lar portion of *Balanus,* but with the base, which in the latter genus is not only entire, but under suitable conditions assumes a tubular conical form, and in one species, the *Balanus lævis* of Darwin, sometimes has the lower portion of this tube more or less filled with a vesicular mass of shell substance closely resembling the tube of *Tamiosoma.** This conclusion was fortified by the discovery of an undoubted species of *Balanus* in the same horizon as that of *Tamiosoma,* forming a tubular base like that of *B. lævis,* though much smaller, in the proximal portion of which a certain amount of vesicular filling had taken place. Lastly, complete confirmation was attained through the kindness of the authorities of the State Mining Bureau of California which at the intercession of Dr. J. C. Merriam, of the University of California, forwarded a unique specimen which had been supposed to exhibit an 'upper valve,' but in which the subconic base filled this rôle, while a careful cleaning of the much-crushed but otherwise nearly intact 'base' revealed the remains of six very solid valves typical of the genus *Balanus,* and the cavity, now filled with gravel and fragments of the shell, in which the soft parts of the animal had originally been enclosed. These valves were so crushed and worn that a complete figure of the valvular summit of *Tamiosoma* is not yet attainable, but the fact that the valves are smooth, except for the rude concentric rugosities due to resting stages and other exigencies of growth, and that they agree with the typical *Balanus* in number and general character, is conclusively demonstrated.†

It is interesting to discover new types of animal organisms, but perhaps still more so to be able to place those already known to some extent, but whose relations, in the absence of complete information, have been so differently estimated as in the present case. It only remains for systematic students of the cirripedes to determine whether the notable peculiarities of growth of this singular fossil warrant the retention of the name *Tamiosoma* in a subgeneric or sectional sense, or whether it shall be relegated to the genus *Balanus* as a synonym.

Some time since, the supposed occurrence of *Radiolites* in a bed of clay pierced for a tunnel in the city of Los Angeles was noted in SCIENCE. A further examination of fossils collected from these clays by Mr. Hamlin shows that sixty per cent. of the mollusks are recent species, and the age of the deposit therefore Pliocene. Mr. T. W. Vaughan is confident that the fossil which was taken for the smaller valve of the supposed *Radiolites* is a solitary coral; and, while the other portion still remains problematical, it is highly improbable that it belongs to the group of Rudistes.

WM. HEALEY DALL.

*Darwin, Mon. Cirripedia, *Balanidæ,* p. 227, 1854. See figure of the variety *coquimbensis,* Plate 4, Fig. 2a, giving a section of the tubular base, partly filled with vesicular septa.

†Since the above was written a letter from Mr. Hamlin announces the discovery of a number of complete specimens with the valves.

*THE RELATIVE PROGRESS OF THE COAL-TAR INDUSTRY IN ENGLAND AND GERMANY DURING THE PAST FIFTEEN YEARS.**

THE coal-tar industry is the flower of the chemical industries. It represents the highest development of applied chemical research and chemical engineering, and a country which allows the most scientific branch of chemical industry to languish cannot expect to maintain preeminence

*From a paper by Arthur C. Green read before the British Association (Section of Chemistry) at the Glasgow Meeting, 1901. This accurate statement of the present status of the coal-tar industry, and incidentally of the whole chemical industry, is of interest, not only to the audience for which it was prepared, but also to Americans. For this reason the most important portions of the paper are here presented.

long in any simpler branch of chemical manufacture. Skill trained for attacking the difficult problems of organic chemistry is certain, sooner or later, to be brought to bear on the simpler problems, and to result in improvements along the whole line of chemical industry, resulting in better products and cheaper production. This is well exemplified in the recent revolution in the manufacture of sulfuric acid. The manufacture of alizarin colors and artificial indigo has made a strong demand for cheap sulfur trioxid. With the object of satisfying their own requirements in this respect, the Badische Anilin and Soda Works of Ludwigshafen devoted much time and research to improving the catalytic process of Winkler. This endeavor was attended with such success that by means of the process and plant which they finally evolved they were enabled to produce sulfur trioxid so cheaply that it could not only be used for a large variety of purposes, but, by combination with water, afforded a profitable source of sulfuric acid. This new method of manufacturing sulfuric acid is, for concentrated acid at least, cheaper than the chamber process, and since the product is absolutely free from arsenic and can be produced at any desired concentration, it seems likely to supplant eventually the time-honored method of manufacture.

