The centre of mass describes an elliptic orbit in a period of 34·08 days, with a semi-amplitude of 33 km. per second. The spectral lines vary in width, and are broadest near periastron. Some of the peculiarities of the star may be due to its being actually involved in the nebulous matter by which it appears to be surrounded.

A REMARKABLE HELIUM STAR.—A notable exception to the rule that the helium stars are usually characterised by small parallax, small proper motion, and low radial velocity has been found by Mr. J. Voûte in the star Boss P.G.C. 1517 (*Astrophysical Journal*, vol. xlviii., p. 144). The investigation was undertaken at the suggestion of Prof. Kapteyn, who had suspected that this star might be found to have the unusually large parallax of about a tenth of a second. Mr. Voûte's result is $+0{\cdot}069'' \pm 0{\cdot}006''$, in good agreement with Prof. Kapteyn's supposition. For the proper motion Mr. Voûte has found $+0{\cdot}235'' = 0{\cdot}0185$s., but this is greatly in excess of the value $-0{\cdot}0001$s. given in Boss's catalogue, and needs further confirmation. The radial velocity of the star is also exceptionally large, amounting to +83 km. per second. The position of the star for 1900 is R.A. 6h. 0m. 37s., decl. $-32^\circ\ 10'\ 12''$, and the magnitude 5·6.

THE ORBIT OF SIRIUS.—The results of a new determination of the elements of the orbit of Sirius are given by Dr. R. Aitken in Lick Observatory Bulletin, No. 316. The elements with their probable errors are:—

$P = 50{\cdot}04$ years $\pm 0{\cdot}09$ year	$i = +43^\circ\ 31' \pm 0{\cdot}25^\circ$
$T = 1894{\cdot}133 \pm 0{\cdot}011$ year	$\omega = 145{\cdot}69 \pm 0{\cdot}38$
$e = 0{\cdot}5945 \pm 0{\cdot}0023$	$\Omega = 42{\cdot}71 \pm 0{\cdot}33$
$a = 7{\cdot}570''$	

Dr. Aitken concludes that the available micrometric and spectrographic data give no evidence of departure from undisturbed elliptic motion. It will be observed that the period given above is in close agreement with that of 50·02 years recently deduced by Jonckheere.

PRODUCTION IN THE SEA.[1]

A HIGHLY interesting report by Dr. C. G. J. Petersen describes the methods and results of recent work on the evaluation of the bottom fauna and flora of the sea in the Kattegat, Limfjord, and elsewhere. Abandoning the use of the dredge, as affording misleading ideas of the abundance of life on the bottom, the author invented his "bottom-samplers," which are apparatus that can lift up a sample of the sea-floor with its contained animals and plants. The area of bottom lifted varies between 0·1 and 1 square metre, the smaller apparatus being used at the greater depths. By a process of washing, the organisms are removed, counted, and weighed. The plates represent typical results, all the organisms found being drawn, in actual size, on paper ¼ square metre in area, which is then reduced to ⅗ in. linear.

Very often the bottom deposit consists of a "black, malodorous mass of sulphurous mud," and it was difficult to imagine that animals could utilise this as food. Sampling this by means of a glass tube thrust down into it, it was, however, seen that there was a thin surface layer of quite different composition, grey or brown in colour, and charged with vegetable remains. Oysters and other bivalves and demersal worms do not feed on the black mud or on the plankton in the water, but "literally stuff themselves with this upper layer of fine detritus." "The great bulk of the bottom animals are, and must necessarily be, herbivorous." They mostly burrow in the mud, but a large number are attached to solid objects, stones, and shells. These constitute the bottom epifauna.

The bottom fauna in general may be divided up into "communities," each characterised by one or more predominant forms; thus the author describes the bottom in the deeper parts of the Kattegat as inhabited by communities of *Amphilepis pecten, Brissopsis sarsii, B. chiajei,* and *Echinocordatum filiformis,* the typical forms present in each case being indicated by the systematic names.

The survey being a quantitative one, an attempt is made at an actual estimate of the mass of life in the whole Kattegat. There are about 24,000,000 tons of Zostera, 50,000 tons of plaice, 6000 tons of cod, 7000 tons of herrings, 25,000 tons of starfishes, 50,000 tons of predatory Crustacea and Gastropods, 10,000 tons of small fishes, with, of course, much else. These estimates are based, not only on the results of bottom-samples, but also on fishery statistics, the very probable assumption being made that the fish stock is practically constant, so that the fraction taken in commercial fishing represents the production.

