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New Zealand Education

A soft, wet, green version of Hollywood's Wild West describes New Zealand in the 1870s. There were the wooden buildings lining the solitary street of one-horse towns. There were occasional gold strikes, the pioneering spirit, and the first railways being driven through the wilderness. There were even some "Indians", in the shape of a fierce race of brown warriors recently responsible for various "massacres". The role of the US Cavalry, however, was rather woodenly performed by the red-coated files of the infantry of the Victorian British Army, brought over from the former penal settlements of Australia when occasion demanded.

The people, the white settlers, however, were different in culture and outlook from even the soberest citizens of America's western frontier. They were serious, self-conscious emigrants from "Home" in Britain, and there was no glamorous dash of the French voyageur or the hard-riding cowboy. They were people from almost every class of British society selected or self-selected for their skill, ability or even financial backing. They came to New Zealand in carefully planned and often well-financed parties, with their laws and their land distribution worked out before they sailed. They were examples of that Victorian "high-mindedness" which we, a century later, may find embarrassing, even hypocritical, but which we may regret losing.

Many of the settlers were Scottish, especially those who went to the South Island of New Zealand, and perhaps it was their influence that counted most. But right from the colony's earliest days education was of enormous importance, and publicly accepted to be of enormous importance, throughout the colony.

It was into this isolated, sober, almost crime-free society that Ernest Rutherford was born. Among his few known ancestors there is no trace of anything more than solid worth. Among his many collateral relatives still alive in New Zealand – cousins, nieces, nephews and their offspring by the dozen – there is none who has risen to fame. His only child was in no way remarkable for intellect, and though two of his four grandchildren are scientists in

their own right, neither of them would claim to be their grandfather's equal.

Yet this Ernest Rutherford, born on August 30th, 1871, in a remote country area thirteen miles south of the pioneering town of Nelson in the South Island of New Zealand, the fourth child in a family of twelve, became, quite simply, the greatest experimental scientist of his age, "the father of nuclear energy". The ashes of Ernest, Baron Rutherford of Nelson were buried in Westminster Abbey, close to the tomb of Isaac Newton, sixty-six years later.

There can, therefore, be no accounting for Rutherford, no explanation of him, in terms of a sudden brilliant flowering of an unusual genetic stock. Still less was he the culminating bloom of some brilliant school or subculture. Writers of the 1920s and 1930s, including some of Rutherford's own colleagues acting as obituarists, were very prone to speak of the fine "stock" exported from Britain to New Zealand in the shape of the first organised colonists, and they seem to have felt, unaware of the Hitlerian overtones we now perceive, that such a stock transported to the fertile and empty spaces of New Zealand was sufficient to account for the appearance of a Rutherford. But there was no one to equal him among his own generation of New Zealanders, and it is not easy to find any subsequent New Zealander in any field who seems to be of his stature.

The explanation of Rutherford must therefore lie in the interaction of his particular individual qualities and personality with the cultures and environments in which he found himself, and more especially in the precise stage of development of the areas of science and technology in which he chose (or was lucky enough) to work. In fact only a "Life and Times" of Rutherford can explain the man and his achievements. The picture that emerges is not that of a brilliant man; it is no portrait of a genius but a story of an exceptionally powerful man, a huge personality, a problem-solver, who provided humanity with a new explanation and description of the world in which we live and who provided compelling reasons for everyone to accept his view. It was his closest colleague, Sir James Chadwick, the man who worked longest with him, who triumphed most with him and who suffered most from him, who explained that Rutherford was not even a clever man, he simply was like an enormously powerful battleship ploughing majestically through the storms and seas.

The unusual thing about Rutherford is that despite this power, his outstanding characteristic was that, without any effort, he made himself loved; few men could claim to be admired and loved by such disparate persons as Marie Curie and Stanley Baldwin.

So Rutherford must be studied first in the environment of New Zealand, the country which can well be described as having the least history of any nation in the world. But it is a country with an exceptionally close relationship to the development of science, a country which has shown an exceptional interest in science.

