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SCIENCE, WAR AND RECONSTRUCTION[1]

By Dr. JULIAN SORELL HUXLEY

LONDON, ENGLAND

WHAT can a natural scientist say about war and reconstruction which can not be better said by a sociologist, a political scientist, a historian or a practical politician? He can at least attempt to see this war and the problem of war in general in the long-range perspective of science, even though, if he is not to indulge in the merest puerilities, he must not be afraid of leaving his last and becoming a "political animal" as well as a mere scientist.

War, in its proper sense of organized intra-specific group fighting, is a very peculiar phenomenon. So far as is known, it is confined to men and to a few species of ants. This does not mean that war is instinctive in man as it must be in ants. The evidence from some ancient civilizations, such as Mohenjo-Daro, indicates that they were wholly pacific. In any case, the basic quality of man's nature is its plasticity, its absence of unalterable instincts. To say that it is hopeless to try to eradicate war because that would mean altering human nature is unscientific. It rests on a confusion between phenotypic human nature, as actually expressed, and human nature as something genetically given. The former can readily be modified, the latter can not. War is a phenomenon on a par with duelling and religious persecution. These latter have dropped out of civilized societies without any alteration in the genetic basis of human nature: and the same could be accomplished for war.

War is of course not the same as conflict. Conflict is a permanently inevitable feature of human life—internal conflict, conflict between individuals, conflict between groups. The overcoming of conflict in the right way is indeed an indispensable process in the development of human personality. But inter-group

[1] The first address in America under the arrangement between the American Association for the Advancement of Science and the British Association for the Advancement of Science for exchange lectures on alternate years. Columbus, Ohio, December 29, 1939.

conflict need no more lead to war than inter-individual conflict to murder or intra-individual conflict to suicide or a nervous breakdown.

We may admit that phenotypic human nature is essentially plastic: but we must not forget that wherever repression has been operative—and repression of some sort is probably well-nigh universal among human beings—there will be great resistance to change of outlook and even to self-knowledge. It is undoubted that repressed sadistic impulses, inferiority complexes, and the like, provide ready fuel for inflammation by war, and that not merely political and economic machinery but also the structure of developing human minds should be modified if war is to be made really unlikely. At the moment, the resistance to self-knowledge in this field extends to the level of educators and scientists: it is an important task of the near future to break down this resistance, face the facts (however unpleasant) fairly and squarely, and devise a system of education and training which will get rid of this dangerous reservoir of undesirable repressions.

War evolves and changes like other social activities. Tribal wars are very different from imperialist wars, such as those of Rome, Spain and Britain, from religious wars, from dynastic wars fought with mercenary armies. To-day the type of war is nationalist, between nation-states; and in the last century this type of war has become increasingly totalitarian and increasingly scientific, until it is now defeating its own ends—not only in being out of scale with its possible functions, as mentioned below, but by causing stalemate when two reasonably equal powers are matched, partly by the increase of the power of the defensive, partly by holding back aerial attack for fear of reprisals.

War, except in a polygamous tribal society, is dysgenic. Even totalitarian wars with reservation of specialist brain-power for non-combatant uses are still somewhat dysgenic, and so long as the voluntary principle was in force, and the national need great, as in Britain in 1914, the dysgenic effects were appallingly large.

To-day, however, the social ill-effects of war are much more serious than the biological. Quite apart from the effects of militarization and regimentation of the people in every type of activity, war is now so expensive that it bleeds countries white, and interferes very seriously with social progress. A temporary boom and reduction of unemployment due to arming for war does not alter the basic fact that the more we spend on armaments, the poorer we become. Britain alone is spending some £6 million per day on this war. It is becoming poorer instead of richer, as it would be if the same amount were spent on health, education, research, new roads and other needed public works, the reequipment of industrial plants, and so forth.

But do not let us forget that war has still another social function—it can be, and often is, the occasion for valuable change. To take but three examples, the last war brought about the peaceful settlement of the long-standing and acrimonious dispute over women's suffrage in Britain; forced the medical profession in general to recognize the power of repressed unconscious impulses, and so gave a most powerful impulse to the growth of modern psychology; and led to the formation of the League of Nations, which, for all its defects, was the first serious attempt to realize a supernational organization, and from whose defects we have been able to learn valuable lessons for the future.

