now agree, that properly controlled commercial pasteurization causes practically no nutritional damage to milk. In the near future it will almost certainly be a national requirement that all milk sold for liquid consumption shall either be effectively pasteurized, or shall be from disease-free animals. The methods of pasteurization which will be used for the majority of town supplies after the War will undoubtedly be the H.T.S.T. process, recently officially accepted, which offers considerable technical advantages besides requiring far less space and metal than the old 'holder' process

A beneficial consequence of such a national requirement is that many of the dirtier milk-handling and distributing premises will have to shut down. This will save a good deal of the unnecessary and wasteful duplication of milk rounds that still persists even under present war-time conditions. It is quite absurd that in a town of 100,000 inhabitants there should be no fewer than 200 licensed distributors of milk, many of them working from domestic kitchens and back-yards under indescribable conditions. Ten distributing units, adequately staffed and hygienically equipped, could do the job far more satisfactorily. Whether compulsory pasteurization is introduced or not, careful re-inspection of all licensed milk distribution premises is urgently needed in the immediate future, with revocation of licence where ordinary conditions of decency are unattainable.

The milk-distributing, like the milk-producing side of the industry, suffers from having too many small, dirty and inefficient units. It also suffers, even to a greater extent that the milk-producing side, from a paucity—almost a complete absence—of organized technical and vocational training and advisory help. Modern milk distribution is not a robot operation which can be carried out by unintelligent and untrained personnel. One of the pressing needs of the immediate future is the organization of courses of technical training in processing and distribution of milk.

Education and Research

Any long-term view of the future of the milk industry must concern itself with (*a*) the general education, and (*b*) the vocational training of the dairy farmer, the milk distributor and manufacturer, and the housewife. The milk industry is founded on knowledge that is continually advancing and extending, and its future prosperity and ability to meet the demands which the nation will make on it will depend in large part on the rate with which new knowledge can be acquired, assimilated by the industry and effectively applied.

As regards the acquisition of new knowledge, the total number of workers dealing with the research problems of milk production, processing and distribution is very small, probably less than fifty for Great Britain. Compared with the magnitude of the industry, the extent to which it is based on scientific and technical knowledge, and the number and importance of the immediate problems, both fundamental and otherwise, that await solution, this number is almost incredibly small, able though the little handful may be, and until a year or so ago its financial resources were grossly inadequate.

One of the needs of the near future is increased facilities for semi-large-scale experiments, both on milk handling and processing problems, and in methods of milk production, with an adequate research staff to deal with them. (Research workers of the type I have in mind require from five to ten years of post-graduate training before they can tackle such problems adequately, and the training of such workers is in itself a problem which the paucity of dairy research facilities in the past has rendered acute.) At present there are in several cases only two alternatives: either to leave a piece of work at the laboratory stage of development and trust that some better equipped country or some private firm will take it up, or to endeavour to go direct from the laboratory to the full industrial scale through the good will, and at the risk of, a firm in the industry. This latter method, even at the best, inevitably involves lack of control of details, of labour and of management that may make the difference between success and failure.

For experimental work on the improvement of milk production, research facilities are still meagre. Experiments on an adequate scale in dairy husbandry and on the physiology of the dairy cow will need, in the future, the use of several large experimental herds under careful control, if they are to have a prospect of success within a reasonable time.

As regards the dissemination and practical assimilation into agriculture without too great a time-lag of the results of research, the recently founded Agricultural Improvement Council should be, both in the immediate future and after the War, of considerable benefit to the production side of the milk industry, and to a smaller degree to the handling and distributive side. The maintenance of adequate financial support for the activities of the Agricultural Research Council and the Agricultural Improvement Council, after the War, is a vital step towards securing a brighter future for the milk industry.