New Zealand was discovered by Abel Tasman, the Dutch explorer, in 1642, and it did not provide much welcome. Attempting to establish the limits of "New Holland" – Australia – for the Dutch East India Company, he never discovered that there were two main islands; he never landed, for everywhere he was met by fierce warriors, who killed some of his men. It cannot be said that Tasman put New Zealand on the map in the ordinary sense, for the Dutch were so secretive as part of their commercial policy that his discoveries were not published for many years.

So for all practical purposes New Zealand was discovered by that great man, Captain James Cook. He first sighted it in 1769, and he paid the islands five visits during his explorations of the South Pacific. His first visit alone lasted six months, and at the end of his life the country was truly on the map, properly surveyed and well described. The main feature of the description was undoubtedly the natives, incredibly fierce and intelligent cannibals, brave to such a degree as to be undeterred by firearms either from attacking or trading with the Europeans. Lives were lost on both sides, brown and white.

Captain Cook could not possibly have realised the most striking natural features of the islands – they contained no animals and the flora included no major crop plants. Perhaps he may have suspected something of the kind, for he landed pigs – whose descendants still survive as wild-pig among the mountain forests – as well as seed potatoes, and the seeds of cabbage and turnips.

And so the Maori had not expanded to fill the Islands. They remained mostly confined to the coastal or riverside villages, living comfortably enough by fishing, by hunting birds in the vast and often gloomy forests, and by cultivating their comparatively limited vegetable crops in gardens beside their houses. They were a Stone Age people when Cook first brought metals into their ken. And there cannot have been more than two or three hundred thousand of them throughout New Zealand. Huge areas of the South Island, in particular, were uninhabited. All this became important only when large-scale white colonisation started, for it meant that the new settlers did not have to dispute every inch of land with the indigenous "natives", and though there were disputes and wars and skirmishes a-plenty, the relations between the two races have rarely been bitter.

Although Captain Cook claimed New Zealand on behalf of his King, that King's government rejected the acquisition of lands so far – twelve thousand miles – from home and took no interest in New Zealand for nearly eighty years. It was not until May 1840 that Britain formally annexed New Zealand, and then the government acted only to forestall the French, who had a colonising expedition underway, and because the first properly organised British attempts at settlement had already begun after years of official discouragement.

Before 1840, that is to say only thirty years before Rutherford was born, the white population of New Zealand was tiny, perhaps only two or three thousand, consisting mostly of whalers, sealers, traders and missionaries. Throughout the 1830s, however, the movement to colonise the country had been growing in strength in Britain – partly this was the first appearance of an "Imperial vision" of Britain's role in the world; partly it was a reaction against the growth of population and the living conditions which we associate with the early days of the Industrial Revolution in the home country.

Wellington, at the extreme south of the North Island, which was to become the capital city, Nelson, at the extreme north of the South Island, and on the opposite shore of the Cook Straits to Wellington, and Christchurch on the east coast of the South Island, which was to develop into the most English city of the British Empire, were the three major settlements of the colonisation of the 1840s. The expeditions organised by the New Zealand Company under its guiding spirit, Gibbon Wakefield, were financed by the sale of parcels of land before the emigrants left the shores of the home country. This in itself implied that many of the emigrants were people of some skill or standing. Care was taken to see that, as far as possible, all the trades and techniques that would be needed on the other side of the world were included in the make-up of the emigrant parties. Provision for religious and educational endowments was made before embarkation, and teachers were included in the earliest parties. Later, when secondary education became desirable, teachers and professors were recruited from English public schools and the English and Scottish universities. The settlement of Otago, with its chief city at Dunedin, was carried out on similar lines further south, with the difference that the majority of the settlers were dissidents from the Scottish Free Church, and there was therefore the possibility of some sectarian disagreements.

The North Island, where the majority of the Maoris lived, and where the greater part of the earliest, more free-wheeling, white

settlement had taken place, also received its share of planned settlements.

