The example was unfortunate, for these molecules are far more complex than Dalton realized. This fact, coupled with the introduction of the simpler Berzelian notation, which led to the writing of empirical formulæ, such as $CO_2$ instead of the structural ○●○ (or OCO), caused Dalton's observation to be overlooked. Consequently when later chemists discovered true examples of isomerism, Dalton's contribution had been forgotten.

The question now arose as to how the union of atoms could take place. The first suggestion that atoms possess mechanical hooks was very natural at the time but was soon found inadequate. The connexion between chemical combination and electrical forces was then just beginning to be realized, for Nicholson and Carlisle had already in 1800 decomposed water electrically. In his Bakerian Lecture to the Royal Society in 1806, Davy formulated a qualitative electrochemical theory of chemical combination which was improved upon by Berzelius in 1812; but curiously enough, attention was focused more on the combining power of groups of atoms (radicals) than on individual atoms themselves. It was not until eight years after the passing of Dalton that Frankland introduced the conception of an atomic attractive power, that is, valency. The gate was thus opened to an enormous field of research on atomic forces and molecular structure, the confines of which even now appear to recede, like the end of a rainbow, the further we progress.

The foregoing may be regarded as some of the more immediate consequences of Dalton's theory. But the tale is not complete even yet. The atomic theory has migrated into realms undreamed of by its creator, and has opened up avenues of approach to problems the immensities of which appear to grow with each succeeding age.

In his brilliant researches, Faraday showed that electrically charged atoms or groups of atoms can exist in solution; he called them 'ions' and in 1835 enunciated his Laws of Electrolysis. It was inevitable, therefore, that the atomic conception of matter should eventually be extended also to electricity. This was first clearly done by Johnstone Stoney in 1874, who named the 'atom' of electricity an electron, and pointed out that $Ne$ is Faraday's ionic charge for a univalent ion, $N$ being Avogadro's number and $e$ the 'atom of electricity', that is, the electronic charge.

But if electricity is atomic, what about other forms of energy? The breakdown of classical methods of calculating the intensity of radiation of a black body at various temperatures led Planck in 1900 to extend the atomic idea to energy in general. He suggested that bodies can only emit radiation in discrete portions or quanta—atoms of energy. This enabled him to draw up an expression that would account completely for the observed distribution of energy in the temperature-radiation spectrum. He was also able to explain the lack of agreement between the classical formulæ of Wien and Rayleigh, and to show that these formulæ represent extreme cases of his own universal expression.

Five years later, Einstein explained photo-electric effects as due to 'atoms of light' or photons; in other words, light waves possess atomic characteristics.

Limitations of space forbid further discussion of these themes. Sufficient has been said, however, to show that Dalton's Atomic Theory has proved one of the most fertile ever propounded. Just as a crystal dropped into a solution may yield a vast crop of crystals entirely unrelated in quantity to the size of the original crystal, so Dalton's theory has been a nucleus around which have collected, and are still collecting, new laws, hypotheses and theories.

# MEN AND SCIENCE IN THE SEA FISHERIES*

By MICHAEL GRAHAM

IN 1863–65, Huxley, as a member of a Royal Commission, on fisheries, made a tour; and I cannot do better than quote a report in his own words on one of the places visited—the Isle of Skye. "He would mention an occurrence which made an indelible impression on his mind—the total earnings of one of those peasants, he might say his whole property and everything belonging to him, would not come to more than £5. Certain interested parties in Glasgow . . . had got a law smuggled through the House of Commons, where nobody cared anything about it, by which it was made penal to catch a herring during the three summer months of the year, a time at which herrings were swarming in innumerable millions . . . that meant that [a man] might be totally ruined or might be put in prison for doing this. . . . Now there was not the smallest imaginable reason why that enactment should have been passed. It was a stupid, mischievous and utterly useless thing. . . . That appeared to be one of the worst forms of modern oppression."

I cannot find words to express my admiration for this passage, of which I have given only excerpts. There the man of science, quite sure of his ground, raised his voice against arrangements that were not based on scientific facts; and in this cause he used all the power of the English language to convey meaning and feeling. Reading it to-day has a reviving effect, by contrast with the polysyllabic jargon of good intention, among which so many of our modern aims meander, and are lost.