OPENCAST MINING

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DURING recent months the provision of sufficient coal to meet the growing needs in Great Britain of the munition industry, as well as the domestic consumer, has been exercising the minds of the public and has been the subject of considerable discussion in the Press and both Houses of Parliament. Among the many suggestions for increasing the war-time output, the winning of coal by opencast methods has been mentioned. Opencast workings or opencuts are surface excavations in which the overburden is stripped by hand or mechanical excavators, thereby laying bare the mineral, which is afterwards broken and loaded into wagons or lorries by methods similar to those used for removing the overburden. In some localities in Great Britain the conditions are known to be suitable for the successful application of this method of working and intensive prospecting may result in the discovery of more. Several estimates of the total amount of coal available and also of the amount that can be extracted in the current year have been given wide publicity, but the facts, as so far proved, suggest these figures are optimistic.

The coal seams outcrop at the surface in nearly all the coalfields of Great Britain, but in the majority of cases they have already been worked by the 'old men' from bell-mouthed pits or else by gangs of miners during periods of industrial trouble, such as strikes or lockouts.

There is nothing new in the method, which has been practised since the early days of mining, and it is in common use in most parts of the world to-day. The brown coal of Silesia is worked this way, large quantities of bedded ironstone are produced from such operations in Great Britain itself, also ironstone in Austria, the United States and the Gold Coast, tin in Malaya and Nigeria, chrome in Turkey, coal in the United States, Australia and Bulgaria, copper in Chile and the United States. These are typical examples, which can be multiplied many-fold, of successful exploitation of the method.

In Great Britain the application of the method to coal has never before been tried, the reason being that much of the better quality coal close to the surface has already been worked by underground methods, and successful opencasting requires either a large force of cheap labour or the provision of heavy, costly, excavating machinery of various types, many of which have only become available in recent years. Such machinery has been most successfully applied to home ironstone mines where the quantity of ironstone is large and the mining conditions very suitable. The majority of the remaining available excavating plant is in the hands of public works contractors who, while skilled exponents of the art of removing ground, have had little or no experience of the much more difficult problem of selective excavation, which arises when two or more seams of coal are separated by comparatively thin layers of stone. Special machinery is needed to deal with such a problem and it is not usually readily available in Great Britain.

As a coal seam approaches the surface its quality deteriorates. The moisture content is increased and the coal substance oxidized, it becomes dull and friable and loses both its coking and gas-making properties. It resembles in many ways an inferior lignite or brown coal. A typical analysis from one outcrop showing the change in composition of the coal as the cover gets thicker is given below :

Sample	Moisture as obtained or received	Air-dried moisture	Ash	Volatile matter less moisture	Total sulphur	Cal. val. (B.Th.U. per lb.) As received	Cal. val. (B.Th.U. per lb.) Air-dried coal	Carbon on ash-free dry coal	Hydrogen on ash-free dry coal
1st strip	31	10·3	6·3	33·4	0·7	7,150	9,350	70·7	3·8
2nd strip	25	6·8	2·8	33·3	0·8	8,690	10,750	72·7	4·0
3rd strip	18	8·5	1·6	31·8	1·1	10,470	11,670	76·4	4·6
Normal seam	—	5·9	3·7	33·3	2·0	—	13,600	82·3	5·3

As a consequence of this deterioration, thorough prospecting of each site by boring or trial holes to prove the quality of the coal and, at the same time the nature of the overburden, should be undertaken before productive operations begin. Failure to undertake this preliminary investigation may result in disaster.

The nature of the overburden is important ; it should not be too porous or too hard. Tough clay not containing too many large boulders makes the best top surface, and this should be underlain by an impervious shale which can be broken by the digger without the use of explosives. Harder rocks like massive sandstone may render an otherwise desirable site unworkable. Explosives often have to be used to shake the tougher rocks so that they can be removed by the excavators, but their use adds to the complexity of the operations.

An ideal site involves a horizontal seam of coal with overburden that can be stripped in one operation. Rarely, except in the United States, are these conditions found ; certainly not in Great Britain. Here the conditions usually consist of a more or less horizontal seam with a gradually increasing overburden ; that is, the seam outcrops on the side of a gently sloping hill or, alternatively, the seam dips away from the outcrop and the surface remains level.