Both Rutherford's parents came to New Zealand as children with their parents in the early waves of organised settlers. His grandfather, George Rutherford, a wheelwright from Dundee who worked for a Perth firm of coachbuilders, came to the Nelson colony in 1843. He had been specifically recruited by Captain Thomas Thoms to set up saw-milling equipment which had been sent out by an earlier boat. George Rutherford came on the ship *Phoebe*. He was then thirty-four, and he brought with him his thirty-one-year-old wife, Barbara, and their four sons, the third of whom, James, then aged five, was to be Ernest Rutherford's father.

George Rutherford duly set up the saw-milling equipment at Motueka, where it was driven by a twenty-horsepower water wheel. Then he moved his family to the nearby Wairoa river valley to the south of the chief city, Nelson, and set up in his old business of wheelwright. In the pioneering circumstances a wheelwright was unlikely to find much of a carriage-trade and therefore his work mostly concerned the local saw-mills and flour-mills – indeed he went into an unsuccessful flour-milling business himself. All his sons followed in his footsteps, working as wheelwrights, setting up small local mills and businesses in flour and flax, utilising the water power of the Wairoa river. The three daughters born in New Zealand all married local men and the various Rutherford and related establishments were clustered in the same area around the village of Brightwater, which was later renamed Spring Grove.

It is quite possible that in the more class-conscious society of England the Shuttleworths, a Sussex family, might not have spoken very much to a family of Scottish wheelwrights such as the Rutherfords. But one of their daughters, Caroline, who had married the son of a flour miller at Hornchurch in Essex, was tragically widowed when her young husband, who was reputed to be a clever mathematician, and who worked in his father's counting house, died young. So Caroline Thompson, with her daughter Martha and three sons, emigrated to New Zealand with her Shuttleworth parents in 1855. They sailed in the *Bank of England*, landed at Auckland and immediately went on by the brig *Ocean* to the Taranaki district of the North Island on the fertile and beautiful slopes of Mount Egmont. Caroline Thompson had a profession of her own as a teacher and the whole group settled down in the New Plymouth area.

New Plymouth and the Taranaki were among the New Zealand Company's early settlements, but, for reasons as much connected

with the inter-tribal wars of the Maoris as with any fault of the white settlers, they were one of the few places where there were troublesome land disputes between the two races. The problems had not been cleared up under the Governorship of Admiral Robert Fitzroy, who had been told in no uncertain terms in the 1840s that the settlers there were faced with the ruin of their hopes. This Governor Fitzroy, as Captain Robert Fitzroy, had commanded the ship *Beagle* when it brought Charles Darwin for a few weeks' botanising on the North Island in 1838, during that famous trip around the world which is said to have provided the material for *The Origin of Species* and the Theory of Evolution. His Governorship, short though it was, had been a great deal less productive than his captaincy of the *Beagle*, for his autocratic methods had produced the first major clash with the Maoris, the *casus belli* being a flag-post.

So when the one and only serious war between settlers and Maoris broke out in 1860 it was over a land problem in Taranaki – the Waitara land purchase. The white settlers were nearly all driven to take refuge in New Plymouth. The Shuttleworths sent Caroline Thompson, her four children, and another of their women to the safety of Nelson and the South Island.

The Thompsons never returned to the North Island. Caroline got herself a job as schoolteacher at Spring Grove and there she stayed until she married William Jeffries, a man who had at one time been in partnership with George Rutherford. Her daughter, Martha, who had helped her mother in the school, had risen at four o'clock on many mornings to study in order to qualify as a teacher. Eventually she took over the teaching at Spring Grove school when her mother married. At Spring Grove Martha met and married James Rutherford on April 20th, 1866, and five years later their second son and fourth child, Ernest, was born at the same place.

By this time, 1871, the ten years of war with the Maoris had at last come to an end. There had been virtually no fighting in the South Island, in any case. Gold had been discovered in various places, notably around Otago, and a flood of population had poured in. The country as a whole was booming and the boom was led by the southern provinces of Canterbury and Otago, where it had been discovered that a land without animals or foodcrops of its own was ideal for sheep running in enormous numbers on the tussock grass of the bare downlands sloping up to the eastern flanks of the mountains. And so, at exactly the time Ernest Rutherford was born, the first generation of New Zealanders began to develop the future of their country on a firm basis, and being the people

they were, they started with public works, mostly railways, and education.