This visit of Huxley's led to the Act of 1868, by which most of the restrictions on fishing were abolished; and it set the policy of no restriction without scientific justification which has ruled Britain ever since, and affected millions of lives and fortunes. Such is the power of the scientific attitude, in a bold and able man.

A second notable event in the history of British fisheries was an International Fisheries Exhibition and Congress in 1883, presided over by Huxley, who was now president of the Royal Society. The exhibits included a very good one from the United States Bureau of Fisheries, which was at that time pre-eminent in knowledge of life in the sea, owing to the inspiration of Agassiz. This exhibit aroused great interest among British scientific men, of whom Ray Lankester was one, and it led to their signing a memorial calling for organized marine research in Britain. Their feeling formed one of the major trends at the Exhibition.

A second noticeable trend, closely connected, was the demand from Mr. James Alward, and from other good skippers, for research into the biology of the fish themselves; and a third trend, voiced by the

* Substance of a discourse delivered at the Royal Institution on June 9.

fishermen and by the younger men of science, was one of contention with Huxley and the Civil servants on the fundamental problem. Huxley said: "Nothing that we do seriously affects the number of fish. And any attempt to regulate these fisheries seems consequently, from the nature of the case, to be useless." Finding the truth on this third question called for what we may call 'population studies'.

It seems to me that there were very sensible people gathered at that Exhibition, sixty-one years ago; and that the time is overdue for something of a progress report.

Looking first at the branch that was inspired by the American exhibit, we see in the past sixty years an enormous accumulation of knowledge, and an increase of certainty. Many of the thousands upon thousands of species of animals and plants in the sea have been described, named and classified. The majority of these are in the plankton, that is, the free-floating population, mainly of very small animals and plants, which are found principally in the surface and near-surface layers of the ocean, and in the shallower seas in all layers. Even those animals whose habit is to live near the bottom or near the shore, with few exceptions, begin life as members of the plankton. Besides their structure, something is also known of the behaviour of these animals and plants. Although their active motion in the horizontal is very limited, they appear to have some control over the layer at which they swim, and undertake more or less regular daily migrations—generally to the surface at night and to deeper layers by day. The surface and deeper layers of water often move differentially. Thus by the movements of horizontal layers of water, plankton organisms do effect some horizontal movement, almost like balloonists. It also seems that some of them settle on or very close to the bed of the sea at times, leaving it at others. But there is much about the behaviour of plankton that is still unknown.

It is also now known that the major seasonal changes in numbers of the plankton are closely related to the supply of nutrient salts in the water; shortage of nitrate, phosphate and silicate being liable to limit the growth and multiplication of the plant forms. Here too, though, there is much that is unexplained. Knowing also that the supply of these nutrients varies with the great water movements, which in their turn are correlated with major meteorological changes, investigators are reaching out to a statement of correlated fluctuations—in weather, fisheries, agriculture, water and plankton. This much indeed is known, that particular species are found in different water masses, and their presence denotes an incursion of that kind of water. An example is afforded by three species of the arrow-worm, each of which is confined almost entirely to one kind of water—inshore, Atlantic, or mixed coastal.

Turning to the animals that live on the bed of the sea, it is now known that these tend to occur in more or less well-marked ecological communities, depending on the nature of the ground; but that their numbers are liable to great fluctuations according to the variations in the current that carries the larvæ.

As an example of the application of this general marine natural history to fisheries, we may remember that great concentrations of some of the more spiky diatoms have been found to exclude herring from the normal fishing grounds; and that a start has been made in providing guidance to the fishermen accordingly.

Principally, though, the researches that have provided all this knowledge are to be regarded as research for its own sake, rather than as yielding this or that means for directly making a profit; and I would add that without the confidence that the main lines of nutrition, competition and mortality have been brought within human ken, I for one would not feel bold enough to make the recommendations that come from more closely applied researches. Pure research reveals the background, and the background enables the applied research worker to use judgment, which he would otherwise be quite unable to do for lack of perspective—and judgment is the most valuable weapon that can be provided in practical matters.

For a progress report on the first requirement stated at the Exhibition, general marine biology, there is ample material with which to satisfy our predecessors. This is largely to the credit of the laboratory of the Marine Biological Association and of its many relatives. I think that Huxley, Ray Lankester and Alward would all be reasonably pleased.