I suppose that every one of us realizes, though with very different degrees of awareness and to the accompaniment of feelings that range from ardent hope to sullen resistance, that this war too is bound to be an occasion of change, notably of radical changes in the structure of separate societies and the organization of the world. A biologist may be pardoned for maintaining that the biological analogy is helpful not only in creating a general background against which to envisage the coming change, but sometimes in suggesting detailed points in the new order.

In the first place, biology reminds us that change is the normal (though not the universal) rule of life, that certain aspects of biological change can legitimately be called progress, and that man is (biologically speaking) a very recent type, whose social organization is still primitive in the extreme when looked at in the light of evolution. The lesson of biology for the resistant conservative is therefore that his general resistance to change is not only useless but immoral.

But biology has also a warning for the over-enthusiastic progressive. Biological change has normally (though perhaps not universally) been gradual. The rate may vary considerably as between different lines of descent, and at different periods of the world's history, but the change is normally effected through step-by-step alterations of existing organization. In general, it is as frequent for old organs to be converted to new uses as for wholly new organs to be evolved. The zeal of the revolutionary for getting rid of the old system root and branch is thus likely to be wastefully destructive and in the long run to delay progress.

From the standpoint of human biology, what are the chief features of the present time which have altered man's social environment so much that corresponding alterations of social organization are needed to meet them?

The first is the increase in the efficiency and speed of transport and communications, accompanied by the virtual abolishing of frontier-space for expansion. This, as Mr. Wells has so often reminded us, is forcing the remotest regions of the world into often unwilling interaction. It provides a potential basis on which

world unity could be built, and at the same time makes the lack of that unity more and more disadvantageous.

The second is the increase in the potential of power available to states. This is most dramatically seen in respect of war. Armaments have become many times more efficient during the last twenty years: in the last war there were no fortifications remotely approaching the Maginot line in strength, and neither tanks nor machine-guns nor bombers nor fighting planes could compare either in quantity or in all the qualities of their species with those available to-day. The result is that war has become out of scale with its function. During many centuries it operated, wastefully enough, yet with a certain efficiency, in adjusting the variations in the balance of power caused by geographical discovery, economic change and population-pressure. But to-day both its destructiveness and its expensiveness have got out of hand, and have become wholly incommensurate with any positive results which it may help to secure.

This, however, is not the only way in which state power has shot up. The dictator régimes have taken into their own hands the organization of economic power and also of the power of opinion. They are in literal truth totalitarian.

The biological analogy shows that for competing nation-states, such as the great democracies, merely to respond to this challenge by corresponding permanent changes in their own organization (however necessary as a temporary measure) would be to court disaster. Size and armament alone lead up a cul-de-sac. The giant reptiles of the Mesozoic included the largest land carnivores the world has ever seen, like the Tyrannosaurs, and the most heavily armored animals, like the Stegosaurs and the Ceratopsians. They answered bulk with bulk, aggressive with defensive warfare. But they were all doomed to extinction as soon as the changing environment gave the insignificant but brainier little mammals their chance. The contraction of the world due to better communications provides the corresponding change of environment to-day: brain-power spent on devising and running some new system is inevitably destined to supplant the present armored monsters of the nation-state era. The only question is whether it shall be now or after more waste and destruction.

We have numerous examples in evolution of biological short cuts which fade out after a temporary success; a great many of these secure temporary success at the price of continuing adaptability and genetic plasticity—for instance, plants with allotetraploidy but without sexual reproduction, or those which have adopted a ring formation of reciprocally translocated chromosomes. It would appear that the totalitarian state of the Nazi type suffers in this respect also—in being less plastic than the democratic state, although initially more efficient.

A third fact of the utmost importance in the modern world is the search for a new mystic, a new super-personal driving force. Traditional religion of the supernatural type has lost both ground and grip: the curious materialist-idealist compound which expressed itself in the nineteenth century's belief in the inevitability of progress, in the power of knowledge to mould human nature and produce almost millennial prosperity and peace, has wilted in disillusion. In their place, three great nations have already erected new pseudo-religions, all of them involving the glorification of the state. The most radical is that of Nazi Germany, which uses the race-concept as its mystical basis, while for Italy the mystic is the nation, for Russia the millennial picture of the truly Communist society, when government will wither away.

