solution changes colour somewhat after a time, owing to oxidation of the ferrous salt, as Sir Wm. Ramsay tells me, and the moulds found in solutions prepared from fresh stock fluids and from others one or two months old have been of a different kind. The remarkable mould of Cladosporium type referred to in a note to my paper was found in each of a series of tubes the solutions of which had been prepared from stock fluids one month old. An examination of the stock fluids themselves, even after three months, does not reveal moulds of any kind.

H. CHARLTON BASTIAN.

Fairfield, Chesham Bois, Bucks, July 9.

Napoleon and the University of Pavia.

THE following allusion to Napoleon having spared the University of Pavia in 1804 on account of the memory of the illustrious man of science, Spallanzani, who had been a professor there, is so interesting at the present time that I venture to bring it under the notice of readers of NATURE.

The passage is from Baron's "Life of Dr. Edward Jenner" (vol. ii., p. 35), which was published in 1838:—"He who flushed with victory and at the head of the revolutionary army of France had spared the University of Pavia out of respect to the genius of Spallanzani when the city itself was given up to plunder, proved that the claims of science were not forgotten amid the astonishing events which carried him forward to the highest pinnacle of ambition. His animosity to England had been shown in that vehement and decided manner which marked all his actions; yet there was one chord of sympathy unbroken which, when duly touched, showed that his intoxicating success had not raised his proud spirit beyond some of the calls of justice and humanity, and that he could still be moved by the peaceful arguments of truth and science."

Napoleon's conduct in regard to the ancient University of Pavia is in striking contrast to that of the Kaiser in regard to the University of Louvain. The Germans, in their own opinion, are pre-eminent in the subject of the history of medicine, and yet it has been reserved for Germans to destroy the University of van Helmont, the father of chemistry, of Vesalius, the father of anatomy, of Schwann, the originator of the cell-theory. Further comment seems unnecessary.

D. FRASER HARRIS.

Dalhousie University, Halifax, N.S., June 19,

A New Tsetse-Fly from Zululand.

THE Durban Museum has lately received from Mr. R. A. L. Brandon, the magistrate of Ubombo, Zululand, a tsetse-fly captured by him in the court-house at Ubombo, towards the end of March, which is very distinct from the ordinary Zululand species, *Glossina pallidipes*, Austen, and apparently belongs to an hitherto unknown form.

It is a member of the *palpalis* group, and seems most nearly related to *G. tachnoides*, Westw., but the markings on the abdomen are not so strong or so sharply defined, and the dorsum of the thorax is buff. It is a female, and measures 8 mm. in length, exclusive of proboscis. In honour of the captor it may be known as *Glossina brandoni*.

It is my intention to give a detailed description in the next number of the "Annals of the Durban Museum."

E. C. CHUBB.
(Curator).

Durban Museum, Natal, June 16.

MUNITION METALS.

IN this article an attempt is made to compare briefly the resources of the Allies and the enemy countries in respect of metals which are regarded as essential for War purposes.

First in order of importance comes iron, the basis of the modern gun, armour-plate, armour-piercing projectile, shrapnel shell, high-explosive shell, and all the varieties of steel which find application in one way or another. Both sides have a sufficiency of iron ore and the accessories required for smelting, although the deposits in the enemy countries are inferior in quality to those possessed by the Allies. An illustration of this is furnished by a comparison of the amounts of acid and basic steel produced in Germany and Great Britain in 1913—the last year for which the complete figures are available. Germany's total steel production for that year was just under 19,000,000 tons, of which 96 per cent. was made in basic-lined furnaces; Great Britain's output was 7,663,000 tons, of which only 36 per cent. was made by the basic process. Both countries, however, imported considerable quantities of Swedish pig-iron, which is used for the manufacture of steels of the highest class, *e.g.*, tool steels, and Great Britain also imported substantial amounts of Spanish hematite ore, which was smelted with the clay ironstone ores of the Cleveland district, which are low in iron, and contain, for the most part, more phosphorus than is compatible with the transformation of the resulting pig-iron into steel by any acid process.

