

## The Mind of the Century

### *The Mind of the 19th Century*

#### *History*

By J. A. Nicklin

History is both a science and an art. That fact alone makes the task of resuming the century's "Historiography" peculiarly difficult. Not that I have any intention of balancing brilliant writing against learning and research, but, in selecting the main lines of progress, it often happens that one has to choose between the real originator, who would be entirely unknown to the general reader, and the literary exponent who came into the movement later in the day. History, too, as a science, has enlarged her borders so much during the nineteenth century that I shall be in constant peril of encroaching on the domains of the archaeologist, the jurist, the sociologist, and even of the theologian.

The nineteenth century started its career rich in ideas and tendencies that were destined to influence the science of history. There was, in chief, the Romantic reaction against the spirit of the *Aufklärung*, that eighteenth century spirit which despised the past, and had set up an absolute standard by which it condemned all that appeared anomalous. This reaction took many forms. A new interest in the Middle Ages, having its rise in Germany, was seized upon by the triumphant imagination of Walter Scott, and became a fruitful source of new aspects and combinations. With the sympathetic attitude to mediævalism went a curiosity which drew men to exotic Literature's, especially the Scandinavian and Indian, and from this eventually was born the comparative method of examining Language, History, and Mythology, with their kindred problems. The great jurist Savigny left an indelible mark on historic methods. He abolished the law of nature, which had been the motive of 1789, and substituted the law of nationality, the motive of 1848. The absolute standard of the eighteenth century was broken down. Institutions were to be judged, not from an *à priori* point of view, but from their relation to the traditions and character of the race. It was this which Burke had so long been proclaiming, when he would have been a voice crying in the wilderness, had he not been mistaken for a vociferous Tory.

From the eighteenth century there had come a practical interest in constitutional questions, exemplified by Montesquieu and the apologists of 1688, into which, at the last moment, Adam Smith had insinuated a sharper analysis of the causes of national prosperity and decay. And, besides all this, Wolf, in his prolegomena to Homer, had handed on the potent seed of historical criticism.

In Hallam's "Constitutional History" we see a survival of the eighteenth century, as also, in a less degree, in Guizot's "English Revolution," while the much later Roman history of Dean Merivale was wholly inspired by Gibbon. Even Tocqueville's "Democracy in America" has something of Montesquieu in it, though we feel the Hegelian leaven working in its comprehensive generalisation.

Niebuhr was inspired by the ideas of Wolf. He tried to apply the same analysis, under which the unity of authorship of the Homeric poems had dissolved, to early Roman history. It was one of the first applications of the critical method, but Niebuhr only recognised one side of that method. His principle was that truth is not hopelessly buried under tradition, but that the reality could be disentangled from its encumbrances of myth by the observation of apparently fixed laws of development. That principle was only efficacious in dealing with very early times—with pre-historic history. A further advance in the method was made by Böckh.

He was the first historian to see the value of inscriptions, and his treatment was marked by the suppression of personal bias.

It was a fairly easy matter for Böckh to eliminate the personal equation from discussions of Athenian Weights and Measures. For Ranke to investigate creeds and struggles and issues full of vital importance to his own age, with the detachment of a mere spectator, was a heroic feat. This splendid impartiality, which set itself only to explain how events happened in this way rather than that, and how men's aspirations and ideas were formed, while refusing to pronounce any judgment upon them, and while keeping the historians' own opinions strictly in reserve, has influenced the study of history deeply. Tocqueville examined the development, and traced the progress, of democracy without letting fall a hint how deeply he feared it. The loss of a few private letters would even have left us in ignorance of his religious belief. To-day the Bishop of Oxford can make a similar boast. His readers might easily mistake him for a Radical.

This is far from being Ranke's only contribution. He supplemented the critical method where Niebuhr had left it deficient. Documents were submitted to the same questioning as traditions. Evidence was traced back to its source and testimony weighed. Yet another advance was made when, from scrupulous collation of printed texts, Ranke pressed on to the discovery that printed books cannot suffice to reconstruct the past, and it is not science to extract history from anything less than the entire body of written evidence.

In England Macaulay had at first welcomed Ranke's discoveries with enthusiasm. He justly praised the "History of the Popes," for it was only when the Roman Catholic Church received adequate treatment that the key to the Middle Ages was found. Voigt had been the first to release the Mediæval Papacy from the dilemma of good or bad, and Milman was presently to do good work here with his "History of Latin Christianity."

Macaulay afterwards became jealous of Ranke. Certainly no one could accuse Macaulay of impartiality. Yet he is more than a brilliant writer. His "State of England in 1685" was a valuable attempt at a task which J. R. Green afterwards accomplished. On the whole, though he often seems to lean to the doctrine of Thiers, that "L'Histoire c'est le Portrait," Macaulay may be considered as one of the historians who learnt the secret of historical imagination, the imaginative reconstruction of the past, from Scott. With him may be joined a greater writer, Michelet, by far the most splendid type of his school, who succeeded also in bringing the geographical features of a country into vivid connection with the fortunes and character of its people.