Besides exerting a stimulating influence upon the inorganic chemical manufactures, the coal-tar industry has given birth during recent years to several important daughter industries. The manufacture of synthetic medicinal agents, artificial perfumes, sweetening materials, antitoxins, nutritives and photographic developers, are all outgrowths of the coal-tar industry, and in great part still remain attached to the color works where they originated. The requirements of the coal-tar industry have further led to great advances in the design and production of chemical plants, such as filter-presses, autoclaves, fractionating columns, vacuum-pumps and stills, suction-filters, enameled iron, aluminum and stoneware vessels, etc., for the supply of which extensive works have become necessary.

Lord Beaconsfield said that the chemical trade of a country is a barometer of its prosperity, and it has always been regarded as a most important branch of English manufactures. Even those who might be inclined to regard our declining position in the color industry with more or less indifference would consider the loss of a material portion of our general chemical trade as nothing less than a national calamity. The two are, however, indissolubly connected.

It is with the object of ascertaining our present and future prospects in the chemical trade of the world that I propose to compare the relative development of the color industry in England and Germany during the past fifteen years. In 1886, in a paper read before the Society of Arts, Professor Mendola gave a masterly account of the position of the industry in this country at that date, and sounded a warning note to our manufacturers and business men regarding its future progress. These warnings, repeatedly given, have remained largely unheeded, and if the conclusions now forced upon us are unfortunately not of a reassuring nature for our national trade, it is well to remember that nothing is gained by burying our heads in the sand.

In no other industry have such extraordinarily rapid changes and gigantic developments taken place in so short a period —developments in which the scientific elucidation of abstract problems has gone hand in hand with inventive capacity, manufacturing skill, and commercial enterprise; in no other industry has the close and intimate interrelation of science and practice been more clearly demonstrated.

From 1858 to 1886 may be called the 'rosanilin period' of the color industry, since it was chiefly marked by the development of the colors of this group. A few individual members of other groups had been discovered, but had not attained importance. This is especially true of the 'azo' dyes, which have attained such importance that the last fifteen years may justly be called the 'azo period.' The number of individual compounds belonging to this class which have either been prepared or are at present preparable, runs into many millions, and far exceeds the members of all other groups of coloring matters put together. In commercial importance, also, they occupy a position at present far in advance of any other group; the employment of some of them, as the azo blacks, amounting to many thousands of tons annually. A great stimulus to the investigation of the azo compounds was given by the discovery by Boettger in 1884 of the first color possessing a direct affinity for cotton (Congo red), which was followed in a few years by a rapidly increasing series of colors of all shades having similar dyeing properties. The great simplification of cotton dyeing, brought about by the introduction of the new group of azo colors —'benzo' or 'diamin' colors as they are called—led to a rapid increase of their number. Simultaneously therewith proceeded the discovery and investigation of the various isomeric derivatives of naphthalene, required as raw products for the preparation of these colors.

Another method of applying azo colors to cotton, by which much faster shades are obtained, was introduced by Messrs. Read, Holliday & Co., of Huddersfield, in 1880, and consisted in producing unsulfonated azo compounds on the fiber by direct combination. Owing to technical difficulties this process has only reached its full development during the last few years, and that at other hands than those of its discoverers. The most important color produced by this method is paranitranilin red, for which over two hundred tons of chemically pure paranitranilin are manufactured annually.

The search for direct cotton colors led the author to the discovery of primulin in 1887, and this can be used for the synthesis of various azo colors on the fiber, which are remarkable for great fastness in washing. The new principle of dyeing which this introduced has been considerably extended in other so-called 'diazo' colors. The mordant azo colors have also, with the growing demand for faster shades, recently come into much prominence. The laborious scientific investigations of Fischer and Hepp, Bernthsen, Kehrmann and others on the azins, oxazins, and thiazins, have led to the discovery of many valuable new members of these classes, such as the indulins, rosindulins, rhodulins, etc. Much investigation has also been given to the pyrone and acridin groups, leading to the rhodamins, a class of pure basic reds, and to the basic yellows and oranges.

