gold will have to be paid for at a high price, and the simple expedient of raising the bank-rate will restore as much bullion as is needed in England. The interests of other countries cannot be so clearly determined. A state like Germany, holding a large store of depreciated silver, may desire other states to become bimetallic, but will hardly desire to do so herself. The interests of India and other silver-standard countries have been considered before. When all these aspects of the question have been examined the most probable conclusion is, that the chances of a bimetallic league in the immediate future are very small, and that future monetary evolution will be ruled rather by the course of events, and the pressure of circumstances in each separate state, than by the conscious deliberations of an international conference.

Bibliography.—The literature of the various questions connected with money is very extensive, and only a brief notice of it can be given here. The principal authority among the Greeks is Aristotle, who in two passages (*Nic. Eth.*, v. 5; *Pol.*, i. 9) has discussed the qualities of money, and pointed out its functions with great clearness. Xenophon also, in his work *On the Athenian State*, dealt with the value of the precious metals, though his views are partially erroneous. The only passages worth noticing in Latin literature are those of Pliny, who seems to have held a form of the mercantile theory, and Paulus, who, in a fragment preserved in the *Digest*, has treated of the origin of money. The mediæval literature embraces several works dealing specially with the question of changes in the standard of money, which were condemned by the theologians. The first treatise professedly on the special subject of money is a work by Nicholas Oresme, bishop of Lisieux (*ob.* 1382), entitled *De Origine, Natura, Jure, et Mutationibus Monetarum*, reprinted in 1864 (Paris) by Wolowski, and even now worth reading. The next work to be noticed is the *De Monetarum Potestate simul et Utilitate libellus* (Nuremberg, 1542), a fragment of a larger treatise on economics, of Gabriel Biel (*ob.* 1495). It has been remarked that "the favourite subject of the economists of the 16th century was that of money." The first of these works to be noticed is *De Monetæ Cudendæ Ratione* by Copernicus, reprinted along with the work of Oresme above mentioned. At a later date the Jesuit Mariana discussed the variations in prices under the title *De Monetæ Mutatione*. In the same century an anonymous work appeared in German, with the title *Gemeine Stimmen von der Muntze* (1530). In 1588 Davanzati issued *Lezione delle Monete*, advocating a bimetallic system. The problem of the elevation of prices caused by the American mines led to the issue of several works, one of the most remarkable being the *Dialogues* of William Stafford (1581).

In the 17th century Sir W. Petty dealt with money in a tract, *Quantulumcumque* (1682). The recoinage of 1696 called forth Lowndes's *Essay for the Amendment of the Silver Coins*, and Locke's *Further Considerations concerning raising the Value of Money*. In the 18th century the *Reports* of Sir I. Newton, as Master of the Mint, are valuable. Cantillon's *Essai* (Paris, 1755) contains in its 2d and 3d parts a sound account of currency. Harris's *Essay on Money and Coins* (1757) is also useful. An earlier tract by Rice Vaughan, *Discourse of Coin and Coinage* (1675), is brief, but correct in principle. Adam Smith's *Wealth of Nations* (London, 1776) discusses the subject of money in B. i. chs. 4 and 5, while seigniorage is examined in B. iv. ch. 6. The treatise, *The Coins of the Realm* (London, 1805), by the first earl of Liverpool, elaborately discussed the question of the proper standard, and has powerfully influenced monetary legislation in England and Germany. Ricardo's pamphlets on the bullion question added to the knowledge of the laws which regulated a depreciated currency. Senior, in his *Lectures on the Cost of obtaining Money* (London, 1829), developed the theory of the international distribution of the precious metals.

The last half century has been a time of active discussion regarding monetary questions,—the gold discoveries, international coinage, decimal coinage, bimetallism, the resumption of specie payments in countries where an inconvertible currency has existed, each of these topics having had its special literature. Some of these works have been mentioned when dealing with the special questions they refer to, and these, in turn, refer to many others. It will suffice here to mention more general works. The theory of money is dealt with by the leading English economists in their systematic works (Mill, *Principles*, B. iii. chs. 7-10, 19, 21; Fawcett, *Manual*, B. iii. chs. 5, 6, 15, 16; Shadwell, *System*, B. iii. chs. 1-3 and 8), also by Cherbuliez (*Précis*, B. ii. ch. 3, vol. i. and B. ii. ch. 3, vol. ii.). Chevalier has devoted the third volume of his *Cours* (Paris, 1842-50) to the subject, with the title of "La Monnaie." The late Professor W. S. Jevons's valuable work, *Money and the Mechanism of Exchange*, and Professor Hussey Walsh's concise *Treatise on Metallic Currency* (Dublin, 1853) may also be used. More elaborate than either of these is F. A. Walker's *Money*, the most comprehensive work on the subject in English; his smaller work, *Money in its Relation to Trade and Industry*, is likewise very good. Wolowski's *L'Or et l'Argent* contains much information, as does also Knies's *Das Geld*. E. Seyd's *Bullion and Foreign Exchanges* is serviceable, but the changes since its publication (1869) deprive it of most of its value. The various editions of Tate's *Cambist* give the most accurate (though often imperfect) statements as to the facts of currency. Jacob's work on *The Production and Consumption of the Precious Metals* gives many interesting details, though the conclusions are often fanciful, and the authorities relied on not trustworthy. The recent work of Del Mar, *History of the Precious Metals* (London, 1880), furnishes a criticism and continuation of Jacob, and supplies many new details. His criticism of the "cost of production" theory as applied to gold and silver is especially useful. Some of his views on the moral aspects of the question need qualification. Professor Sumner's *History of the American Currency* may be relied upon for its facts. The *Reports* of the various conferences also supply abundant information on their special topics. Among these may be mentioned the *Proceedings* of the Paris conferences of 1867, 1878, and 1881; the *Decimal Coinage Commission* (1868); the French *Enquête Monétaire* (1870); and the *Report of the Committee of the House of Commons on the Depreciation of Silver* (1876). The *Reports of the* (English) *Mint* furnish information as to the coinage changes of each preceding year.