The second requirement was knowledge of the life-history of the food fishes—cod, haddock, plaice, hake, herring, and other less quantitatively important kinds, such as sole, turbot, whiting, mackerel and sprats. Here progress was slow at first, mainly for two reasons. First, researches were mostly confined to the waters near the shore. Observations in bays and inlets were valuable, but they could not be generalized to the much greater population of fish which the fishermen were taking in the open sea. It is true that occasional voyages were made in commercial trawlers, and these are, and always will be, necessary as part of the work of a fishery naturalist because that is the only way in which the naturalist can sample the world of fishing methods and people. Without intimate knowledge of fishermen's methods and aims, a naturalist cannot read truly the fishery statistics, which can provide him with a wealth of valuable material; and unless he sees for himself what fishermen are doing, he cannot have a true conception of whether they would in practice carry out his recommendations.

But we are now considering the natural history of the fish, and here the restriction to inshore studies, with occasional voyages as the guest of the fishermen, could never produce adequate answers. For example, it was a canon of the earlier investigators that the inshore area provided the nursery for the tiny cod of 2–3 in. length, because in the late summer these could nearly always be found in the rock pools. The truth of the matter was, however, found to be very different. Some young cod are indeed found on the mile or two strip of coastline available to the earlier investigators, but the nursery area for the North Sea, as a whole, includes the Dogger Bank to Fisher Bank area, and all the grounds to the south and east, which amounts to more than a third of the whole North Sea. This information was only obtained by several expensive voyages of a large trawler fitted for research.

There are many other examples of the necessity for large-scale operations to determine essential facts in the natural history of fishes. Nowhere has this been better shown than in the matter of growth. One of the very important discoveries since the Exhibition of 1883 was that the various hard structures in fish—bones, scales or otoliths—showed rings on them corresponding with the age of the fish. This discovery, or rediscovery, was made by Hoffbauer in 1892 for carp, and at the beginning of this century it was being applied to the sea fishes. Not all the scales give correct readings in temperate waters, but most of them do, and the record of winter on the scale is on the whole more reliable where the winters are more severe. With the aid of these structures the average age of all the fish in a sample can be determined. In addition, the growth of the fish in past years can also be found by measuring the growth on the scale.

My seniors have told me how at first they expected to find a characteristic growth-curve for each species —the cod, the herring, the hake and so on. This, however, eluded them; samples of cod from Iceland showed a different growth from those in the North Sea, and similar differences between different regions prevail in every species. Even in nearby regions there are differences: the growth-rate of plaice in the English Channel exceeds that of plaice in the North Sea. Recent work has shown that within the North Sea itself there are divisions: in summer a thermocline, or discontinuity in the water layers, becomes established over the deeper parts of the North Sea, denying the warmth of summer to the bed of the sea; and on grounds in that area the growth-rate of cod and of haddock is about half that in the shallower regions.

Furthermore, the growth-rate is not the same from year to year, but varies inversely with the density of the fish on the ground.

A very interesting experiment was carried out by G. T. Atkinson in the early years of this century. He brought back some plaice from the Barents Sea, from crowded grounds which had only recently been found by the English trawlers. Otoliths of plaice from there showed very slow growth. Those of his captive fish that survived, in his barrel of water on the deck of a trawler, he marked and let go near the Dogger Bank. When the marked fish were again caught it was found that they had enjoyed a new lease of life, and had started to grow with the fast growth characteristic of the ground where they had been liberated. Rather earlier, it had been discovered that removing plaice from the crowded nursery grounds of the Dutch coast to the better and more thinly populated feeding grounds of the Dogger Bank resulted in doubling their growth-rate.

All this variation has meant that determination of average growth-rate of fish became a statistical problem of alarming proportions, and it took many years before naturalists could fairly say what the growth-rate is in many regions, under various conditions. Certainly we have lost the old aim of determining a growth-rate characteristic of each species; but, curiously enough, generalization is possible in another way. In one region, the North Sea, under its normal heavy fishing, we can speak for all the important species together. For cod, haddock, plaice and herring, we can say that a good fish, by housewifely standards, is five years old, a notably large fish is ten years old, and a notably aged (and not very palatable) fish is twenty years old.

In most of these studies the only method by which generalization has been possible has been by use of the statistics of the markets. On our English and Scottish fishmarkets are found fish from every part of the North Sea, from the western waters as far as the Atlantic slope, from the Arctic as far as the ice. These fish are recorded by special men in the markets and the place of origin is noted. When all these returns are put together and summed, a series is provided by which the observations of naturalists in particular localities or seasons can be weighted, and so integrated. In this way it has been possible to trace out the main spawning areas and seasons, the main migrations, the main growth-rate and the main areas of immature but catchable fish. So have commercial statistics made possible the solution of problems in natural history.