In all these cases, however, the mystical driving concept is linked with the national organization of power: and this inevitably has brought a recrudescence of intolerance, persecution and cruelty: the fully totalitarian state, as organized to-day, appears to be unavoidably immoral, cruel and intolerant of free ideas. This recrudescence has contributed largely to the final shattering of the belief in progress in other nations. History teaches us, however, that intolerant persecution always arises when an unintelligent mystic doctrine is held with such intensity that the end is deemed to justify the means; and that the persecution will be violent and brutal when the mystic doctrine is bound up with the system of power.

Two by-products of this situation are to be noted. First, the unprecedented refugee problem which it has created—unprecedented partly because of the violence and extent of the persecution, partly because of the nationalist unwillingness of other states to absorb new alien elements. And secondly the distortion of truth which it has brought about, with resultant lowering of the quality of scientific research in the countries concerned. A biological analogy here would seem to be the incredibly small size of the brains of the giant mesozoic reptiles.

The fourth great future of the present is the trend away from *laisser-faire* and individualism towards planned organization and collective action. During the period of rapid industrial expansion in the nineteenth century, *laisser-faire* individualism worked well enough, in spite of all its attendant horrors of slums, exploited labor and imperialist expansion. Indeed, it is probable that no other system could have so rapidly mastered the forces and resources of the world. But to-day, like war, it is defeating its own ends and proving unsuitable for its functions. It is proving unsuitable for four main reasons—first, because unplanned individualisms, as the world contracts, tend to cancel

each other out; secondly, because its basic time-span is too short for many types of projects—the individual demands a return on his money within his own lifetime or at least for his children. Thirdly, because the investing agent is too localized; the individual demands a direct return to himself or to his family whereas many projects are desirable indirectly—because they make a return to the community in general, through better health, greater taxable capacity, higher standard of living and increased consumption demands, and so on. Fourthly, because it prompts the recurrent vicious cycle of trade boom and trade depression.

Already the world has moved far from simple *laisser-faire;* but the present system is a compromise and the agencies of collectivized organization and planning are as yet extremely imperfect.

The fifth point is the gradual evening out of world resources in raw material and power. This has been accomplished partly by new methods (for instance, utilization of nitrogen from the air instead of from the Chilean nitrate beds); partly by artificial substitutes (such as synthetic dyestuffs, artificial silk, plastics); partly by new transformations of old sources of material or power (motor-spirit from coal; hydro-electric power); partly by substituting new raw materials for old (for instance, aluminum for heavy metals). The net result has been that, while many inequalities of distribution remain (U. S. helium; Canadian nickel, etc.), the bulk of natural resources, both in materials and in power, is becoming much more uniformly spread over the habitable globe.

The sixth striking feature of our time is the great increase in leisure—some of it in the compulsory form of unemployment and retirement at comparatively low ages.[2] The totalitarian countries have made some interesting attempts to provide new social organizations for the better utilization and enjoyment of leisure, but so far in other countries the individualistic *laisser-faire* tradition, which tends to regard all state-controlled organization as undesirable interference, has prevented any real evolution in this direction.

Seventh, there is a new attitude to colonial problems. Partly this is due to the jealousy of the have-nots, a normal phenomenon whipped up to exceptional intensity under pressure of nationalist feeling; but in large measure it is due to a new attitude, which has already found expression in the mandatory principle, to a dawning realization of world unity and to the part to be played therein by peoples whose social development has been retarded.

What suggestions of scientific method and of biological analogy can be made for helping mankind to deal with the acute problems arising from these new features of our time?

[2] During actual war, much of this leisure is of course abolished.

We have drawn one evolutionary analogy—that of the over-armed and under-brained reptiles of the late secondary era. We can not, however, suppose that the subsequent course of biological evolution will serve as a pattern for the next phase in our own history. This would imply that the over-armed nation-states would disappear and their places be taken by smaller nations more concerned with flexibility and intelligence of social behavior. This is ruled out by the shrinkage of the world and by the biological peculiarities of man. Do not let us forget that man differs from all other major biological types in consisting of but a single inter-fertile species, in possessing much greater control over the environment, and with the power of forming much larger communities. The only possible climax for such a type is that it should extend over the entire habitable globe in the form of a single community, whatever the organization of that world community may be. All intermediate stages, of racial tribal, national groups, are inevitably unstable and temporary phases.