In the path which Ranke had indicated, when he announced the necessity of adding the study of manuscript sources to the knowledge of books, the chief pioneer was Mignet. His monograph on the Spanish negotiations under Louis XIV. set the example of such specialisation, and led the way in a study of archives—a branch of history still rapidly extending itself year by year. Grote may be said to have received from Niebuhr an impetus rather than any definite conceptions or methods. The dominating conception of his history was to put in a more favourable light the Athenian democracy, which had been misrepresented by the prejudice of Mitford. In this respect he was working on the same lines as Guizot, when Guizot examined the principles of the English Revolution. He was, to a certain extent, carrying on the traditions of Hallam, and the constitutional studies which dated back to Locke and Montesquieu. But he was under the guidance of larger conceptions. His standard was not framed with an eye constantly on the Whig institutions, but had reference to a universal idea of democracy. However, he had learnt something from the mistakes of the last century, and he understood by democracy, not a rigid code to be accepted or rejected, but a force operating differently in different times and places according to national conditions. He was very much

under the influence of the Utilitarian philosophy and sometimes moved, rather indirectly, by the ideas of Comte.

A writer who illustrated these tendencies more conspicuously was Buckle, though his “History of Civilisation” was a failure. He had drawn much on Utilitarianism, more still on Comte’s idea of humanity and human progress, with its three stages theological, metaphysical, and positive—but the most remarkable feature of his book is the aspiration after a principle of unity in man’s history. A transformation had come over the historic mind. For the *Volksgeist*—the spirit of nationality—there had been substituted, under the inspiration of Hegel, the *Weltgeist*, or World Spirit. Buckle was bound by the limitations of a strictly material and positive view. But the conception of the *Weltgeist*, joining hands, as it were, at last with the newer conception of evolution, has modified all subsequent historic science, even for those who would scornfully repudiate the suggestions of any philosophic principle in history. Macaulay’s ideal was a narrative which should compete in popularity with the three-volume novel. Thiers thought that history was a form of portraiture. Kinglake, Motley, Carlyle, and Froude all aimed at portraiture, idealising or caricaturing their subjects with unwavering partiality. Prescott, the compatriot of Motley, had unfolded an impartial panorama.

None of them could have exercised their fascinating art if their generation had not fallen heirs to that historic sense which is founded equally on sympathetic imagination and on the critical and comparative methods.

No one could be farther removed from this theory of history than Freeman, but Freeman was with Kinglake and Froude at least in the indifference to the metaphysical side of historical studies. To Freeman history was past politics, and politics were present history. Some of his best work was the continuation, under more favourable conditions as to material, and with an improved science, of the labours of Anglo-Saxon scholars like Sharon Turner, Kemble, and Palgrave. The idiosyncrasy which is to be noticed in him—resolve to study history on the spot, and elicit it from city walls and the features of a landscape—is repeated, in a finer perfection, in Green and Gregorovius. With Professor Freeman I must be allowed to associate—for no better reason than that they both carried light into regions which most scholars have shrunk from—the name of Burton, the author of the standard “History of Scotland.”

Something like Freeman’s exclusive interest in politics is discernible in the remarkable phalanx of Berlin professors—Mommsen, Droysen, Treitschke, Von Sybel, and Gneist. Mommsen is famous, first and foremost, for his “History of Republican Rome,” with its continuation, the volume on the Roman provinces, and then for his editorship of the “Corpus Inscriptionum”; Droysen wrote the history of the Macedonian Empire; Gneist is second only to Dr Stubbs as an authority on the English Constitution; but all were affected by a common idea, which harsh critics are inclined to characterise as the apotheosis of force. History seemed to them only reasonable if might were also right; if the strongest were also the best. The Romans triumphed, not through treachery, but because success was their desert. Not infrequently the Berlin school have confounded the *Weltgeist* with the *Volksgeist* in their endeavour to prove that Prussia has been so far successful, because she deserved success, and that, in the future, her deserts must inevitably meet still further success. It is a very interesting case of one aspect of the theory of evolution, together with a certain ethical view of history, uniting so as to coincide with the national idea of the beginning of the century.

The application of the principles of evolution, and the comparative method, is strikingly exemplified in Sir Henry Maine’s “Ancient Law” and “Village Communities.” More fruitful scientific hypotheses, and a wider field for comparison, enabled Maine to carry into the whole field of pre-historic institutions, such researches as Niebuhr had endeavoured to apply to the limited area of the institutions of pre-historic Rome. Maine’s work has been widely ex-

tended or corrected by anthropologists ; especially by McLennan, in his penetrating criticism of the Patriarchal system ; and similar investigations are still being carried on in localised departments by scholars like Mr. Seebohm and Mr. Round.