(C. F. B.)

MONFERRATO, or MONTFERRAT, an ancient marquisate of North Italy, in the valley of the Tanaro, the name of which still survives in the fuller title (Casale Monferrato) of the town of Casale. The princes of Monferrato were among the most powerful Italian families of the Middle Ages. Among them were several famous crusaders: Conrad, prince of Tyre from 1187 to 1192, the valiant opponent of Saladin; and Boniface, king of Thessalonica from 1183 to 1207. In 1305, on the extinction of the male line, the marquisate passed to Theodore Palæologus through his mother, the empress Irene. The Palæologi became extinct in 1533. The duchy was subsequently attached to Mantua, and ultimately absorbed in Savoy in the beginning of last century.

MONGE, GASPARD (1746-1818), French mathematician, the inventor of descriptive geometry, was born at Beaune on the 10th May 1746. He was educated first at the college of the Oratorians at Beaune, and then in their college at Lyons,—where, at sixteen, the year after he had been learning physics, he was made a teacher of it. Returning to Beaune for a vacation, he made, on a large scale, a plan of the town, inventing the methods of observation and constructing the necessary instruments; the plan was presented to the town, and preserved in their library. An officer of engineers seeing it wrote to recommend Monge to the commandant of the military school at Mézières, and he was received as draftsman and pupil in the practical school attached to that institution; the school itself was of too aristocratic a character to allow of his admission to it. His manual skill was duly appreciated: "I was a thousand times tempted," he said long afterwards, "to tear up my drawings in disgust at the esteem in which they were held, as if I had been good for nothing better." An opportunity, however, presented itself: being required to work out from data supplied to him the "de lement" of a proposed fortress (an operation then only performed by a long arithmetical process), Monge, substituting for this a geometrical method, obtained the

result so quickly that the commandant at first refused to receive it—the time necessary for the work had not been taken; but upon examination the value of the discovery was recognized, and the method was adopted. And Monge, continuing his researches, arrived at that general method of the application of geometry to the arts of construction which is now called descriptive geometry. But such was the system in France before the Revolution that the officers instructed in the method were strictly forbidden to communicate it even to those engaged in other branches of the public service; and it was not until many years afterwards that an account of it was published. The method consists, as is well known, in the use of the two halves of a sheet of paper to represent say the planes of *xy* and *xz* at right angles to each other, and the consequent representation of points, lines, and figures in space by means of their plan and elevation, placed in a determinate relative position.

In 1768 Monge became professor of mathematics, and in 1771 professor of physics, at Mézières; in 1778 he married Madame Horbon, a young widow whom he had previously defended in a very spirited manner from an unfounded charge; in 1780 he was appointed to a chair of hydraulics at the Lyceum in Paris (held by him together with his appointments at Mézières), and was received as a member of the Academy; his intimate friendship with Berthollet began at this time. In 1783, quitting Mézières, he was, on the death of Bezout, appointed examiner of naval candidates. Although pressed by the minister to prepare for them a complete course of mathematics, he declined to do so, on the ground that it would deprive Madame Bezout of her only income, arising from the sale of the works of her late husband; he wrote, however (1786), his *Traité élémentaire de la Statique*.

Monge contributed (1770-1790) to the *Memoirs* of the Academy of Turin, the *Mémoires des Savants Étrangers* of the Academy of Paris, the *Mémoires* of the same Academy, and the *Annales de Chimie*, various mathematical and physical papers. Among these may be noticed the memoir "Sur la théorie des déblais et des remblais" (*Mém. de l'Acad. de Paris*, 1781), which, while giving a remarkably elegant investigation in regard to the problem of earthwork referred to in the title, establishes in connexion with it his capital discovery of the curves of curvature of a surface. Euler, in his paper on curvature in the Berlin *Memoirs* for 1760, had considered, not the normals of the surface, but the normals of the plane sections through a particular normal, so that the question of the intersection of successive normals of the surface had never presented itself to him. Monge's memoir just referred to gives the ordinary differential equation of the curves of curvature, and establishes the general theory in a very satisfactory manner; but the application to the interesting particular case of the ellipsoid was first made by him in a later paper in 1795. A memoir in the volume for 1783 relates to the production of water by the combustion of hydrogen; but Monge's results in this matter had been anticipated by Watts and Cavendish.