The time of Rutherford's birth was also the time of the birth of many of the institutions that were to educate him and in which he was to spend his life; and the conclusion is unavoidable that the future achievements of the man must have been, to a large extent, the product of the system which was being created to nurture people such as he and that he arrived at the right time to benefit from it.

The New Zealand system of free, secular primary education was being founded in the first five years of his life and was officially blessed and brought into formal existence by an Act of the New Zealand Parliament in 1875. Balfour Stewart introduced laboratory experimental work into the teaching of physics at Manchester in the academic year 1870–1871. The Cavendish Laboratory at Cambridge, where Rutherford was first to make his mark on the scientific world and where as Professor and Director he was later to lead the world of physics, was created in 1870; its first Professor, Clerk Maxwell, was taking up his post as Rutherford was born and delivered his inaugural lecture in October 1871. Rutherford's own university undergraduate education and his first research was completed at Canterbury College, Christchurch, which was launched at a meeting on August 14th, 1871, when the Canterbury Collegiate Union was formed. The idea of a university in New Zealand had received official sanction in 1870, the year 1871 saw bitter battles over the shape of the new institution, but by 1874 the issues had been resolved and the new colony had its university barely thirty years after it had itself been brought into existence.

Many of these events which would affect Rutherford's development were connected among themselves as facets of the same movement for educational reform which also had a profound effect on British institutions. This reform movement reached its first flowering in the 1851 Great Exhibition in London, where Prince Albert was among its leaders. It was the profits from the Great Exhibition reappearing as scholarships forty years later that took Rutherford to Europe and Britain. But the movement reached its culmination in the decade 1867–77 when Gladstone suddenly reversed his earlier implacable opposition and himself carried measures for the reform and restructuring of the Universities of Oxford and Cambridge. On the face of it, these reforms were the removal of religious tests and qualifications for entrance to, and the holding of posts and fellowships in, the two universities. But in reality they meant the opening of the old universities as places of general education rather than their continuation as primarily training establishments for the Church of England.

A high proportion of the men called to New Zealand's young educational institutions as professors, headmasters or teachers were Oxford and Cambridge men, and many of them had been imbued with the spirit of reform which was then abroad in the home country. Some of those who were directly involved in the education movement around the time of Rutherford's birth were to be among the strongest intellectual influences on his life. Balfour Stewart, through a book, was to have a seminal effect. Clerk Maxwell not only set the Cavendish Laboratory tradition, but seems to have been one of Rutherford's exemplars in his method of work, starting, like Faraday, from a physical view or model of the phenomena of physics and translating this into geometrical and hence mathematical terms.

New Zealand's insistence on secular primary education does seem at first sight to be in contradiction to the religious motivation of much of its early settlement. Otago, as has been seen, was a settlement largely of Scottish dissidents from the established Presbyterian Church. Canterbury was looked upon by many of its founders as one of the great hopes of establishing the ideals of the Anglican Church, which could never be realised at home: "It is my only consolation that the Church of England is putting forth vigorous scions in foreign lands when the time of her glory, as far as human eyes can judge, is departing from her," wrote one correspondent on the subject in 1850. Perhaps the purpose of secularisation was to avoid the problems of sectarianism which had already reared their heads over the starting of university education in the 1860s.

Scientifically, however, New Zealand has been well on the map ever since its first discovery. Sir Joseph Banks botanised "with our usual good success" when he came with Captain Cook. Darwin explored the Bay of Islands area on the voyage of the *Beagle*. A country so cut off from the rest of the world, in the evolutionary sense, offered a very happy hunting ground – such as Rutherford himself would later have recognised as a "Tom Tiddler's ground" – for many men anxious to make names for themselves as observational and classifying botanists and geologists in the first half of the nineteenth century, when modern science was first becoming important. Sir Joseph Dalton Hooker, son of the great botanical pioneer Sir William Hooker, for instance, landed in New Zealand in 1841, at the time of the first colonisation, while he was botanist to the Ross expedition to the Antarctic. Twelve years later he published *Flora Novae-Zelandiae* as one of the official works of the expedition, but in the meanwhile he had paid William Colenso, the man who had acted as guide to his own first explorations, to make

plant collections in various parts of the islands, and he had paid out of his own pocket.