I put the absence of good statistics as the second barrier to progress in the early years of the science.

It would not, however, be correct to suggest that inshore researches have contributed little or nothing to knowledge. That is far from being the case. Where those researches have led to the statement of a principle, this has been found of general application. Thus sea creatures tend to move upstream to spawn —this is true for the crabs of the east coast of Britain, for cod, plaice and many other fish in the North Sea, for salmon in rivers, and even for eels in the Atlantic Ocean.

Migration before spawning is connected with a period of helpless drift in the life of the eggs and larvæ, which is part of the life-history that has only been traced out by special voyages of investigation, and of which still too little is known. It is tolerably certain that the fluctuations in numbers of the fish population are determined during that six to ten weeks of life in the plankton, but the factors in the process have not been evaluated.

By this kind of research, repeated for many species of fish in different regions, the position has been reached that we know the outline of the natural history of nearly all the populations of fish in the northern hemisphere that provide the staple sea fisheries—and something of those in the southern hemisphere.

I think that the shades of Huxley, Ray Lankester and Alward would take a good deal of interest in this progress since 1883. The requirement stated for thorough investigation of the life-history of the food fishes has, in fact, been met. The only criticism that I can imagine them making would be that it would have taken thirty years instead of sixty if they had had a hand in it.

I should expect, however, a good deal of trouble with Huxley over the third requirement—what I have called the population problem of fish and fishing. My first statement here would be that, far from the catch being an inconsiderable proportion of the stock of fish in the sea, the industry has now grown until, for heavily fished stocks such as the plaice, cod and haddock of the North Sea, the catch in this century has become about 70 per cent of the fishable stock.

Here I should, rightly, be challenged to produce the evidence for a statement that presumes to know the number of fish in the sea; and I should say that there are two independent lines of evidence which agree in making the catch of that order of magnitude. First, naturalists of all countries have marked large numbers of plaice and cod with numbered buttons, and let them go in the sea again. The same has been done for halibut in the Pacific and for several other species in various parts of the world. Marking fish has been a most fruitful technique; and fishermen have become well used to recognizing marked fish and returning the mark, or both mark and fish, to our officers at the ports. With due precautions and adjustments for lost marks, the percentage of fish liberated that is returned to us through the commercial fishery is an index of the percentage of the stock that the commercial fishery takes. That is the first line of evidence. The second is this. In the 'nineties, Henson and his colleagues started to sample plankton quantitatively, including the floating fish eggs. In the hands of Buchanan Wollaston, particularly, this method has been developed, until an estimate of the total number of eggs liberated in a season can be made. This number of eggs can be converted to the number of mature female fish, and that again to the number of fishable fish of that species in the sea. From the commercial statistics we can estimate the number of fish in the catch; and so we have an estimate of the ratio of catch to stock.

Both these estimates have only been possible for one population of fish, the plaice in the North Sea. However, in the commercial statistics of cod and haddock there are certain signs, namely, the fall in the catch per unit of fishing power, the increasing scarcity of older fishes in the catches, and the recovery that these stocks make when fishing is interrupted, all of which indicate about as high a rate of fishing on haddock and on cod in the North Sea as on the plaice, for which our special technique has given a numerical estimate.

So, the nature of the case, from which Huxley argued, is by now very different from what it was in the past. Already, in those days, the catches of the deep-sea fishing smacks were showing a noticeably smaller weight of flat fish caught per vessel than had ruled formerly, and the same phenomenon has continued since, in every fishery where the fisherman has power at his command, and is not limited by his market. This phenomenon, reduction in weight caught per unit of fishing power, is a very common one all over the world. It undoubtedly shows a reduction in the weight of fish in the sea, and a reduction in the return to the fisherman per unit of effort.

By way of an example let me quote what I believe to be the very earliest statistics to show this phenomenon.

CATCH PER TRAWLER PER ANNUM OF SOLES AND BUTTS

| | Tons | cwt. | To the nearest ton |
|---|---|---|---|
| 1864 | 15 | 5 | 15 |
| 1865 | 11 | 15 | 12 |
| 1866 | 9 | 4 | 9 |
| 1867 | 8 | 10 | 9 |
| 1876 | 4 | 14 | 5 |
| 1880 | 5 | 1 | 5 |
| 1881 | 4 | 19 | 5 |
| 1882 | 5 | 15 | 6 |

The story is just the same wherever a fishery has developed.