A product, in great measure, of the ideas of evolution and the *Zeitgeist*, or Time Spirit, the apprehension of the aggregate of human energies as an organic whole, has concentrated itself, now in the social and civic life of the people, as in Green's brilliant presentation of the development of the English people, now in the activities of the artistic sense, as in Gregorovius' study of mediæval Rome and Athens, and Addington Symonds' delineation of the Italian Renaissance, now in some other manifestation of intellectual or moral energy. Thus Professor Villari has studied the environment of typical Florentines, such as Machiavelli and Savonarola ; Mr. Lecky has explored the moral altitudes and abysses of Europe from Augustus to Charlemagne, and the social, political, and moral ideas of the eighteenth century, and has attempted a kind of natural history of opinions. Mr. Morley has treated in a similar way the intellectual and social environment which prepared the French Revolution, and, in his most recent book, the ideas of the Commonwealth. And here perhaps is the most convenient occasion for noticing a very remarkable development of the Hegelian idea—its creation of the Tübingen School of Theology, which, founded by Baur, has made its influence most widely felt in the “ Life of Jesus” and “ Origins of Christianity” of Renan— not a disciple, but a descendant. I place his work here as an example of the tendency to look on all human activities as interdependent parts of a living whole—in other words, as parts of an organism. As Savigny had first taught the historian to see law as a natural secretion from the social instincts of the nation, so now men are regarding art and morals, and even religion, as states evolved under necessary conditions from the human consciousness. The Hegelians of Tübingen conceived the idea of the “ Formation of Truth”—the truth of religion consisting in its adaptation to the existing order of ideas, and therefore in perpetual motion. Renan took this idea up, and supporting it with a completed science of documentary criticism, and illuminating it with rare literary qualities, made its fortune.

Documentary criticism has inevitably played a very serious part in the development of history, from the time that it became the practice of the historian to go behind the printed book. Charters do not lie. The History of Early England is written in Domesday Book. What did the actors themselves allege as their motives ? That is the object of search, and all the motives historians have credited to them may be swept away. Something like this is the persuasion of the English school of to-day. Pre-eminent in that school, it needs not to say, are Bishop Stubbs, who has an unrivalled knowledge of our early charters, and Dr. Gardiner, who has an unrivalled knowledge of the manuscript sources for the history of the great Rebellion. Most of the activity of to-day is engaged either in the investigation of special points in ancient institutions, as in the case of Mr. Round and Mr. Seebohm, or in the discovery of new evidence to elucidate special points of later history—the case of Mr. Firth. The publication of State papers goes on apace. But there was never the same sensation in England as was produced on the Continent by throwing open the archives of Vienna and Berlin. Our arcana had not been hermetically sealed.

Few results have been more startling to the historian of this age than the discoveries which have been made by archæological exploration. From Champollion's Egyptian discoveries in the first quarter of the century, and Layard's discoveries at Nineveh, the tide has rolled on, wider and wider. To mention a very few of our innumerable acquisitions, there are the Hittite inscriptions, there are the results of Schliemann's excavations at Mycenæ and in the Troad, there are written records of Egypt and its dependent countries, to throw back the art of writing and the first historical data into an unsuspected distance of centuries, and now there are Mr. A. J. Evans's discoveries at Knossos to show that Minos was no myth, but the founder of an actual Cretan dynasty. Probably the writers on Egyptian and Asiatic history best known to an English public are Canon Rawlinson, Professor Sayce and Dr. Flinders Petrie.

If we limit our view of the prospects of history to this country, we shall have little difficulty in observing a strongly marked tendency. The "Dictionary of National Biography," on which most of the historians have been engaged, has set an ideal and a method before the younger men. They assert that history ought to deal only with facts. So did Ranke. But Ranke meant that the historian should stand by absolutely impartially, and let the epoch which he was studying develop itself, in all its aspects, without incurring either his moral condemnation or approval. The new school mean that the historian has no business with ideas, or motives, or tendencies ; it is his business solely to inquire, Did this happen, or not happen ? Did it happen this way or that ? This intention to limit the historian's view to the concrete fact is naturally joined with an intense specialisation. Nothing could be further from the historian of today than the desire to work with the whole field of history constantly before his mind, as Ranke worked. Large views are false ; the only genuine work is done in a corner. The enormous volume of material, increasing daily in geometrical proportions, seems to make specialisation an imperative necessity. Another characteristic of the moment also tends to throw extensive views into disrepute. The age has suddenly become bankrupt of ideas.

It seems as if only a philosophical mind of the calibre of Goethe's, an imagination as sturdy and as versatile as Scott's, joined to such a range of first-hand knowledge as would cost the greatest scholar a lifetime, could hope to-day to animate history not unworthily with a great conception. Yet without that hope, history would scarcely be a subject of the first interest to humanity.