The production of open-hearth steel from pig-iron—and such steel provides the casing of the high-explosive shell and the shrapnel shell—demands, however, a second and very important metal, namely, manganese, which in the form of ferro-manganese or silico-spiegel is used not only to de-oxidise the fluid steel, but to leave from 0·5 to 1·0 per cent. manganese in the finished product. The chief producers of marketable manganese ore in order of importance are Russia, India, and the United States of America, which in 1913 furnished about 93 per cent. of the total quantity mined. The raw material is pyrolusite, a "straight" manganese ore corresponding when pure to MnO_2. The main supplies of pure ores, therefore, are in the Allied or neutral countries. In 1913 Germany imported about 670,000 tons, chiefly from Russia. The figures of her domestic production in 1913 are not available, but in 1912 her output was 90,980 tons, while that of Austria-Hungary was 16,540 tons in 1913.

In spite of these figures there is no sufficient reason for concluding that the enemy countries will be greatly hampered even if all external sources of supply are shut off, as they probably are. Confining our attention to Germany, the predominant partner, it must be pointed out in the first place that 4,300,000 tons of her steel production in 1913 were exported, and that except in so far as Austria-Hungary and Turkey are concerned this excess would be available for her own munition needs if she could obtain sufficient manganese. In the second place, the last-named metal is relatively widespread and occurs in many minerals. It is only the limited demand and the abundant supply of high-grade ores to draw upon which have confined marketable ores to such products. The enemy countries will in all probability be able to supply their needs by mining lower-grade ores within their own territories, and their metallurgists will no doubt have been able to make the requisite changes in the technology of steel manufacture to meet the altered conditions—quite apart from any stores of pure ore that may have been accumulated before the outbreak of war, and apart from any substitutes that may have been discovered.

The case of nickel, however, is very different. It is an indispensable constituent of gun and armour-plate steel, and of the modern bullet and armour-piercing projectile. In all these instances its action is specific, and it is doubtful whether any satisfactory substitute is known. It is therefore a munition metal of the highest importance. The world's production of nickel in 1912 was about 26,500 metric tons (a metric ton equals 2204 lbs.). Of this, Canadian mines and smelters produced 85 per cent. in the form of a copper nickel matte (sulphide), 89 per cent. of which was refined in the United States and the remainder at Clydach in South Wales, with the production of the pure metals. New Caledonia supplied almost all the remaining ore required, this being shipped to Europe and smelted there. Judged by Canadian standards the Norwegian production of nickel was very small, the output in 1912 being only about 400 tons.

The position, therefore, is that fully 98·5 per cent. of the world's output of nickel ore was being produced in the Allied countries before the war broke out, and that the remainder was furnished by a neutral country. So far as Canada is concerned the situation was dominated by two companies, the International Nickel Co. and the Mond Nickel Co., while the production of nickel ore in New Caledonia was monopolised by two large French companies. The only nickel ores situated in the enemy countries are kupfernickel ($NiAs$), cloanthite ($NiAs_2$), and nickel glance ($NiS_2 + NiAs_2$). Each of them can be worked for the production of nickel, but how inadequate a source of this metal they were may be judged from the imports of ore and metal into Germany in 1913. In the first six months she imported 6643 metric tons of ore and 3416 metric tons of metal. (It is to be noted, however, that her exports of the same metal were 2409 tons in the same year.) The Norwegian nickel production may still be available for Germany, but this is nothing like enough for her requirements, and apart from pre-war stocks she will have to fall back on the above-mentioned native ores to furnish the requisite quantity of this metal.

Scarcely less important than nickel is the metal chromium, which, though it finds no application in the pure state, is an essential constituent of armour-plate, armour-piercing projectiles, and high-speed tool steels. Rhodesia and New Caledonia furnish between them the bulk of the principal chromium ore, chromite (an iron chromium oxide). Russia produces substantial amounts, while Greece and Asia Minor used to do so, though their output has diminished in recent years. It is more than likely that the requirements of the enemy countries are resulting in an increased output from the last-named countries, and it will be observed that even if Greece joins the Allies the Asia Minor supplies, which are sufficient, will still be open to the German and Austrian armament firms. Chromite is worked up into an alloy of iron and chromium (with or without carbon) known as ferro-chrome, and applied in this form to the production of the particular steel required.