But for the immediate future, both biological analogy and historical experience demand a step-by-step advance. Some functions are sufficiently advanced to be put on a world footing without dislocation, while for others the step can only be on to a regional basis. The chief functions which could be stepped up to a world platform are those concerned with primary products and raw materials, with certain aspects of research and of communications, and with sea-power. The chief functions for which we must be content with the intermediate regional step-up are the political, in the broad sense of the word.

Let me amplify this second point first. National culture and tradition, usually combined with language, is the strongest political force in the world to-day. So-called race problems, when analyzed, always turn out to owe their acuteness to differences in culture and economic level which happen to be associated with quite minor genetic differences.

It is wholly premature to envisage any immediate world-government which could stand up to the tensions introduced by existing differences in national culture. Regionally, however, there is a hope.

The U.S.S.R. has already established a federal system over one-sixth of the world's land area. Pan-America is beginning to emerge. The present struggle between Japan and China could without too great difficulty be forgotten in a Far Eastern federation. Malaya and tropical Africa are destined by nature to take their place as world regions as their inhabitants progress toward economic efficiency and political self-government. And finally there remains Europe. I use the word Europe in a cultural sense, as that region where western civilization arose and where it still

flourishes, however impeded by the barriers of nationalism and the counter-currents of totalitarian philosophy; regionally, the geographic Europe minus European Russia but plus the Asiatic and African fringes of the Mediterranean Sea.

The most urgent political post-war task is the settlement of this European region. It is here that the greatest number of powerful nationalisms occur, here that they are most crowded, here that the ownership of tropical territories is chiefly concentrated. Geography and history alike dictate a regional solution for this area, now torn by war. And the war is a civil one, between different representatives of the European tradition—the tradition based on Greece, on the Roman empire, on western Christianity, on representative government, on the spirit of modern science, on technology.

Yet the differences between the various nations or groups of nations within Europe are so great, their separate traditions within the enfeebled European tradition so strong, that it would be hopeless to attempt at one bound a full-fledged federal system like that of Switzerland or the U. S. A. On the other hand, a League system, even if confined to Europe, will not be enough—the experience of the League of the American States prior to their federation reinforces the lesson of the last twenty years. A League system will not work because it is a contradiction in terms: the absolute sovereignty of its member states is irreconcilable with collective action for the benefit of the whole. Some abrogation of sovereignty—in other words, a step towards federation—is essential.

What is the minimum degree of federation which would be effective? An executive organ, an advisory organ, an organ of discussion, a financial organ, a training organ, a judicial organ, an organ of opinion, a budget, well-defined restrictions on freedom of action in political and economic matters and, in the present state of the world, alas, an armed force and machinery for sanctions. The executive organ could be restricted to a council, in which smaller countries could be represented groupwise, or preferably as federated units within the greater and looser federation. The organ of discussion would be some sort of assembly, not necessarily elected by western democratic methods, but representing functions as well as regions. For training there is needed some form of international staff college; for moulding opinion back toward unity and away from nationalist separation, broadcasting services and perhaps a film service, together with a European system of university education and newspapers and periodicals. The financial organ would include a European Bank; the judicial organ would be a European Supreme Court.

While it would almost certainly prove impracticable to have a single monetary currency for all Europe or to make it a single tariff area with full internal free trade, it would be essential that none of its constituent units could alter their tariffs or the valuation of their currency without the permission of the council. The budget might be raised as a percentage levy or in various other ways (*e.g.*, from tariff revenue): the one essential is that it should be adequate in amount—at least half a billion dollars per annum. Inadequacy of finances was one of the reasons for the failure of the League. The extent of the inadequacy may be seen from the fact that the total of the contributions of member states during any of the last few years was just about as much as what the London County Council spent annually on main drainage alone! As for armaments, if the European Council alone disposed of military planes, heavy tanks and heavy artillery (whose manufacture can not be kept secret) then effective disarmament, both qualitative and quantitative, could be imposed on member nations, and yet Europe as a whole would dispose of a powerful force. The units of the force should presumably be stationed, whenever possible, in the territory of small nations: that would be one of their chief contributions to collective security. Sanctions could be operated by withholding supplies of key minerals, under the world control scheme considered later, and also by a ban on exports from the offending unit, as was done by Great Britain in her recent dispute with Eire.