Then there came a series of notable men who settled by choice in New Zealand because it offered such fine opportunities of practising science. Julius von Haast, the German geologist, building on the pioneering work of the Austrian Hochstetter, won a world reputation for his systematic study of New Zealand. His work was highly practical, too, for he discovered a coal seam near Nelson, and his collection of specimens, both geological and fossil, was the foundation of Canterbury Museum, which in turn became part of Canterbury College. James Hector, a Scot, was rather similarly an exploring geologist and map-maker, but more comfortable in association with official enterprises. By 1880 he had passed from exploring to leading the government's geological survey of New Zealand, and finally became the country's leading scientific official, organising the Meteorological office, the Government Laboratory and the botanical gardens. He was also Chancellor of the university. Frederick W. Hutton, a former Captain in the British Army who had fought in the Indian Mutiny, occupied a corresponding pioneering position in the biological sciences, and was the authority on the country's Mollusca. Both Hutton and Haast were among the early Professors at the infant University Colleges of Otago and Canterbury.

The importance of these men lies not only in the first-rate work they did, which earned them firm places in the (still largely European) world of science, but also in the value of their work to the early colonists and the fact that they showed the importance of science to New Zealanders. It can clearly be claimed that no other country has appreciated the value of science and placed public value on the work of scientists as much as New Zealand. An official historian of New Zealand science goes so far as to claim, "In proportion to their numbers, New Zealanders have done more for the progress of modern science than any other people."

Whether this claim can be substantiated or not is of little import. What matters is that New Zealand in the latter half of the nineteenth century, when Rutherford was growing up, was a place where science and scientists were valued, where they received official recognition, where they were among the chief public figures. Admittedly the approach to science was in expectation of practical benefits: scientists were valued for the practical value of their work in discovering mineral deposits, in improving fertility, in dealing with agricultural disease and other problems. And this was very different from the attitude of officialdom and the leaders of society, both political and educational, back in Britain – as the

story of the foundation of the University of New Zealand shows.

The chapter on the history of the founding of this university in the government-sponsored book on *New Zealanders and Science* is entitled "The Establishment of a Scientific University". The good Scottish people of Otago, arriving with their national spirit of reverence for learning, had agreed that one-eighth of the price they paid for their land should be set aside for religious and educational purposes – and a university was one of the specified projects. Twenty years after their arrival, by 1869, they were hard at work setting up their university, which they planned to start with four chairs: one in philosophy, one in classics and literature, and two in science. What was unprecedented, shocking even, was that these chairs should all be equal in standing and stipend – never before in the English-speaking world had chairs of science been given foundation status and equal salaries with the humanities. The long battle over whether each province was to have a separate university, or whether they should join in a national university, and whether that university was simply to be an examining body need not concern us here. But the first Council of the University of New Zealand, rather wantonly against the wishes of the government that had founded it, refused to accept Otago's view that the curriculum should give equal status to science. Otago proceeded independently for several years with a university of its own.

When the province of Canterbury joined the battle with its own College at Christchurch, it also joined Otago in demanding that students should be allowed to take degrees in either arts or sciences and that they should be provided with equal facilities for both studies. Since the two provinces were then much the wealthiest and most prosperous in the country, they won their battle and the New Zealand University Act of 1874 provided that the national university should simply be an examining body to which independent provincial colleges should be affiliated. But when the new university applied to the British authorities for a Royal Charter, offering degrees in medicine, law, music, arts and science, the Crown would only grant letters patent if the original Act were amended to exclude any science degrees.