No attempt is made to compare density of life on sea-bottom and land. "Strange as it may seem," says the author, "there does not exist any survey of the animal communities on land based upon quantitative investigations of the commoner species." J. J.

[1] Report of the Danish Biological Station to the Danish Board of Agriculture. "The Sea Bottom and its Production of Fish Food." By C. G. Joh. Petersen. Pp. 62+10 plates+chart. (Copenhagen, 1918.)

MILITARY EXPLOSIVES OF TO-DAY.[1]

THERE have been no epoch-making discoveries in explosives such as, say, the discovery of nitroglycerine for many years. Nitroglycerine, discovered in 1846, still remains the most powerful explosive in practical use. Many useful advances have been and are being made, but new explosives are merely new mixtures of old materials, given fancy names. The nations at war use practically the same explosives, and no one can be said to be ahead of the others.

The following table gives a comparison of some of the most typical explosives in use:—

Name of Explosive	Volume of gas per gram in c.c. = V	Calories per gram = Q	Coefficient = Q × V ÷ 1000	Coefficient G.P. = 1	Calculated temperature $= \frac{Q}{C}$. Assuming C = 0·24 C = Specific Heat of Gases
	c.c.				°C.
Gunpowder	280	738	207	1	2240
Nitroglycerine	741	1652	1224	6	6880
Nitrocellulose (13 per cent. Nitrogen)	923	931	859	4·3	3876
Cordite, Mk. I. (N.G. = 57, N.C. = 38, Vaseline = 5)	871	1242	1082	5·2	5175
Cordite M.D. (N.G. = 30, N.C. = 65, Vaseline = 5)	888	1031	915	4·4	4225
Ballistite (N.G. = 50, N.C. = 50, Stabiliser = 0·5)	817	1349	1102	5·3	5621
Picric Acid (Lyddite)	877	810	710	3·4	3375

The coefficients correspond fairly well with the results obtained in practical use.

Detonating substances are called *high explosives,* and their immense shattering effect is due, not only to the volume of gas and quantity of heat, but also to the velocity of detonation and density of the explosive. Shattering power is proportional to

Volume of gas per gram × cals. per gram × velocity of detonation × density.

[1] From three Cantor Lectures delivered before the Royal Society of Arts in April last by J. Young, Chief Instructor in Science, Royal Military Academy, Woolwich.

Detonation is more easily started in powder or crystals, probably because there is a smaller mass to take the initial shock; but the wave travels slowly, and may die out in a loose powder. Advantage is taken of this fact in detonating shells. Detonation is first set up in crystals or pellets, and transmitted to the dense filling.

Mixtures of high explosives which require different waves are always difficult to detonate.

Amatol a mixture of T.N.T. and ammonium nitrate, is more difficult to detonate than pure T.N.T.

Ammonium Nitrate Mixtures.

Ammonal.—One of the best known and most used of the ammonium nitrate mixtures is ammonal, in which use is made of the great heat given out by the oxidation of aluminium. A mixture of aluminium powder with the theoretical amount of ammonium nitrate for complete oxidation would contain 81·6 per cent. of NH_4NO_3. It would yield 1578 calories per gram—nearly as much as nitroglycerine—and 682 c.c. of gas. But such a mixture is difficult to detonate, and charcoal was added to make it more inflammable.

All cartridges must be hermetically sealed to preserve them from moisture, which quickly ruins ammonal. The velocity of detonation is about 4000 metres per second, and the effect intermediate between that of gunpowder and that of dynamite. Its power is three to four times that of gunpowder.

Sabulite.—This is an explosive resembling ammonal, but calcium silicide, Ca_2Si, an electric-furnace product, takes the place of the aluminium. Its composition is as below:—

	Per cent.
Ammonium nitrate	78
Trinitrotoluene	8
Calcium silicide	14

It is detonated in the same way as ammonal, and has about the same power.

Amatol.—This is a mixture of ammonium nitrate and T.N.T. in various proportions, which is now of great importance. T.N.T. does not contain enough oxygen for its complete combustion, and although the addition of ammonium nitrate increases the weight of the charge, the increase of the heat given out more than compensates for this.

The higher the proportion of ammonium nitrate, the greater the difficulty of detonation, and the difficulty increases when the ammonal is melted and cast into solid blocks or slabs, as is necessary for shells. Hence the higher proportions are used in the form of powder for bombs, grenades, and mines, and detonated by fulminate detonators. The others, used for shell-filling, are detonated by special methods, and will be referred to later.

All varieties of amatol are powerful high explosives. The velocity of detonation is about 4500 metres per second. All are spoiled by moisture and must be waterproofed, and all are practically smokeless.

Chlorate Mining Explosives.