The budget would be mainly employed, apart from armaments, on long-term development schemes which would not readily attract private capital—partly in Europe (and there mainly in the less developed regions, though special projects could be contemplated in any country), partly in the colonial dependencies. But a reasonable fraction would be reserved for the other European agencies and for leisure organizations on a European scale.

To these last I shall return. Meanwhile let us consider world organizations. Some or all of these would presumably be part of a remodelled League of Nations (though there are some who would prefer a wholly new world authority set up to supersede the League).

In the first place it would be desirable to extend the Research and Health Sections of the League very considerably. Next, it is urgent to establish a world organization concerned with population policy—emigration and immigration, refugee problems, the rural-urban population ratio, birth control for over-populated areas, etc.

Most important, however, would be the economic organizations. These would fall under three main heads—those designed to liberate world trade from undue restrictions, those designed to regulate the output of commodities, notably raw materials and primary products, and those designed to increase the prosperity and purchasing power of backward areas. Those of

the first type call for no special comment. Those of the second would have as their basic functions, first to iron out the vicious cycle of slumps and booms, and secondly to promote a higher standard of living through higher consumption. The League has been blamed, perhaps rightly, for its lack of proper organization on the economic side. It is, however, fair to remember that in 1919 the machinery for large-scale control of raw materials was virtually non-existent. Most of it was called into being by the great depression of 1929 and subsequent years. It exists to-day in the form of cartels and other international schemes for commodity control. From the technical aspect of economic machinery, these have been much improved during the last decade: it remains to alter their direction, to harness them in the interests of consumption and of the general public instead of permitting the dominance of a policy of restriction and short-term profits for sectional interests. From the technical point of view, the provision of really adequate buffer pools and the wholehearted application of scientific research would also lead to improvement.

They would be under a Permanent Commodities Commission of the League of Nations or whatever world international organization took its place. In addition, such a body would have the duty of supervising organizations of our third type, aimed at canalizing world long-term investments for development purposes. Such an aim would be achieved partly by means of rural and other loans, international public works, and the like, partly indirectly through the setting up of what might be called International Chartered Companies and Regional Development Commissions, to promote the general development of backward areas. The latter are suitable for self-governing territories, where they cooperate with a local administration. The Depressed Area Commissions in Britain and still more the T.V.A. (in its general, as opposed to its "yardstick" program) provide possible models for such bodies. They should also be employed by the European Council. For non-self-governing territories (colonies) with really backward populations, such a set-up would not work. Here the International Chartered Companies could find their use; such bodies would (as with similar semi-public organizations like the London Passenger Transport Board) operate on a basis of limited profit, making over everything above this for the development of the area for which they were responsible, as well as being under international supervision.

We may take colonies next. Here, as with Europe, the task is to steer a safe course between the Scylla of doing nothing and the Charybdis of attempting too much and seeing the shaky edifice collapse. It is easy enough to say, as many people are saying (and sometimes shouting!) that all colonies should be handed over in the immediate future to an international administration. But would it work? Those who know something about native peoples and the problems of tropical administration say "no." There must be somewhere in the system a firm organ of authority and an adequate focus for the loyalty both of those administered and those who administer them. Until the incipient federation of Europe that we have outlined grows into a true Federal Government, and until training and tradition have produced an *esprit de corps* in the international administrative service, these essential organs of colonial administration will not exist on the international plane. To take a somewhat remote yet valid biological analogy, before the development of the cerebral cortex, lower vertebrates had to delegate most of their behavior to a rather poorly constructed system of reflexes and simple instincts.

The remedy would seem to be retention of the principle of national and executive authority at the periphery, with a reasonable and increasing degree of international non-executive control at the center. The separate colonies and their administration would remain British, French, Belgian, and so on, though they should all be put on the footing of mandates, and the Mandates Commission strengthened by the grant of powers of investigation on the spot in addition to those of mere review of policy. Under the European Council would be established a Colonial Commission, truly international, with small but picked international staff of research workers, experts and traveling advisers, *and* the power of allocating considerable grants out of the European common budget, for education, for health, for conservation, for roads and other public works in the separate colonial territories.