The value of the product determines in peace-time the thickness of overburden that can be removed. With coal the ratio is of the order of 3 or 4 to 1 ; with ironstone the figure is larger. To-day in England 20–30 ft. of cover are being removed to recover 5 ft. of coal, whereas with ironstone as much as 70 ft. are taken. The general plan of operations consists of combinations of loosening, stripping and transporting of overburden and mineral. The combination selected depends upon the shape, size and depth of excavation, the type of mineral, the quantity and value, output required, the surface topography, the nature and inclination of the overlying strata. Output and method should be adjusted to the total value of the product, so as to secure a minimum cost of production, though this may be qualified in war-time if output is more important than cost.

Stripping may be completed before beginning mining, or stripping and mining may proceed simultaneously when a sufficient area has been uncovered to avoid interference between the two operations. The latter plan is the better as it reduces the initial expenditure before production begins. Stripping may be done in one or more stages, depending on the depth. The overburden must be disposed within reasonable distance to avoid haulage costs and double or treble handling at points where the dumps will not embarrass future operations. The usual procedure is to remove the overburden with mechanical shovels or drag-line excavators and lay it on barren ground behind the outcrop line. Sometimes mechanical scrapers remove the top soil and carry it away, so that when the land is reclaimed after the coal is extracted the top soil can be put back on top.

Frequently large excavators with buckets carrying 12 cu. yards at the end of an 80-ft. boom are used in the main excavation, while smaller 2-yard machines stack the excavated ground clear of the cut. After the overburden has been removed down to the top of the coal, the Americans use mechanically driven rotary brooms to clean off the remaining dirt. Then the coal is dug by small shovels of $\frac{3}{4}$–$1\frac{1}{2}$ cu. yards capacity and loaded on to conveyor belts, wagons, large or small, or into lorries, some of which have a capacity of 10 tons. These take the coal either direct to the consumer or to simple screens where it is graded into two or more sizes.

The first coal obtained, that under the thinnest cover, is usually of poor quality, friable and breaks into small pieces quite suitable for the modern mechanical chain grate boilers, but as the cover thickens the quality improves and the average size of the product increases, so that in order to obtain its full value it has to be graded into large, nuts and slack, each of which has a definite commercial use.

Ironstone workings are usually of a more permanent nature than coal projects; consequently much larger and therefore more efficient plant can be, and is, used. The actual cost of mining ironstone is remarkably low.

The average coal prospect so far exploited in Great Britain contains up to 250,000 tons of coal, its breadth is 60–100 yards and its length ½–¾ mile. The overburden increases from about 12 ft. at the outcrop to 40 ft., giving an average thickness of 25 ft. for a 4–5-ft. seam. One interesting operation is working both flanks of an anticline where there are five seams of coal totalling 30 ft. in all, and these are being pursued to a total depth of 70 ft.

The largest known deposit unfortunately lies under 25–30 ft. of peat in the centre of a low valley, which was once a marsh, and the surface has only recently been drained. The difficulties of dealing with water-logged peat and water make the proposition at present unattractive. Other outcrops which have not been touched are situated in built-up areas, public parks or allotment gardens.

Many of the outcrops in Great Britain occur under land which is suitable for agricultural purposes and in such cases care has to be taken to disturb as small an area as possible. The top soil is removed first and laid on one side, then the overburden is removed and dumped behind the excavation. After the overburden has had time to settle, it is levelled by mechanical spreaders or 'bull-dozers', field drains are renewed and then the top soil is brought back and the whole re-levelled. Experience has shown that the land, though at a lower level, loses none of its fertility and in two to three years is under cultivation again.

In some instances in Great Britain, and particularly so in America, the overburden is only roughly levelled and then planted with conifers. Flourishing plantations of larch, Scotch fir and spruce can be seen in the ironstone area.