All shells, whether shrapnel, high-explosive, or armour-piercing, are fitted with a copper band which serves a double purpose. It prevents contact between the shell and the gun-barrel, and, owing to its great ease of deformation under stress, accommodates itself to the very rapidly altering stresses set up in the tube after firing, making good contact with the rifling of the barrel, and thus preventing the rush of gas out of it in advance of the projectile. Before the war it was customary to use not pure copper, but an alloy containing a little zinc, as the material of the band, not because the zinc improved the properties of the copper, but because it was a cheaper metal, and a certain proportion of it could be used with only a slight sacrifice of ductility. Now that zinc has become much more expensive than copper there is no object in doing this. Copper is also the main constituent of cartridge brass and shell fuses, Admiralty gun metals, and high-tension hydraulic bronzes, so that from the point of view of both branches of the service it is a most important munition metal.

Of the normal annual world's output of copper —about one million tons—the United States of America produced 55 per cent. in 1913. They are by far the greatest producers of this metal. Next came Japan with 7·3 per cent., followed closely by Spain and Portugal, Mexico, Australasia, Russia, and Chile, each of which supplied between 5 and 4 per cent. Of the Allies Italy furnished 0·16 per cent., Great Britain 0·03 per cent., while France was a non-producer. Of the enemy countries Germany's output was 2·5 per cent., and that of Austria-Hungary 0·4 per cent. None of the belligerent countries except Japan supplied its needs from internal sources in 1913; all of them except Japan imported copper from the United States of America; in that year Germany took 137,000, France 71,400, Italy 18,500, Austria-Hungary about 17,000, and Great Britain 15,000 tons.

The Allies are able to take delivery of such copper as they need, thanks in the main to the British Navy, whereas the enemy countries have found it increasingly difficult to import this metal. The position probably is that they have succeeded in obtaining through neutral shipping and neutral countries more than is generally suspected, but nothing like enough for their war needs, more particularly since Italy joined the Allied countries. In 1913 it is estimated that Germany's consumption was 265,000, and Austria-Hungary's 50,000 tons; their united production was 29,400 tons. There is no means of estimating the War demand for this metal in these countries, to which, of course, Turkey must be added. It is quite certain, however, that its use is being rigorously restricted to purposes for which there is no substitute, and it is extremely probable that large stores were accumulated before the war. The very high price that Germany has recently been willing to pay for copper shows nevertheless that her reserves have been considerably depleted. Two things may be stated with confidence. The first is that all her copper mines, mills, and smelters are being worked to their utmost co-ordinated capacity, the second that her technical metallurgists will have endeavoured to find a substitute for copper shell bands.

Aerial warfare has enthroned aluminium as *par excellence the* munition metal for this purpose, but its war usefulness is by no means confined to the construction of aircraft. One of the greatest metallurgical achievements of the last century was the adding of aluminium to the metals of everyday life. Thirty years ago the world's annual production was 5500 lb.; in 1913 it was estimated to be 173,175,000 lb. In this time it has risen from a rare metal to a yearly tonnage exceeded only by iron, lead, copper, zinc, and tin. To quote Prof. J. W. Richards ("Mineral Industry," 1913, p. 14):—"It can confidently be anticipated that by the middle of this century it will rank next to, or even ahead of, copper. It is already cheaper than tin, pound for pound, and cheaper than copper per unit of bulk or per unit of electrical conducting power, while the range of its applications and usefulness is extending more rapidly than that of lead or zinc."