It would be desirable that a small but progressively increasing fraction of the technical and perhaps later of the administrative posts in the local services should be thrown open to nationals of other countries, but the appointments should be in local hands, not in those of the international authority.

A somewhat similar system works quite successfully between the Federal and State authorities in the Tennessee Valley Authority, and it ought to work well enough in the colonial sphere.[3] Do not let us forget that international administration is *per se* no solution of the basic colonial problem, which is the welfare of the native inhabitants and the development of the colonial territories towards self-government. It could only help at the European end, in reducing jealousy among the great powers. But even the partially international scheme set forth above would remove most of the political objections to the transferring of colonial mandates to other powers.

[3] The scheme would have to be modified in the minor colonial areas, such as the Caribbean and the Pacific, to allow of the participation of other powers, *e.g.*, the U. S. A. and some of the British Dominions.

Meanwhile the world organization, too, through its International Chartered Companies, its rural loans, its international public works and its expenditure on research, would be aiding in the progress of the tropical countries. The International Staff College would have its colonial section, and, after perhaps a generation, there would have been built up a truly international *esprit de corps* among the staff, which would then permit the full internationalization of the colonial system.

I previously mentioned the growth of leisure and the need for its better organization. This is especially urgent in Europe, for it will be largely through such organization that the people of its separate countries will be able to understand the European tradition and to participate in it, only so to experience the greater European loyalty which will render the lesser national loyalties innocuous, as inspiring a sense of local but cooperative pride instead of a sense of jealousy and hate. To do this, the democracies must learn from the totalitarian states; they must build up their own leisure organizations, and then extend the principle internationally.

One can think of so many ways in which such organizations could promote "life, liberty and the pursuit of happiness" on the international plane. Cheap travel, properly organized in international parties; youth hostels, walkers' and climbers' hostels, all over Europe; international festivals, like Salzburg in the old days, or Oberammergau, but more numerous and made available to many more people; an international system of holiday camps, of summer schools, of study and hobby groups, of retreats, dotting Europe from end to end. The whole could easily be linked up with the extension of the exchange system which will be necessary on the educational side—exchange of undergraduates, of graduates, of teachers and professors, to a certain degree of schoolboys; and also with international schemes of adult education and of refresher courses for administrators and professional men of every description.

One may even envisage the substitution of international citizen service (preferably voluntary) for national military conscription and the placing of that, too, on a broad inter-European basis.

In all such ways, Europe could become a reality to its inhabitants, and the onward flow of its great cultural tradition would be reenforced.

Let us try to envisage what improvements such changes would bring about. Nationalism and self-determination would not disappear; but they could be relegated to the cultural sphere (as has been largely done in the U.S.S.R.) and banished from that of economics, power politics and war. Political boundaries and national governments would continue to exist; but their importance, and especially their importance in causing trouble, would be reduced. The risk of conflict between major regions would remain until the time was ripe for world as opposed to regional federation. But the financing of development schemes in the poorer or less advanced countries, and the reduction of economic distress by ironing the bottom out of depressions and by planned schemes for world production and distribution of raw materials and primary products would remove some of the chief causes of unrest and war. The deliberate employment of state and international organizations to enrich life for the individual citizen would give a new meaning to the common man's existence, and help in establishing the new mystic, the religion of this world, which is so urgently needed to reinforce the old other-worldly religions and to replace the crude pseudo-religions of state worship.

The proper utilization of the new resources offered to man by science, by which the raw materials that he needs, the sources of power, the productivity of the land and the possibilities of better living can be in large measure spread equally over the globe, will begin to remove the disastrous separation of the world into exploiting and exploited areas, and so pave the way for a true federation of federations.

Friction and difficulty will remain: we have the fundamental biological analogy of hostile symbiosis of the parts within the body to remind us of that. But man and his societies are organisms, albeit with their own unique nature; and the equally fundamental biological analogy between animal and social evolution shows us that the difficulties can be overcome, and the friction of the parts subordinated to, and even utilized for, the benefit of the whole.

But do not let us delude ourselves into thinking that it will be easy. Wishful thinking issuing in impractical schemes is one of man's unique biological attributes. Historical experience demonstrates that the only method for the adequate control of complex phenomena is the scientific method. The biological analogy with evolution demonstrates that the most important line of evolutionary progress has been through the improvement of brain-mechanism, notably the mechanism for acquiring knowledge and correlating it with action.