## Travels and Exploration

By Major Martin Hume

NOT a column alone, but a library, would be needed to tell the story of the world's unfolding during the nineteenth century, for in no previous hundred years have so many of the earth's secrets been wrested from her. Men still in middle age were taught geography in their school-days from maps in which the whole of the interior of Africa was represented as a blank, and the fringe of Australia alone was traced. The mirage of marvels has vanished before the torch held high by the explorer, and in our own generation almost the last retreat of mystery has been exposed to the prosaic influence of modern civilisation. The opening of Africa appeals first to the imagination, both in consequence of the vastness of the field, and because the exploration of the Dark Continent reveals traces of mighty empires long ago vanished and of civilisations dead before the birth of our chronology. Before this century commenced, scattered factories and settlements of English, Dutch, and Portuguese fringed the coasts, but all beyond was darkness. In 1788 the African Association was founded, and Mungo Park under its auspices reached the Upper Niger from the Gambia coast before the end of the eighteenth century. In 1805 the same intrepid Scotsman again attacked the great river which he hoped to identify with the Congo, and passed the mystic Timbuctoo on his way down towards the sea. Of his forty-five European companions only three survived the seven months' tramp to the banks of the stream, and Park and the few survivors were soon afterwards done to death at Boussa, leaving the secret of the Niger outlet still unrevealed. Then all slumbered for ten years, until 1816, when two unsuccessful expeditions subsidised by the English Government attempted to meet, by respectively ascending the Congo from its mouth and descending the Niger from Boussa, believing them to be the same stream. The next forward step was Denham and Clapperton's splendid march from Tripoli through Fezzan to Lake Chad and Bornou (1822). But the explorers died without solving the Niger's secret, and it was left to their follower Lander to sail down the great stream for 800 miles of its course and emerge from one of its myriad mouths, at Brass, in the Bight of Benin (1830-32). In the meanwhile the French were busy with the same problem. In 1828 Callié made his wonderful journey from Senegal through Timbuctoo and the Western Sahara, even to the Straits of Gibraltar.

Thence-forward French travellers have never ceased in the work of exploring and Gallicising the valley of the Upper Niger and its hinterland in order to connect the Senegambia region with their colony of Algeria ; and the partition treaty with England now practically gives France a free hand in that region. The Germans, as usual eager for knowledge, were not idle in the same field. Barth (1850), Rohlfs (1865), and Nachtigal (1870) worked down from the north to the Chad country, Rohlfs travelling on foot from the Mediterranean to the Gulf of Guinea, and Dr. Nachtigal striking across Africa from Lake Chad to Khartoum and Egypt (1874). But a greater than Nachtigal was already at work tearing Africa's secret from her heart. David Livingstone first travelled from Cape Town in 1840 through Bechuanaland to the first of the great inland lakes, N'gami, and explored what we now call Rhodesia and the Transvaal Colony. But between 1853 and 1856 his greater work was begun. Still pushing northward, Livingstone discovered the great Zambesi Falls, and thence travelling to the west he emerged at St. Paul de Loanda (1856). Then he retraced his steps and crossed Africa from west to east and came out at Quilimane. Between 1858 and 1861 Livingstone explored the basins of the Zambesi and the Shiré, which latter river led him to the vast reservoir of Lake Nyassa (1864). In 1866 he explored the regions to the west of Nyassa, and as high up as the great Tanganyika (1869), which Burton had previously reached (1857). Livingstone was ill, and returned to Ujiji on the east of Tanganyika, where Stanley met him in 1871. But he persisted in his task of exploring the coasts of Tanganyika and Bangawelo until May, 1873, when the sublime martyr of African exploration died in solitary prayer, beloved of all men, black and white. The problem of the Nile was being attacked at the same time. Bruce had followed the course of the Nile from Egypt as far up as Berber in 1768, and now in 1857 Burton and Speke struck inland from Zanzibar, and discovered Tanganyika and Victoria Nyanza, which latter Speke rightly guessed was the great feeder of the White Nile. In 1860 Speke again started with Grant to verify this surmise. Passing through M'Tesa's realm of Uganda, they traced the stream from Victoria Nyanza northward for a great distance, and on their way back at Gondokoro met Samuel Baker and his heroic wife, who were exploring from the opposite direction. Baker then followed the course of the Nile backward to Lake Albert Nyanza, which he first discovered ; and the veil which for centuries had covered the birth of the great river was lifted (1864). I have incidentally mentioned Stanley's search for Livingstone (1871). Five years afterwards Stanley again started, and crossed Africa from Zanzibar to the mouth of the Congo, tracing that river for the whole of its course (1876), and aiding King Leopold to carve out for himself that great African empire which has led to the partition of the whole continent among the European Powers. A more marvellous journey still was that of Cameron, who, on foot, and for a great distance alone, crossed the continent from Zanzibar to Benguela (1875), adding greatly to geographical and astronomical knowledge. Egypt, too, reached down the now ascertained course of the Nile, whilst England claimed the Nyanzas and their regions ; the efforts of Lugard, Johnstone, and Rhodes forming a continuous line of British possessions from the Cape to the White Nile. Unfortunately our weak agreements with Germany have broken the line at Lake Tanganyika ; but with this one interruption the Queen's flag flies from the Nile to the Cape. Thus, with France supreme in the north-west hinterland, Germany on the east of Tanganyika, Belgium on the Congo, Portugal in Angola and Zambesia, and England everywhere else where value lies, in our own century Africa has been tamed and partitioned, thanks to the intrepid explorers who have led the way.