During war-time, land for opencast work can be requisitioned under the Defence Regulations and this is usually the simplest method to employ. But various questions of compensation have to be settled. The coal owner must be paid for the coal extracted from under his land and the purchase price is generally on a tonnage basis; the colliery company that has leased the right to work the coal from its owner wants compensation for loss of rights or potential profit; the surface owner, if the land is divorced from the mineral beneath, requires compensation for damage to his land, loss of rent and amenities, while the farmer is denied, for the time being, the opportunity of cultivating the area in question.

Another point that has to be settled is transport. In some instances the coal can be loaded into lorries and carried direct to the consumer, but in most cases the railway or canal has to be utilized. This means the provision of new sidings or loading stages or, alternatively, the adaptation of existing sidings to outside traffic.

In peace-time the practice will not offer any financial attraction to operators, but in war-time, when it is essential to produce every ton of coal, it is worth pursuing.

IS MUSCLE CONTRACTION ESSENTIALLY AN ENZYME-SUBSTRATE COMBINATION?

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About twelve months ago an account was given in NATURE of the striking action of adenylpyrophosphate upon the flow-birefringence and viscous properties of the globulin of muscle, myosin[1]. Since the dephosphorylation of adenylpyrophosphate is believed to be the immediate source of energy for contraction, and since, in the most recent work, it has proved impossible, in spite of serious efforts, to separate adenylpyrophosphatase activity from the protein myosin (Bailey[2], Needham[3], confirming the original work of Engelhardt and Ljubimova[4]), a continuation of this work seemed necessary. Having in the meantime made further progress in the study of the physico-chemical relations of adenylpyrophosphate and myosin, we desire to make the following further interim report.

The apparatus used was partly described in the previous note. It now consists of a small annular cell with rotating external cylinder, mounted on the stage of a polarizing microscope; and a co-axial viscosimeter with glass bottom permitting optical measurements of flow-birefringence. Three variables are observed: (*a*) the intensity of flow-birefringence itself; (*b*) the extent of the anomalous viscosity (that is, the fall of viscosity at low shear-rates); and (*c*) the relative viscosity, that is, the constant level to which the viscosity eventually falls as the shear-rate increases. The flow-birefringence and the anomalous viscosity of myosin solutions are, of course, taken to indicate that the particles are of considerable length.

Since the data in the literature on the physico-chemical properties of myosin, though numerous, are rather disjointed, we had to devote a good deal of time to the systematic examination of certain effects, as background for the interpretation of the action of adenylpyrophosphate on myosin. Thus we find that in passing from member to member of the Hofmeister series of cations at $0{\cdot}5M$ ($Li^{\cdot}$, $Na^{\cdot}$, $K^{\cdot}$, $Rb^{\cdot}$ and $Cs^{\cdot}$), there is no change in the flow-birefringence (hereinafter written $\triangle$), and only slight effects on the relative viscosity (η). $NH_4^{\cdot}$, however, decreases $\triangle$. The behaviour of these properties as a function of different salt molarities is very similar for $K^{\cdot}$ and $Li^{\cdot}$; $\triangle$ falls (for example, from $\triangle$ 60° at $0{\cdot}5M$ to $\triangle$ 20° at $3{\cdot}5M$); while η first falls to about $1{\cdot}0M$, and then rises. (A hump is often observed at salt concentrations varying between $0{\cdot}5$ and $1{\cdot}5M$, which explains certain results mentioned in the previous note, but requires further study on more purified preparations.) At the higher salt concentrations corresponding to the rising limb of the curve, the flow anomaly appears to be lost. The whole picture may therefore be interpreted either as one of progressive disaggregation, or the formation of larger, unoriented, tangles; the process ending in precipitation by salting-out. With divalent cations, such as $Ca^{\cdot\cdot}$ and $Mg^{\cdot\cdot}$, though the flow-birefringence ($\triangle$) falls steadily as their concentration rises up to $0{\cdot}5M$, the relative viscosity (η) on the contrary *rises*, continuously in the case of $Ca^{\cdot\cdot}$, but reaching a maxi-