The corresponding social machinery is yet in its infancy. The end of the war will face the world with a task for which it is ill prepared. It is urgent that every country, and perhaps most of all those countries which are not actually immersed in the struggle, should begin thinking out the plan of the new world order in detail, designing machinery which will work, as well as defining the limits of their own participation. It is equally urgent that the world, perhaps again chiefly through those countries like the U. S. A. which are already best equipped technically for the task and are not being diverted from it by the needs of war,

should begin constructing planning organizations on a large enough scale to function as a social brain and not a mere ganglion, in order to ensure that any first step which we may be able to take directly after the war will be a step in the right direction.

But again, do not let us attempt any ideal or complete plan, any grandiose scheme for which the world is not ripe. That was one of the causes of the League's failure; it was an attempt to impose an ambitious ready-made plan of world citizenship, for which public opinion was insufficiently prepared. Rousseau and the Encyclopedists had been preparing opinion for a radical change in society for half of the eighteenth century; without that preparation, the French Revolution would have been a fiasco. In 1918, the idea of supernational organization had not penetrated beyond a limited circle of intellectuals, and even they had not had time to work out the idea in detail, before Wilson sought to impose it in reality. To-day we have at least had twenty years of discussion, together with some bitter if salutary experiences. If the leaders of thought in the various nations can now work out a less pretentious but more workable plan, and at the same time can prepare public opinion for the idea of a dual citizenship, national and world, this war may be the occasion for taking a small but decisive step away from war and towards a world organization of humanity.

THE GRAVITY ANOMALY AN IMPORTANT FACTOR IN EARTH SCIENCE

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U. S. COAST AND GEODETIC SURVEY, RETIRED

THE difference between the observed and the theoretical value of gravity, called the gravity anomaly, is receiving much attention by students of the earth who are striving to discover the causes of the changes that have occurred in the configuration of the surface of the earth during the past 2,000,000,000 years. Why are there oceans and continents, mountain systems and broad lowlands, earthquakes and volcanoes? What is the shape of the sea-level surface? How far down do the hard crystalline rocks extend? Is the rock below the outer shell lacking in rigidity and strength? These are some of the problems which were discussed by several hundred delegates to the seventh general assembly of the International Union of Geodesy and Geophysics, held in Washington early in September of last year.

In most countries there are governmental and private agencies and educational institutions in which geodesists and geophysicists are studying the earth with a view to the solutions of the problems enumerated above. These problems are also receiving the attention of many geologists, especially those who are searching for minerals and petroleum.

There are many phases to the sciences of geodesy and geophysics and it would require several large volumes to cover them in a comprehensive way. In this paper I shall confine my comments to one phase only of the earth sciences, the gravity anomaly.

In deriving the formula for theoretical gravity the sea-level surface of the earth is supposed to be a spheroid, with its shorter axis coinciding with the polar axis of the earth. This assumption has been found to be close to the truth. The sea-level surface deviates not more than one or two hundred meters from the spheroid or mathematical surface. The geoid or sea-level surface is above the spheroid for continental areas and below it for oceanic areas. This is as it should be, for the spheroid is an average of the geoid.

The constants of the gravity formula are derived from observed values of gravity in many countries and at different latitudes. Different groups of stations will furnish different sets of constants.

The International Geodetic Association has adopted the following formula which is based on a large number of stations located in many countries: $\gamma_o = 978.049 (1 + 0.0052884 \sin^2 \phi - 0.0000059 \sin^2 2\phi)$ gals, in which γ_o is the value of gravity at sea level and ϕ is the latitude of the station.

Further gravity measurements will make it possible to obtain constants that should be of more universal application. But it is believed that with the data now available it may be possible to derive constants for the theoretical formula that will enable the student of earth science to more correctly interpret the significance of the gravity anomaly than he can now do.

In order to derive a gravity anomaly, a number of corrections must be applied to the observed value of gravity, and then the corrected value is compared with the value given by the theoretical formula for the latitude of the station and at sea level. The difference is the anomaly.

Various corrections must be applied. Owing to the irregular surface of the earth, topography and isostasy must be taken into account. Corrections must be applied to the observed values of gravity to eliminate the effect of the topographic masses above sea level and of the deficiency of mass in the ocean basins.