It is evident, therefore, that if a fisherman is to continue to earn a living, he can only do this by increasing his efforts. He must work harder, and invent new and better fishing gear, or use a larger or faster ship. In that way each man can continue in business. But, of course, this reduces the weight of the stock still more.

I have talked of the weight of the stock in the sea being reduced, but in all fisheries where there are good statistics this has not at first meant any reduction in the total weight landed each year. On the contrary, the fishery as a whole grows each year at first. But experience has shown that the process does not continue indefinitely: there comes a stage where an increased effort produces no increase in total weight caught; and in fact there are many fisheries where a decrease has followed.

At the stage when increasing effort produces no greater catch commercial depression sets in, and becomes chronic. I am here only describing known facts, but facts that were unknown in 1881, and not conceived possible by Huxley and by those who thought with him.

I will not here recount the mechanics of this characteristic process—a falling weight per unit of effort, and a total yield that first rises, then rises no more, and sometimes falls: but it is in fact all explicable in terms of the growth-curve of individual fish, and of the rate of mortality by fishing and the rate of mortality from natural causes. These relations have been demonstrated in papers written since 1935, or before, and are thus well established. A broader explanation is probably of more use here. I can put it this way. You can fish at a *high* rate and take a large percentage of stock kept *small* by that high rate, or fish at a *low* rate and take a small percentage of a stock allowed to grow *big* by that low rate. Or you may have your equilibrium at any point in between—or so it seems to me; because I believe that the multifarious systems of animals and plants behind the fish stock can nourish young fish or old using different food chains. The catch is therefore stock × fishing, with one going up as the other goes down. Personally, I do not find it at all surprising that extremes of values of the factors give a less product than intermediate values of both.

If, for the present purposes, it is allowed, on the grounds as it were of symmetry, that moderate fishing will give the greatest yield—and the student who has more time at his disposal may check the precise evidence for that conclusion—then some very serious and far-reaching consequences follow.

Let us look at a commercial consequence first. It is necessary to explain that the great steam-trawling industry of Britain has expanded by adventure—that is, by successive exploitation of new grounds, always farther and farther afield. In the years preceding the War, the far Arctic was the new Eldorado, where the cod was still at an early stage of the fishery, where the more you fish, the more the total catch rises. But on all the nearer grounds, such as the North Sea, Irish Sea, and Atlantic Slope, the total catch has ceased to rise long ago.

Yet the traditional psychology of pursuit remains, and whenever these near-waters fisheries appear promising, more ships, or better gear, or better fishermen, immediately engage.

Experience shows that this may be successful for a little while, as when new trawls were profitable in the North Sea for about three years from 1924 onwards; but of course the new effort drives the stock down to a new low level, and the fishery is unprofitable again.

So the net effect of the psychology of adventure is to give an average equilibrium, governed only by the equation:

$$\text{Average profit} = \text{nil}.$$

This is what happened in the Dreary Thirties—as there is ample independent evidence from account books to prove.

The Great Law of Fishing is that unlimited fisheries become unprofitable. It is clear that the only adequate measure to conserve the fishery is to set some limit to the amount of fishing. The alternative is what we have in fact seen, the history of boys not being so unwise as to join an industry where unexampled hardship is coupled with such unattractive prospects.

However, the moment you agree to set a limit to fishing power, you find that you have in practice taken on responsibility for the way of life of the fishermen—and that brings me to the social consequence of the natural law of the stock of fish. Here it seems to me that Huxley would be on my side. He had such a practical and clear-sighted appreciation of arrangements as they affected people, as he showed in his statement of the position of the crofters, in the passage that I have quoted.

No one likes ordering the lives of other people, but control forces us either to order them or to disorder them ; and to order them seems to me to involve fostering all the qualities that we admire in them. Thus we could foster individual enterprise, inventiveness, skill, technical improvement, better conditions, and any other thing that we know to be good.

Thus it seems to me, at any rate, fishery science has in these sixty years since the Exhibition brought in the power of knowledge. I do not suppose that we have more than a first approximation to the truth yet—in many departments of the science—but we have that approximation established beyond any doubt whatever, and we know exactly what has to be done.