All the older chlorate explosives are much too sensitive for use in large quantities in military operations. But a discovery made by Street in 1897, that if the chlorate mixture contained oils or fats its sensitiveness was greatly decreased, initiated an entirely new set of blasting explosives.

Blastine.—This is the most important military chlorate explosive, and vast quantities have been used in the present war. There are several varieties, but a typical military blastine has the following composition:—

	Per cent.
Ammonium perchlorate	60
Sodium nitrate	22
Trinitrotoluene	11
Paraffin wax	7

It is made in the form of a soft, yellowish, granular substance, which can easily be compressed.

Permite.—This is a mixture intermediate between ammonal and blastine, and may be looked on as ammonal in which the expensive aluminium is replaced by zinc powder, the consequent diminution in power being compensated for by using ammonium perchlorate instead of the nitrate. It is made in several varieties.

All the chlorate explosives require fulminate detonators, and for this reason, besides being too sensitive, are unsuitable for use as a high-explosive shell-filling. The rate of detonation is 4000 to 5000 metres per second.

Mixtures of ammonium perchlorate and paraffin wax with combustibles such as aluminium powder or wood-meal are also used, and are powerful high explosives.

Thermit, now an important munition of war, is in a class by itself. It is used for charging incendiary bombs, and sometimes in a kind of shrapnel. A small explosive charge scatters the contents, which rain down bits of blazing iron, which will instantly set fire to anything capable of burning.

Nitrocellulose, containing 12·5 per cent. of nitrogen and soluble in alcohol-ether, or at least completely gelatinised by it, is now made on an enormous scale, and constitutes 99·5 per cent. of nitrocellulose smokeless powders, as well as being used in the new cordite.

Guncotton was formerly used exclusively for torpedo warheads, marine mines, etc., but has now been largely replaced by T.N.T. and ammonium nitrate and chlorate mixtures.

There are two varieties of smokeless military powders in use at present: (1) *Nitrocellulose powders,* which consist of 99·5 per cent. of gelatinised nitrocellulose, and 0·5 per cent. of a preservative; and (2) *nitroglycerine powders,* which are gelatinised mixtures of nitroglycerine and nitrocellulose, with a few per cent. of a stabiliser.

American nitrocellulose powder (N.C.T.) is typical of the first class. It is made from soluble nitrocellulose containing about 12·5 per cent. of nitrogen.

N.C.T. is a good powder, and fairly stable. It is the weakest of the smokeless powders. Charges must be about 10 per cent. heavier than with cordite to give the same muzzle velocity.

N.C.T. is now much used in our Service for guns and howitzers, the charges being adjusted to give the same muzzle velocity as cordite M.D.

Cordite Mk. I. is a very powerful propellant, but owing to the high temperatures produced it is very erosive, and as a result of the South African War a modified cordite, "Cordite M.D.," was introduced. It has the composition: guncotton 65, nitroglycerine 30, mineral jelly 5. Its power is about 10 per cent. less than that of Mk. I., but the guns last three times as long. Cordite M.D. is the standard British propellant, although others are used at present.

In a new modified cordite soluble nitrocellulose is used instead of guncotton, and alcohol-ether is used for the gelatinisation instead of acetone. It contains a larger percentage of nitroglycerine than cordite M.D., but is very similar, although not quite so powerful.

High Explosives for Shell-filling.

A high explosive, in order to be suitable for shell-filling, must possess special qualities not necessary when it is used for other purposes, even in bombs and torpedoes.

None of the shell high explosives possess all the desirable qualities. Those now in use have little more than half the shattering power of blasting gelatine. All are products derived from the distillation of coal.

In spite of its great merits, picric acid has now been largely replaced as a shell-filling by trinitrotoluene and amatol.

Given that the picric acid is pure and proper precautions have been taken, it is quite safe and the most powerful shell-filling in use. It is also unaffected by high atmospheric temperatures, unlike T.N.T., and is specially suitable for tropical climates.

Trinitrotoluene ($C_6H_2(NO_2)_3CH_3$).—Usually called T.N.T., this substance, at present the most important of the shell high explosives, is known in the Service as trotyl. When heated to about 300° C., T.N.T. ignites and burns with a hot, but very smoky, flame. When a large mass is involved, the heat given out will invariably raise the temperature to the detonating-point. It is fully detonated by fulminate, except when in the form of cast slabs untamped, when the addition of a little lead azide to the fulminate is necessary. Fulminate detonators are used in bombs, torpedoes, and grenades. T.N.T. can also be detonated by less sensitive substances, such as picric powder and tetryl, and these are used in shells. The velocity of detonation in its densest form is about 7000 metres per second. The power is less than that of picric acid, about in the proportion of 91 : 100. Owing to the inferior velocity of detonation, the shattering effect (brisance) is proportionately still less, about 87 : 100.