One of the less well known uses of aluminium is as a constituent of the bursting charge for shells. "Ammonal" is an explosive the constituents of which are ammonium nitrate and finely divided aluminium. It is not a propellent explosive, such as cordite or other of the smokeless powders; its disruptive effect is too great, and its explosion too sudden. But this very fact renders it suitable as a bursting charge for shells, and Austria-Hungary is using it for filling the shells for the howitzer batteries. The United States and Canada produced nearly half the world's output of aluminium in 1913, the remainder being furnished in almost equal amounts by France, Great Britain, and Switzerland, leaving out of account a tonnage of 800 produced in Italy. So far as the Allies are concerned, therefore, they are in a much better position than the enemy countries with regard to the supply of this metal. Moreover, France contains the most suitable European deposits of the raw material of manufacture, viz., bauxite. The Swiss production is available for the enemy countries, and it is known that Germany has since the war become a producer of the metal.

Next there is zinc, the metal of which the selling price has appreciated to five times its pre-war figure. Originally only two-fifths the price of copper, it is now decidedly above it, in spite of a marked appreciation in the price of copper itself. The most important munition uses of zinc are as a constituent of cartridge brass and shell fuses, and as a covering for iron barbed-wire fencing. In 1913 the principal producers of the metal were the United States, Germany and Belgium; whereas, however, the first-named smelted domestic ores, the two latter relied mainly on zinc concentrates imported from the Broken Hill mines in New South Wales, where, owing mainly to the high price of labour, it does not pay to smelt the ore locally, or even in the country. France, Spain and Great Britain also produce substantial amounts, though not enough for their own needs. Although the importation of Australian ore into the enemy countries is now stopped, they have considerable supplies of local ore both in Silesia, Hungary, Carinthia, and Tyrol. Unfortunately for Great Britain her zinc-smelting furnaces are not well adapted for dealing with Broken Hill concentrates, and there are upwards of 80,000 tons seized in enemy shipping which are lying idle in our yards in this country. She is in the unsatisfactory position of having to draw upon the United States for the bulk of her supplies. The shortage of domestic zinc is bound to continue unless works are built and operated which are capable of dealing with the zinc concentrates from Broken Hill. It is therefore of national importance so long as the war lasts that the use of zinc, whether as such or for alloys, should be restricted to purposes for which this metal is absolutely necessary.

Lead calls for only brief mention. Germany is a very large producer, and her output with that of Austria is sufficient for the requirements of the enemy countries. Australia is the largest producer among the Allies, who, however, do not furnish enough for their needs, and draw upon the United States, Spain, and Mexico. The shrapnel bullet is a lead-antimony alloy, the antimony producing the requisite hardening and embrittling effect. In spite of the fact that the shrapnel shell is much less suitable than the high-explosive shell for the offensive land operations of the present war, the price of antimony has appreciated almost as much as that of zinc. The normal annual world's production is less than 20,000 tons, of which China furnishes two-thirds and France the bulk of the remainder. Before the war Hungary was producing about 800 tons per annum, but doubtless this amount could be substantially increased.

Tin as a constituent of tin-plate, the various anti-friction metals, solders, and Admiralty gun-metals, is a munition metal of no small importance, the world's normal annual output being about 120,000 tons. Of this the Federated Malay States produce about half from native ore, in addition to exporting ore which is smelted in various European countries; England comes next as a producer of the metal, although 75 per cent. of her output is derived from imported ores; then follow Banca, Germany, Australia, Billiton, and China in the order mentioned. The enemy countries have hitherto relied on imported ores for raw material, their own deposits being very inadequate.

To sum up, the position may be stated broadly as follows:—Of the ten munition metals, the chief sources of production and uses of which have been passed in review, the enemy countries can certainly produce five without having recourse to imports, viz., iron (the basis of the various steels used for war purposes), manganese, chromium, zinc, and lead; on the other hand, it is doubtful whether they can produce sufficient nickel, copper, aluminium, tin, and antimony from domestic ores. In view of the fact, however, that they prepared for this war with extreme care and foresight, it may safely be concluded that large stocks, either of ores or the corresponding metals, or both, will have been accumulated in those countries. However confident the Higher German Command may ostensibly have been of a rapid victory, they will quite certainly have laid their plans to wage a prolonged war if it should prove to be necessary, and such plans will have included the accumulation of munition ores and metals of which their countries produced an insufficient amount. There is accordingly no adequate reason for concluding that the enemy countries are likely—in spite of the prodigious scale upon which the war is being conducted—to run short of metals which are *essential* for war purposes for some time to come. Moreover, it may safely be concluded that their technical metallurgists will have been mobilised in the direction of discovering substitutes for any of the above metals of which a shortage is liable to occur in a long war.