Next in importance to the opening of Africa is the exploration and settlement of Australia. At the beginning of the century the interior was unknown, the convict settlement of Botany Bay and Port Philip alone representing civilisation. The first explorers naturally started from these points. In 1813 Philip Wentworth first crossed the Blue Mountains, and discovered the rich rolling plains of Bathurst, and in 1828 Sturt explored and opened up the fine valleys of the Darling and Murray Rivers. In 1845 the German Leichart, who in a subsequent journey (1848) perished, made a fine journey from the extreme north point parallel with the east coast down to Brisbane ; and in 1860 Burke and Wills travelled from the Gulf of Carpentaria in the north down to New South Wales. In 1862 Stuart started from Adelaide and crossed Australia

in its centre or broadest part, from south to north, surveying for the telegraph line which now marks his course. The gold fever had attracted great populations to the eastern portions, which were rapidly settled ; and in 1870-4 John Forrest explored the country from the west coast to Stuart's central telegraph line, Ernest Giles and Warburton in several journeys almost simultaneously mapping out the country further north from the west to the centre. Quite recently, in 1897, David Carnegie made an adventurous journey from Coolgardie Goldfields in the south of West Australia to those of Kimberley in the north, but much of the desert interior of West and Northern Australia is still imperfectly known.

In America the progress has been still more marvellously rapid. The United States only obtained possession of the vast territory west of the Mississippi in 1803 by purchase, and at once set about exploring it (1804-1807). Then the Mexican War of 1848 gave California to the States ; and the 1846 treaty with England fixed the limits on the west coast to the north, and later still Alaska was acquired from Russia. The exploration of these vast territories has been effected piecemeal by pioneers, settlers, and gold seekers. In South America the progress has been slower. Until the last few years the interior of Patagonia was still virgin, but hunters, sheep farmers, and naturalists like Mr. Hudson, have now traversed and described it, whilst the surveyors of the Argentine Government, under Señor Moreno, have during the last three years fully explored the Patagonian Andes. A similar cause has added to our knowledge of the valleys of the Orinoco down to the Amazon basin, which had remained fallow since Schombergk's survey in 1835. The valley of the Upper Amazon still continues unknown away from the banks of the river ; but as steamers ply as far up as the Madeira, trade will gradually push savagery aside even here, and no mystery will remain in South America.

The exploration of Central Asia in the last fifty years has largely obeyed political impetus. Father Huc, a missionary, in 1845 made a notable journey through Thibet, but Russian officers on the one side and English agents on the other have since competed in penetrating the forbidden lands. In 1859 Valikhanoff penetrated Kashgar, in Turkestan, which has now become almost Russian. In 1870 Fedchenko explored north of the Pamirs, and Douglas Forsyth reached Yarkand, in which the Russians have now also established their influence. Western China, too, has been traversed in many journeys (1871-1888) by Prevalsky, whilst Bonvalot, alone and with Prince Henry of Orleans, has visited the Pamirs, Thibet, and Moru (1880-1890-1896). More recently. Dr. Sven Hedin, a Swede, made his really important journey (1893-97) through Chinese-Turkestan, Thibet, and Mongolia ; and Mr. Savage Landor and the late Captain Wellby have penetrated Thibet.

To tell the story of a century of Polar exploration adequately would fill many volumes. At the opening of the century the problems of the North-West and North-East Passages were still unsolved, and the position of the true magnetic poles was undecided. In 1817 the Scoresbys discovered a great open sea to the north-east of Greenland, high up in the Arctic circle ; and at once John Ross and Parry endeavoured to find the North-West Passage by that route, whilst Buchan and Franklin tried to reach the North Pole (1818). Both attempts failed, but in 1819 Parry sailed again, and discovered many fine waterways—Barrow Strait, Wellington Channel, Melville Sound, &c.; and in 1821 he sailed once more with Ross, Buchan and Crozier, in search of the North-West Passage. In this he failed, as he did in a third attempt in 1824, and in another effort to arrive at the Pole in 1827, when he reached 82°45 N., the highest point yet attained. In 1829 John Ross, financed by Sheriff Booth, attempted to find the North-West Passage in a steamer, spending three winters in the Arctic regions ; and on this occasion James Ross first fixed the position of the north magnetic pole (1831). In the meanwhile, Franklin was attempting to reach the Pole by land (1821 and 1825), and obtained much fresh information. Simultaneously Beechy and Richardson, in conjunction with Franklin, nearly completed the survey of the Arctic coast of America, a task which was completed by Simpson in 1837. In 1845 Franklin and Crozier sailed in the *Erebus* and *Terror* on the voyage from which they never returned. Rae (1848), McClure (1850), Belcher (1852),