When an amatol shell detonates there is only a little grey smoke, and no definite indication as to whether detonation has been complete or not. For observation purposes a packet of smoke producer is put in. The power is a little greater than that of pure T.N.T., but the velocity of detonation much less—4000 to 4500 metres per second, so that the local shattering effect is much less. For some purposes this is even an advantage.

Amatol is the most used of all the shell high explosives at present.

Tetranitromethylaniline ($C_6H_2(NO_2)_3NCH_3NO_2$).—This substance is known in the trade as tetryl, and in the Service as C.E. (composition exploding). It is readily detonated by a very small charge of fulminate, such as that used in shell detonator caps, is very powerful, and has a velocity of detonation of more than 7000 metres per second. It is an excellent initiator of detonation in other less sensitive explosives. In powder, pellets, and cylinders it is used in the gaines or detonators for T.N.T. and amatol shells, with which it is very effective.

Detonation of High-explosive Shells.—The problem of the detonation of a high-explosive shell is difficult. The shell is subjected to an enormous shock in the act of firing, the detonating charge must be in intimate contact with the filling, and if fulminate were used there would be a great risk of this being detonated by the shock. The problem seems to have been solved by the introduction of the gaine method.

The Gaine.—The gaine is a metal tube screwed to the fuse, which enters a cavity in the filling and makes good contact with it. This is very necessary. It contains a chain of substances, about four, of decreasing order of sensitiveness, starting from the fuse, and increasing order of violence of explosion. Use is made of the fact that a substance in powder is more easily detonated than when in compressed pellets, and pellets than a cast, dense solid. The actual substances vary with the shell and nature of the filling, but always start with gunpowder, which is very certain in action. Thus we may suppose the chain to consist of (1) gunpowder, (2) tetryl powder, (3) tetryl pellets, and (4) T.N.T. pellets.

The action is started by a fulminate cap in the fuse, which fires the gunpowder. This partially explodes and partially detonates No. 2, which detonates No. 3, which in turn detonates No. 4, and this detonates the main filling. With fuse and gaine in good condition there are very few failures now.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

ABERDEEN.—Lord Cowdray has been elected Rector of the University in succession to Mr. Churchill, who has occupied the position for the last four years.

THE Mercers' Company has given 125*l.* towards the maintenance fund of the Cancer Investigation Department of the Middlesex Hospital.

THE sum of 1000*l.* has been given to the City of London School by Prof. Carlton Lambert for the foundation of a science scholarship.

A RESEARCH fellowship of the annual value of 150*l.* has been founded at Guy's Hospital in memory of the late Lieut. R. W. Poulton Palmer and his sister, the late Mrs. E. H. A. Walker, the object of which will be the investigation of obscure diseases in man.

THE London County Council has arranged a series of addresses to London teachers on various aspects of the problem of national reconstruction after the war. The first two addresses will be:—November 22, "The British Commonwealth," by C. Grant Robertson; and December 11, "Hours of Labour," by Lord Leverhulme. Sir Cyril Cobb, chairman of the Education Committee of the Council, will preside at these lectures. Other lectures in connection with reconstruction will be given on the following subjects:—Economic Recovery, Housing, Agriculture and Rural Life, Women's Employment, Adult Education, Food Supply, International Relations, India, and National Health. The lectures are arranged for London teachers, but other persons can be admitted if accommodation is available. Applications for tickets should be made to the Education Officer, L.C.C., Education Offices, Victoria Embankment, W.C.2, marked H. 45. A stamped addressed envelope should be enclosed.

ONE of the main matters to which Sir J. J. Thomson's committee on the position of natural science in the educational system of Great Britain gave attention was the provision of courses intended to stimulate interest in natural facts and phenomena and their human aspects. The appearances and movements of the heavenly bodies are particularly suitable for observations and instruction of this kind, yet few pupils leave school with any knowledge of them, and most people go through life without an intelligent understanding of the simplest facts of astronomy. Sir Frank Dyson, the Astronomer Royal, in an address to the British Astronomical Association on October 30, urged that the claims of astronomy should be borne in mind in any schemes for the broadening of science teaching in schools. A certain amount of valuable work in this direction is done already in connection with the practical geography lessons; and the British Association Report on Science Teaching in Secondary Schools contains, in one of the syllabuses, much useful guidance to such observations. Sir Frank Dyson rightly lays stress upon the educational value of work