In 1868 the scientific attitude liberated the fishery from unnecessary regulations, and allowed it to become great. But the industry has now reached the bounds set by Nature, and science, which allowed the child to grow to manhood, has now the knowledge to say what is proper in a mature industry, dependent on a natural resource.

## SYNTHETIC RUBBER PROBLEMS

The chairman of the Division of Rubber Chemistry of the American Chemical Society, at the spring meeting of the Division in April in New York City, well said that while the achievements of rubber technologists with natural rubber in a hundred years of progress are a subject for just pride, the actual production work with synthetic rubber in less than a hundred weeks is nothing short of a miracle.

Nevertheless, the processing problems involved in using *GR–S*, which is the butadiene–styrene polymer mass-produced in the United States to replace the million tons of natural rubber in enemy hands, are still numerous, difficult, and of serious significance to the available output and service life of the products. There is ample evidence of this in the papers read before the Rubber Division, the great majority being devoted, directly or indirectly, to *GR–S* processing difficulties.

Six to twelve months ago, the rubber manufacturer's primary anxiety was to masticate, plasticize and render self-adhesive or 'tacky' the *GR–S* mixings from which rubber articles are built or moulded. No entirely satisfactory methods are yet available for this work, but provisional practical processes have been made generally known with which we can 'make do' until better are found. The relief from this anxiety has transferred attention to vulcanization difficulties, of which the variability aspect is the worst. A paper by F. E. Rupert and F. W. Gage reveals that atmospheric humidity is a factor of the first importance in the question. Exposure of unvulcanized mixings to increased humidity and increased length of exposure increases the rate of vulcanization by as much as one hundred per cent. Other evidence has been accumulating for some time, all indicating that very exact control of the water content of *GR–S* mixings is of vital practical importance.

Revolutionary ideas on the acceleration of vulcanization were given in a paper by A. A. Somerville in announcing two new copper compounds as being several times as active as conventional accelerators. So little as 0·01 per cent by weight of ordinary 300-mesh copper powder added to a *GR–S* mix will shorten the vulcanization period by half, and the new copper compounds are even more effective. Moreover, instead of the rapid perishing frequently encountered in natural rubber contaminated with copper, *GR–S* articles containing the copper accelerators actually have increased resistance to ageing. Sixteen other metals failed to show these remarkable effects.

Equally novel was a paper read by G. M. Wolf, T. E. Deger, H. I. Cramer, and C. C. de Hilster, on the successful use of a new class of vulcanizing agents —alkyl phenol sulphides, in particular *p*-tertiary-amylphenol disulphide. These agents are claimed to possess two very important advantages over sulphur in that (1) they impart some tackiness to *GR–S* mixings, and (2) they give products with outstanding resistance to deterioration by heat. The heating up of large tyres in use, which is the most serious of the unsolved production problems, since the only remedy at present is to use up the scanty stocks of natural rubber, may at least be ameliorated by the application of these sulphide vulcanizers. The heat build-up problem was touched upon, also, in a paper by G. M. Massie and A. E. Warner, who report that the use of a non-persistent accelerator, for example, a substituted lead dithiocarbamate, much reduces the tendency of *GR–S* to stiffen due to service heat, especially if diphenyl-ethylenediamine is used in the mixing.

A third paper, by A. R. Lukens, was also associated with the heat-stiffening question. It was pointed out that the trouble arises mainly from the presence in *GR–S* tyres of liberal loadings of very fine particle carbon blacks. Such loadings have become customary since the other reinforcing agents often used in natural rubber—zinc oxide, magnesium carbonate, whiting, for example—fail to confer any improvement in *GR–S*. It has now been shown, however, that mineral pigments such as those noted can be prepared in much more finely divided forms than hitherto, with the result that they considerably reinforce *GR–S*, but do not cause heat build-up. Mixings containing lower proportions of carbon black and these new fillers may well be a great improvement on to-day's practice.

Other papers at the meeting dealt with various standard problems, adding much valuable information without conspicuous novelties. Reference may be made in conclusion to an account by R. A. Emmett of an interesting range of raw materials comprising blends of various butadiene rubbers with plasticized polyvinyl chloride. Both vulcanizable and non-vulcanizable plastics have been developed in this range. They possess the good qualities of both components and provide a much-needed economy in rubber in a wide variety of applications.