Next to the azo group, it is in the alizarin group that the greatest progress must be recorded. The demand for fast colors for calico-printing and for dyeing chrome-mordanted wool to withstand severe milling operations, has led to a long series of investigations and patents for producing new derivatives of anthraquinone—the anthracene and alizarin colors. The 'Vidal' blacks and other colors, for the direct dyeing of unmordanted cotton, are now being rapidly developed, although thus far their constitution has resisted elucidation.

It may be fairly claimed, however, that the greatest triumph of the coal-tar industry for the past fifteen years has been the successful production of artificial indigo on a large manufacturing scale.

Returning to the economic aspect of the subject, I will ask you to consider what

share we have obtained in the great expansion of trade resulting from all these new discoveries, of which many have originated in this country. The development of the industry in Germany is well illustrated by the following figures:

Exports from Germany to the World.

	1885. Tons.	1895. Tons.	1899. Tons.
Anilin oil and salt.....	1,713	7,135	.....
Coal-tar colors (excl. of alizarin)	4,646	15,789	17,639
Alizarin colors.....	4,284	8,927	.....

The value of the exports of coal-tar colors from Germany in 1894 was 2,600,000 pounds sterling, in 1898 3,500,000 pounds, an increase of nearly a million in four years. The total annual value of the industry of Germany is hardly less than ten millions of pounds sterling. With the increase in the production of synthetic indigo it may be taken to-day to considerably exceed this figure.

One may well wonder what becomes of this enormous quantity of coal-tar products. According to the United States Consular reports the three and a half million pounds' worth of coal-tar colors exported by Germany in 1898 were consumed as follows:

The United States took...	750,000	pounds' worth.
The Unted Kingdom took.	750,000	" "
Austria and Hungary took	350,000	" "
Italy took.....	225,000	" "
China took.....	270,000	" "

whilst the rest of the world took the remainder.

The great increase in production in Germany is further shown by the growth in the capital and number of work-people employed. Thus, according to a report of the Badische Works recently issued, the capital of this company, which was increased in 1889 from 900,000 pounds to 1,050,000, will be further augmented this year by the issue of 750,000 pounds' worth of bonds. The number of work-people employed by this company in 1900 was 6,485, as against 4,800 in 1896, an increase of over thirty-three per cent. in four years. The firm of Leopold Cassella & Co., of Mainkur, near Frankfort, have increased the number of their work-people from 545 in 1890, to 1,800 in 1900.

In England we find that the imports of coal-tar colors are steadily rising, having increased from 509,750 pounds sterling in 1886 to 720,000 pounds in 1900. Contrasted with this, the exports of coal-tar colors manufactured in England have fallen from 530,000 in 1890 to 366,500 pounds sterling in 1899. It is therefore apparent that we have had little share in the great increase which this industry has experienced during the past fifteen years, and we have not been able even to supply the expansion in our own requirements. This is well shown by the following statistics of the two Associations who together form a very large proportion of the entire dyeing trade.

Coloring-matters Used by the Bradford Dyers' Association.

English	10 per cent.	Swiss	6 per cent.
German	80 per cent.	French	4 per cent.

Coloring-matters Used by British Cotton and Wool Dyers' Association.

Anilin colors.....	English	22 per cent.
	Foreign	78 per cent.
Alizarin colors.....	English	1.65 per cent.
	Foreign	98.35 per cent.

Out of a total of sixty tons of coloring-matters and other dyeing materials derived from coal-tar, used by the English Sewing Cotton Company, only 9 per cent. were of English manufacture.

The following table gives a fair picture of the present dimensions of the industry in Germany.

Compared with such figures as these, the English color manufacture assumes insignificant proportions. The total capital invested in the color industry in this country does not exceed 500,000 pounds, and the

POSITION OF THE SIX LARGEST COLOR WORKS IN GERMANY IN THE YEAR 1900.