In 1792, on the creation by the Legislative Assembly of an executive council, Monge accepted the office of minister of the marine, but retained it only until April 1793. When the Committee of Public Safety made an appeal to the savants to assist in producing the *matériel* required for the defence of the republic, he applied himself wholly to these operations, and distinguished himself by his indefatigable activity therein; he wrote at this time his *Description de l'art de fabriquer les canons*, and his *Avis aux ouvriers en fer sur la fabrication de l'acier*. He took a very active part in the measures for the establishment of the Normal School (which existed only during the first four months of the year 1795), and of the School for Public Works, afterwards the Polytechnic School, and was at each of them professor for descriptive geometry; his methods in that science were first published in the form in which the shorthand writers took down his lessons given at the Normal School in 1795, and again in 1798-99. In 1796 Monge was sent into Italy with Berthollet and some artists to receive the pictures and statues levied from several Italian towns, and made there the acquaintance of General Bonaparte. Two years afterwards he was sent to Rome on a political mission, which terminated in the establishment, under Massena, of the shortlived Roman republic; and he thence joined the expedition to Egypt, taking part with his friend Berthollet as well in various operations of the war as in the scientific labours of the Egyptian Institute of Sciences and Arts; they accompanied Bonaparte to Syria, and returned with him in 1798 to France. Monge was appointed president of the Egyptian commission, and he resumed his connexion with the Polytechnic School. His later mathematical papers are published (1794-1816) in the *Journal* and the *Correspondance* of the Polytechnic School. On the formation of the Senate he was appointed a member of that body, with an ample provision and the title of count of Pelusium; but on the fall of Napoleon he was deprived of all his honours, and even excluded from the list of members of the reconstituted Institute. He died at Paris on the 28th July 1818.

For further information see B. Brisson, *Notice historique sur Gaspard Monge*; Dupin, *Essai historique sur les services et les travaux scientifiques de Gaspard Monge*, Paris, 1819, which contains (pp. 162-166) a list of Monge's memoirs and works; and the biography by Arago (*Œuvres*, t. ii., 1854).

Monge's various mathematical papers are to a considerable extent reproduced in the *Application de l'Analyse à la Géométrie*, 4th edition (last revised by the author), Paris, 1819—the pure text of this is reproduced in the 5th edition (revue, corrigée et annotée par M. Liouville), Paris, 1850, which contains also Gauss's Memoir, "Disquisitiones generales circa superficies curvas," and some valuable notes by the editor. The other principal separate works are *Traité élémentaire de la Statique, 8e édition, conformée à la précédente, par M. Hachette, et suivie d'une Note etc., par M. Cauchy*, Paris, 1846; and the *Géométrie Descriptive* (originating, as mentioned above, in the lessons given at the Normal School). The 4th edition, published shortly after the author's death, seems to have been substantially the same as the 7th (*Géométrie Descriptive par G. Monge, suivie d'une théorie des Ombres et de la Pérspective, extraite des papiers de l'auteur, par M. Brisson*, Paris, 1847).

(A. CA.)

MONGHYR, or MUNGIR, a district in the lieutenant-governorship of Bengal, lying between 24° 22′ and 25° 49′ N. lat., and 85° 40′ and 86° 52′ E. long., is bounded on the N. by Darbhangah and Bhágalpur, on the E. by Bhágalpur, on the S. by the Santál Parganás and Hazáribágh, and on the W. by Gayá, Patná, and Darbhangah, with an area of 3922 square miles. The Ganges divides the district into two portions. The northern, intersected by the Burí Gandak and Tiljugá, two important tributaries of the Ganges, is always liable to inundation during the rainy season, and is a rich, flat, wheat and rice country, supporting a large population. A considerable area, immediately bordering the banks of the great rivers, is devoted to permanent pasture. Immense quantities of buffaloes are sent every hot season to graze on these marshy prairies; and the *ghí*, or clarified butter, made from their milk forms an important article of export to Calcutta. To the south of the Ganges the country is dry, much less fertile, and broken up by fragmentary ridges. The soil consists of quartz, mixed in varying proportions with mica. Ranges of hills intersect this part of the district, and in the extreme south form conical peaks, densely covered with jungle, but of no great height. Irrigation is necessary throughout the section lying on the south of the Ganges.

In 1872 the population of Monghyr was 1,812,986 (males, 897,074: females 915,912): Hindus, 1,613,546; Mohammedans,