The Allies for their part can produce from their own resources all the iron, manganese, nickel, chromium, tin, and most of the aluminium they require; their command of the seas enables them to obtain, principally from the United States, their deficiencies in aluminium, copper, and lead; China furnishes the requisite antimony. Zinc is the only important munition metal of which there is a shortage, in spite of the great speed with which the American furnaces are being operated. Wherever it is possible to substitute zinc by another metal it is of national importance that it should be done.

It is satisfactory to note that on July 7 Mr. Lloyd George, in answer to a question in the House of Commons, stated that "the necessary steps have been taken to stop the export of lead, spelter (zinc), antimony, and nickel, and other metals necessary for the manufacture of munitions of war. The four metals named cannot be exported except to places in the British Empire."

H. C. H. CARPENTER.

THE PRODUCTS OF COAL DISTILLATION.

IN a paper before a conference recently held at Cardiff on the extension of British trade, Mr. W. J. A. Butterfield dealt with the many important aspects of this question, which has become of vital national importance to us now that supplies from Germany are cut off. We probably scarcely yet realise how dependent we have been on Germany for many raw and finished products; indeed with many coal tar derivatives it has amounted to a German monopoly.

The output of coal in the United Kingdom in 1913 was 287,430,473 tons; in Germany 188,485,000 tons, but in addition to the ordinary coal 86,093,000 tons of brown coal or lignite were raised. England retained 189,092,369 tons for home consumption in 1913; Germany retained about 155,503,000 tons and 93,455,000 tons of brown coal, part of which was imported. These figures show a mean consumption of coal of 4·108 tons per head in the United Kingdom and 3·68 tons of coal and brown coal in Germany. Broadly speaking, the coal consumption is a measure of the industrial activity of the two countries, and on this basis it is gratifying to note the greater consumption in England.

In order to arrive at some idea of the products available from distillation, the amounts of coal carbonised for gas and coke making, and the quantities treated in recovery plant in the latter case, must be considered. It is estimated that, in 1913, 37,483,944 tons of coal were used in the manufacture of gas and coke in this country; something above 16,000,000 tons being carbonised in gas works. In Germany the total quantity carbonised was 62,613,000 tons; only about 9,000,000 tons being used in gas works. There is, however, a difference of considerable importance so far as the utilisation of products is concerned, that whereas in the United Kingdom 42·7 per cent. of the total coal carbonised is treated in gas works, primarily for the production of coal gas, in Germany the corresponding figure is only 14·4 per cent., the larger bulk being treated primarily for the production of coke.

Owing to the larger proportion carbonised in ovens in Germany, the quantity of some crude products which are of primary importance in chemical industries—such as benzol, which is recovered only to a very small extent in gas works—is very much greater in Germany, relative to the total amount of coal carbonised, than in the United Kingdom. The output of pig iron, which dominates the question of coke production, is clearly an important factor. Germany derives a further advantage from the more extensive use of by-product recovery plant.

Benzol recovery is now a matter of national importance, since toluene, which forms from 10 to 25 per cent. of the benzol, is in large demand for the manufacture of trinitrotoluene. In recovery oven practice the gas is stripped of the whole of the benzol content, but in gas making only the toluene content of the benzol is removed permanently from the gas. It has been proved, however, that at least one-third of the benzol content of the gas can be removed without reducing its calorific value below the standard of 500 B.Th.U. per cubic foot. The possible supply from coke ovens, if the whole of the gas produced in them were debenzolised in recovery plant, would probably amount to 60,000,000 gallons; in