McClintock (1857), and others, were sent in search of Franklin ; and gradually the entire loss of the expedition became known. The search expeditions resulted also in a great addition to our knowledge of the Arctic coasts and islands. McClure discovered the North-West Passage, by the frozen Melville Straits (1850), and Grinnell Land, Franz Joseph Land and North Greenland were surveyed, especially by Nares (1873-4). A great number of American Arctic expeditions followed ; and Greely, in 1882, reached within 450 miles of the Pole. In 1888 Nansen started overland across Greenland, and Peary in 1892-4 crossed it still further north. In 1895 Nansen in the *Fram* wintered in the ice, and reached the highest latitude touched : 84°4 N., by drifting, and, by sledge, to 86°14 N. On the other hemisphere, Nordenskjöld, in a series of expeditions (1875-1879) had sailed around Arctic Asia and had successfully established the existence of a North-East Passage ; and so far as coast surveys go, there seems little more to be done in Arctic exploration.

The Antarctic has been less fruitful of result. Cook in the last century had succeeded in pushing back the great Austral Continent that had haunted men for ages ; but the American whalers and Weddell (1820-3), and Balleny (1839) traced the South Shetland Archipelago south of Cape Horn ; and in 1839 the Frenchman Dumont d'Urville discovered Adélie Land and many islands in Dirk Gerritz's Archipelago. In 1840 Sir James Ross sailed from Tasmania southward, and discovered Mount Sabine and Victoria Land, with its active volcanoes, reaching the great ice barrier in 78 S., and in January, 1842, attaining the highest Antarctic point touched up to that time, 76 S. In 1895 Borchgrevinck visited Victoria Land, and the same explorer, financed by Sir George Newnes, passed the winter of 1899-1900 on that inhospitable shore, determining, at last, the position of the south magnetic pole. A Belgian expedition passed the previous winter blocked in the ice off Graham's Land, but obtained no result of importance, nor does there seem to be much more worth knowing in that direction. Thus has the world shrunk in the century of steam, whilst civilised man has entered upon an increased inheritance.

## Natural Science

By Edward Clodd

The eighteenth century passed on to the nineteenth, with no small accumulations of its own, the rich legacy bequeathed it by the seventeenth century. To name only a few items, this included Kepler's three laws of the movements of the planets ; Newton's theory of gravitation ; Harvey's discovery of the circulation of the blood, and his formula of development ; " every living thing comes from an egg" (*omne vivum ex ovo*) ; and, in mechanics, the microscope and telescope, the latter instrument confirming, in the hands of Galileo, the Copernican theory of the universe.

To these followed, when the eighteenth century opened, Boerhaave's experiments proving that all living things are built up of the same materials ; Hunter's demonstration of the likeness of structure of animals ; and Hutton's investigations proving that past and present changes in the crust of the globe are due to the same causes. The later years of that century were made memorable by Herschel's discovery of Uranus, for no new planet had been added to the mystic seven since prehistoric times, and by Galvani and Volta's researches in electricity, while, as the threshold of the nineteenth century was crossed, Cuvier's genius restored the form of some extinct animals, and Laplace, acting upon hints thrown out by Kant fifty years earlier, published his theory of the origin of suns and their systems from nebulous matter. Thus was every branch of science—physics, chemistry, astronomy, geology, and biology—bringing in material for a theory of the fundamental unity and identity of phenomena ; a theory whose demonstration is the crowning triumph of the nineteenth century.

The present sketch must be limited to a summary of discoveries in the domain of biology, with such reference to complementary discoveries in the other sciences as may be necessary.