	Badische Anilin Works.	Meister, Lucius and Brüning.	Farben Fabriken Bayer and Co.	Berlin Anilin Co.	Cassella and Co.	Far werk Mühlheim Leonhardt, and Co.	Total of Six Firms about.
Capital	£1,050,000	£833,000	£882,000	£441,000	{ Private concern }	£157,000	£3,500,000
Number of Chemists	148	120	145	55			500
Number of Engineers, Dyers and other Technologists	75	36	175	31	60	450	350
Commercial Staff	305	211	500	150	170		1,360
Work People	6,485	3,555	4,200	1,800	1,800		18,260
Dividends (per cent.)							
1897	24	26	18	12½	not known	9	
1898	24	26	18	15	" "	3	
1899	24	26	18	15	" "	5	
1900	24	20	18	?	" "	nil	

total number of chemists employed cannot be more than thirty or forty.

A similar relative proportion is maintained in patents:

Comparison of Number of Completed English Patents for Coal-tar Products taken during 1886–1900 by Six Largest English and Six Largest German Firms.

German firms:

Badische Anilin Works	179
Meister, Lucius and Brüning	231
Farbfabriken Bayer & Co	306
Berlin Anilin Co	119
L. Cassella & Co	75
Farbwerk Mühlheim Leonhardt & Co.	38
Total of six German firms	948

English firms:

Brook, Simpson & Spiller	7
Clayton Anilin Co	21
Levinstein	19
Read Holliday & Co	28
Claus & Reë	9
W. G. Thompson	2
Total of six English firms	86

Nor does this represent the sum total of our losses. The new coloring matters, made chiefly in Germany, have in many cases been introduced as substitutes for natural products, which were staple articles of English commerce. Madder and cochineal have been replaced and logwood and indigo are seriously threatened. The capture of the indigo market by the synthetic product, which would mean a loss to our Indian dependencies of three million pounds sterling a year is regarded by the Badische Company as so absolutely certain, that having already invested nearly a million pounds in the enterprise, they are at present issuing 750,000 pounds of new bonds to provide funds to extend their plant for this purpose.

Again, besides the loss of material wealth which the neglect of the coal-tar trade has involved to the country, there is yet another aspect of the question which is even of more importance than the commercial one. There can be no doubt that the growth in Germany of a highly scientific industry of large and far-reaching proportion has reacted with beneficial effect upon the universities, and has tended to promote scientific thought throughout the land. By its demonstration of the practical importance of purely theoretical conceptions, it has had a far-reaching effect on the intellectual life of the nation. How much such a scientific revival is wanted in our own country the social and economical history of the past ten years abundantly testifies. For in the struggle for existence between nations the battle is no longer to the strong in arm, but to those who are the strongest in knowledge to turn the resources of nature to the best account.

In 1886 it could perhaps still be maintained that we held the key to the situation if we chose to make use of it; inasmuch as the principal raw products of the color industry (tar oils, naphthalene, anthracene, soda, ammonia, iron, etc.) were in great measure imported from England. In 1878 Professor von Bäyer had said: "Germany, which in comparison with England and France possesses such great disadvantages in reference to natural resources, has succeeded by means of her intellectual activity in wresting from both countries a source of national wealth. The primitive source of this wealth is in England. It is one of the most singular phenomena in the domain of industrial chemistry that the chief industrial nation, and the most practical people in the world, have been beaten in the endeavor to turn to profitable account the coal-tar which they possess. We must not, however, rest upon our oars, for we may be quite sure that England, which at present looks on quietly while we purchase her tar and convert it into colors, will unhesitatingly cut off the source of supply as soon as all technical difficulties have been surmounted by the exertions of German manufacturers."