Towards the close of the eighteenth century Linnæus had completed his great scheme of classification of animals and plants, but, for some years to come, observations continued to be restricted to the external features of organisms. The microscope, however, changed all this. It supplied the means of examining the internal structure of living things, and hence opened the way to inquiry into their origin and life-history. Study of anatomy invited comparison of structures and of the several corresponding organs in divers plants and animals, and of the functions discharged by those organs ; hence the rise of the comparative method, with its demonstration of relations between living things. Goethe has an honoured pre-eminence in the formulation of a theory of metamorphosis of plants, that is, of the modification of their stems and leaves into the several parts adapted for the work which they have to do. For this doctrine of transformation gave impetus to search after proofs of a fundamental unity in the individual organism which was afterwards extended to the species, and, finally, to the totality of living things. Important results rewarded the inquiry. Schleiden discovered that the cell is the unit of plant life ; Schwann, a pupil of Johannes Müller, the founder of the doctrine of comparative physiology, proved that the same applied to animals. Every living thing springs from a cell. The lowest animals are one-celled, or, sometimes, a loosely-connected cluster of cells ; all other animals are built up of a number of cells which form tissues whence the several organs are developed. These higher animals are the result, at least in the more complex life-forms, of the blending of the sperm-cell of the male with the germ-cell of the female (both of which are visible only under the higher powers of the best microscopes), giving rise to a fertilised egg, whence is developed an individual inheriting the character of its parents. Great is the mystery of heredity, stamping, by means of infinitesimal particles, the bodily and mental traits of ancestors on the third, or even later, generations. But, not to dwell on this amazing problem, the discovery of the cell as the fundamental structure of living things raised the question, “ Of what material is the cell composed ?” That question was answered a few years after Schwann’s discovery, by Von Mohl, who showed that each cell is filled with a viscous, granular-looking substance, called protoplasm, which, in Huxley’s well-known phrase, is “ the physical basis of life.” This stuff, which contains the four elements, carbon, hydrogen, oxygen, and nitrogen, in very complex union (Haeckel accords the primary activity to carbon), may exist naked for a time, but as a general rule it secretes at once a firm, continuous coat, and, so to speak, to borrow Anton Kerner’s words, “ builds itself a little chamber wherein to live.” Thus far as to unity of origin and identity of material, each of which fell into line with an earlier discovery, adjudged by Agassiz as “ the greatest in the natural science of modern times.” This came about through an examination of the embryos of animals by Von Baer, who showed that creatures so unlike one another in their adult stage as fishes, birds, dogs, apes, and men resemble one another so closely in the earlier stages of their development that it is impossible to say to what class they belong. The explanation, speaking broadly, is that the embryo, as it develops, epitomises the series of changes through which its ancestral forms passed in their evolution from simple to complex organisms ; and the nearer that animals resemble one another in the adult stage, the longer and more closely do their embryos resemble one another. At an early stage the human embryo has gill-like slits on each side of the neck like a fish ; these give place to a membrane like that which super-sedes gills in the development of birds and reptiles ; the heart is at first a pulsating chamber like that in worms ; the backbone is prolonged into a movable tail, and, three months before birth, the body is covered with hair except on the palms and soles. Von Baer, as founder of the science of comparative embryology, went behind the embryonic to the primary processes of cell-cleavage, and the advance of the theory of evolution from a special to a general doctrine is largely his work, Mr. Spencer finding in Von Baer’s Law of Development contributory evidence supporting his own thesis of progress from simplicity to complexity, as applied to the Cosmos, in the “ Doctrine of Evolution.” In unconscious contribution to the conception of fundamental relationship between living things which the knowledge of cell-material, cell-changes, and embryos engendered, three naturalists, Cuvier, St. Hilaire, and Lamarck were working shoulder to shoulder in Paris during the early years of the century. While all were busy in the study of fossils Lamarck began an investigation of the lower animals, which re-

sulted in a book on the “ Organisation of Living Bodies,” wherein he suggested that the various species had not been separately created, but had been developed by sundry causes, operating through long ages, from a few simple forms. To throw doubt on the universally accepted belief in special creation was a perilous step in those days of the long-reaching secular arm (Buffon hinted his scepticism in covert phrases) ; but, the doubt once expressed, a number of facts telling against the orthodox view came into unwonted significance. As for the fossils, the Noachian deluge explained them ; and although Cuvier identified a fossil skeleton claimed to be that of a child drowned in the Flood as that of a salamander, even he held to a belief in successive catastrophes followed by fresh creative acts. His mantle fell upon Owen, who accepted the Cuvierian creed of “ archetypes,” but whose researches made so evident the unbroken connection between certain past and present lifeforms that, as Huxley once said, “ if evolution had not already been an accepted theory, the palaeontologists would have been forced to invent it.” He, with Agassiz, Marsh, von Zittel, and others, had ingathered a mass of evidence in proof of the order and succession of life, and of the descent of existing animals, as, *e.g.*, the horse, the camel, and the hippopotamus, along well-marked ancestral lines, while the vast multitude of fossil plants brought their “ cloud of witnesses.” Stimulus to every branch of inquiry was given by “ Lyell’s Principles of Geology,” the publication of which suggested the question, “ If natural causation is competent to account for the not-living part of our globe, why should it not account for the living part ?” Cumulative as were the proofs, adduced by biologist and palaeontologist, discrediting the belief in special creation, it held the field in the absence of a theory commending itself as adducing a sufficient cause, or causes, of the origin of the myriad species of plants and animals. Until that theory was formulated, even Huxley, well nigh despairing of solution of the problem, tells us that he was “ disposed to turn aside from an interminable and apparently fruitless discussion to labour in the fertile fields of ascertainable fact.”

The theory which, in essentials, satisfied him and others as indicating a cause competent to produce new species, was formulated independently by Charles Darwin and Alfred Russell Wallace. “ How exceedingly stupid not to have thought of that,” was Huxley’s remark when “ mastering the central idea.” “ Natural selection,” as the theory is conveniently named, is based upon the fact that every living thing multiplies its kind at so rapid a rate that if all the offspring came to maturity there would, within a measurable time, be no standing-room, still less food, for all. The result is a struggle for life, in which the weaker go to the wall. The qualities by which the stronger overcome are transmitted to their offspring, and, moreover, as each individual varies from every other, the favourable variations become helpful in the struggle, and are likewise transmitted by the victors. The result, in time, is the origin of new species. If the theory of “ descent with modification” be true of any one living thing, it is true of every living thing, hence its extension to man himself; physically, from an ape-like ancestry, and psychically, since, in Huxley’s words, “ comparative psychology confirms the position in relation to the rest of the animal world assigned to man by comparative anatomy.” Moreover, some years before Darwin’s theory was published, there had been unearthed from the ancient river-valleys of Northern France some rudely-chipped tools and weapons pointing to man’s great antiquity and to his state as one of savagery. These witnesses, at first looked upon askance, were now welcomed as confirming the application of the theory of development to man, and the more so as like evidence of his primitive condition came from every quarter of the habitable globe.

Our chronicle of the advance of knowledge by sure and steady tread to a goal of unity has thus far been limited to the organic. But while the question of the origin of species awaited its answer, a series of discoveries in the realm of the inorganic prepared the way for the acceptance of an all-embracing doctrine of development. At the beginning of the century there seemed little probability that our knowledge of the heavenly bodies would be extended to their physical constitution. There was a new departure in the discovery of minor planets, of which above 400 are now known to exist ; midway through the century Adams and Leverrier

added Neptune to the number of the great planets, and Sir John Herschel completed the star-gauging work of his father, whose theory that the matter which he could not resolve into stars was “ a shining fluid, of a nature totally unknown to us,” fell into line with Laplace’s nebular hypothesis, and marked the then existing limits of human observation. But before he died the key was found which was ultimately to unlock the long-hidden mystery of the nature of the “ shining fluid,” and of much else besides. One hundred and thirty years after Newton had broken a sunray on a prism and shown that light is made up of differently coloured rays, Wollaston, using a thin slit to admit the ray, noticed that it was crossed by seven dark lines, which were increased to nearly six hundred by Fraunhofer when he repeated the experiment. He made some shrewd guesses as to their significance, but it was not till the year when Darwin published the “ Origin of Species” (a suggestive coincidence) that the riddle was solved by Kirchhoff. The details of the solution cannot be given here ; it must suffice to say that the lines, which are now counted in their thousands, the spectrum of iron alone numbering above two thousand, reveal the secret of the chemical constitution of the sun. Iron, carbon, calcium, sodium, and more than thirty other elements are known to be present in his atmosphere. Kirchhoff’s discovery was followed by Sir William Muggins’s analysis of the light from stars and nebulae, which proved that the former, broadly speaking, are made of the same materials as the sun, himself one of their myriad number, and that the latter are gaseous, the vagrant comets having a spectrum which is a compound of carbon and hydrogen. Sir William Huggins also discovered that a minute displacement of the lines gave a key to the direction of the movements of the stars in space, while their colours indicate whether they are in the stages of youth, maturity or decay. The marvellous revelations of the spectroscope are supplemented by those of the camera, notably since the invention of gelatine dry plates, whereby exposure can be indefinitely prolonged, and stars whose existence lies beyond the light-gathering power of the finest telescope recorded “ in a scripture that cannot be broken” on the celestial chart.

The genius and industry of men athirst for knowledge have brought the infinitely vast and the infinitely minute within human purview, revealing life-cell, sun, and star, as made of like stuff, and as stirred by like activities. Matter, everywhere the same, yet ever changing its state and relations, remains indestructible ; to it nothing can be added ; from it nothing taken away. The agencies of its ceaseless flux, whereby alone we are made conscious of its presence, these also are indestructible ; they vary in their modes of motion, and affect in divers ways the thing which they move, yet their essence is in their unity. Dalton’s and Avogadro’s laws of the behaviour of atoms ; the grand generalisations of Helmholtz and others concerning the conservation of energy and the correlation of the forces ; these have exercised the deepest influence on all speculation and research. But the ultimate nature of the phenomena which affect our sensations remains an unsolved, perchance may ever remain an insoluble, problem, leaving play for the exercise of man’s sense of wonder and of mystery the loss of which would be the atrophy of the soul.

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