But the initial advantages which our natural resources afforded us have been neglected, and now, in 1901, the conditions are completely changed, and Germany is no longer dependent upon England for her raw material. Through the shortsightedness, ignorance, and want of enterprise of those with whom rested the care of the color industry of this country in its earlier days, the opportunity has been allowed to pass forever. The English manufacturer considered that a knowledge of the benzene market was of far greater importance than a knowledge of the benzene theory, and little encouragement was given here to chemical investigators and discoverers. The control of the industry passed into the hands of men who had no knowledge and absolutely no appreciation of the science upon which their business rested, and concerned only with getting the ultimate amount of present profit, discouraged all scientific investigations as waste of time and money. The chemist who devoted himself to the elucidation of the chemical constitution of a coloring matter was regarded by them as an unpractical theorist of no value to a manufacturing business. Even when he discovered new coloring matters of commercial value, they were so blind to their own interests and so incapable of believing that any practical good could come out of such theoretical work, that in many cases they refused to patent or in any way take advantage of the discoveries made by him.

During recent years this attitude has certainly undergone considerable modification. Certain firms must indeed be given the credit of endeavoring to pursue a more enlightened policy, but these attempts have always been directed too much in the expectation of realizing immediate financial results. The difficulties which must be encountered in an attempt to regain the lost ground are of necessity very great and quite unappreciated by our business men. It seems, in fact, to have been the opinion of the public and of the average financial man that this industry ought to be easily won back by the establishment of a few technical schools, the engagement of a dozen chemists, and the investment of a few thousand pounds in new plants, forgetting that the supremacy of our German competitors has been won by years of patient toil, by the work of hundreds of trained chemists, and by the outlay of millions of capital. Who can be surprised, therefore, if such expectations have not been realized, and if in spite of some notable successes the general position of the color trade in England to-day presents a gloomy aspect?

Where, then, are we to look for an improvement? Some would find a remedy in the imposition of heavy protective tariffs, but such tariffs in France have not availed to prevent a similar state of things there, and protection in coloring matters might have a very detrimental effect upon the textile industries of the country. Others expect salvation from the extension of technical schools, but laudable as is the aim of these institutions, I cannot see how they can effect much until their raw material is of a very different character from what it is at present, and until the public can be completely disabused of the fallacy that a year or two of technical training pumped into an ignorant schoolboy will produce a better works-chemist than a university course of scientific study laid upon the foundation of a good general education.

The remedy for the present state of affairs must of necessity be a slow one, and in my opinion can only be found in a better appreciation of the value of science throughout the length and breadth of the land. Until our government and public men can be brought to realize the importance of fostering the study of science, and of encouraging all scientific industries, until our schools and universities appreciate the importance of a scientific education, until the rewards for public service in science are made equal to those in other branches of public service, so long will science continue to be held in insufficient esteem in our country. It is not so much the education of our chemists which is at fault as the scientific education of the public as a whole.

When our capitalists more completely realize the importance of calling in the aid of the best scientific skill available, when our universities and technical schools are able to supply a sufficient number of highly educated chemists equal in knowledge, originality and resource to those trained in German universities, when our professors and manufacturers are willing to work together in this and other matters, when our patent laws are rendered just to ourselves, we may confidently hope that our natural engineering skill and practical resource will once more bring us to the front.

CONCERNING CERTAIN MOSQUITOES.

DURING the season of 1901 the writer studied the mosquito problem, as it exists in the State of New Jersey, with a view to determining whether it was possible in any way to reduce or control the number of these pests in the State. It was decided that the first point of importance was to ascertain just what species was or were the most troublesome, and just where these troublesome species bred. Collections were made in all parts of the State and local boards of health were enlisted in the service everywhere. The result was the accumulation of a large amount of material, covering every county and almost every district in the State.

Based upon these collections, it was found that the most abundant species was *Culex sollicitans,* and, after this fact was determined, especial attention was paid to the life history and breeding places of this mosquito. It has been known that the species breeds in brackish water; but it has been believed, and is so stated by Dr. Howard in his book on mosquitoes, that it would not breed in water as salty as the sea itself. Collections made along shore soon proved that this general belief was incorrect: so far as noted the contrary is true, for larvæ were found in great abundance in pools and ponds in which the water was fully twenty-five per cent. more salty than ordinary sea water. The collections in the marshes along the coast demonstrated that some percentage of salt was absolutely necessary for the development of the larvæ. In no case were