The colonial government decided that half a loaf was best, and actually accepted this extraordinarily conservative dictatorship by passing an Amending Act excluding science degrees in 1875, so that it got its charter a year later. One student did complete a science course in 1877 but had to be satisfied with a Bachelor of Arts degree. By 1884 however the colony got its way and was allowed to grant science degrees by a supplement to the charter. New Zealand's first science degree was granted, appropriately

enough at Otago, in 1888, only three years before Rutherford started as an undergraduate.

For some reason biographers seem to like their scientific subjects to have a rural background – to be felt to have spent their formative years in close contact with nature whose secrets they are later to unravel, perhaps because they have learned the value of close and intimate observation of living things and the forces of weather, sun and water. The young Rutherford certainly grew up in the country, in pioneering, almost untamed, country at that. He could hardly have had an urban background since there was no truly urban environment within two thousand miles or so – and that is counting Sydney in Australia in the 1870s as truly urban. The irony of this is that Rutherford in his great scientific days was not an observer of nature in the usual sense; his fame was to come from his ability to manipulate and interpret the unobservable.

Yet stories of his childhood are easy enough to come by, as is only to be expected from a still largely rural community containing many dozens of his relatives and the immediate descendants of those who taught him and went to school with him.

There is no doubt that his mother was the dominating influence of Rutherford's early life. She set the tone of the home, and indeed it was reported just before she died at the age of ninety-two in 1935 that she "still ruled" the house. Since she was a schoolmistress it is hardly surprising that she valued learning and that the home was one in which intellectual endeavour was valued above what would normally be expected in a small wooden house near the edge of civilisation.

It can, indeed, be argued that his mother remained the dominating influence throughout his life. Certainly he wrote to her once a week or once a fortnight without fail for his entire life after he had left New Zealand. He placed all his triumphs before her rather than anyone else, and the story of his telegram to her when he was ennobled in 1930 is widely quoted: "Now Lord Rutherford, Honour more yours than mine," he cabled. He continued to say throughout his life that he owed everything he had gained to his parents and he frequently referred to the sacrifices they had made to procure his education. It is impossible to draw a line between proper filial duty and love of parents on the one hand, and that slightly unhealthy feeling of life-long psychological dominance over a child that one often meets. In Rutherford's case his unusual sexual diffidence, his hatred of physical contact with others, his delight in receiving overt honours, justifications of his worth to present to his mother as it were, leave a feeling that her influence was rather greater than perfect balance would demand. On the

other hand, he was always scrupulously fair to women professionally, and a pioneer in encouraging women to work in his laboratories and to become professional scientists, all of which must be accounted to the same influence of a schoolmistress mother.

His father is a more shadowy figure, at least in personal terms. He was plainly honest and upright, a pioneering "bush engineer", hardworking and inventive, able to turn his hand to most tasks of practical necessity in a new country, and perfectly capable of adapting existing machinery to the new tasks of a strange environment and even of inventing new devices to cope with new situations. He was firm and even daring in his decisions but he was not the man to carve an empire of his own out of the bush. He provided successfully for his family, avoiding both luxury and starvation, in a series of small, not always successful, business enterprises in logging, milling and flax cultivation. But he was often away from the family home for most of the working week, or even for longer spells, and the roles of disciplinarian and family treasurer both fell on his wife.

There were, however, so many children, twelve in all, that sibling relationships must have been as important as any others and must have tended to balance out any deficiencies or overemphases in parent-child relationships.

In social and economic terms the childhood of Ernest Rutherford occurred in a period of ever-increasing depression, the worst depression New Zealand has ever known. Nelson, the province in which he was born, had started as the most promising of all the private-enterprise colonies set up by Wakefield. The harbour of Nelson, almost concealed from the sea behind a shingle-bank, was a far finer anchorage than Astrolabe Bay used by earlier explorers such as d'Urville, and it had been revealed to the colonist by friendly Maoris. Nearby was a fine and fertile coastal plain, and superb deeply forested hills and mountains provided a backing. The climate was temperate, reasonable, and as good as any in New Zealand.

But the province proved deceptive. The coastal plain was too small for the number of new settlers – almost 2,000 in the first year and 4,000 by 1850. The steep valleys that run northwards to the sea were fertile enough in the bottom lands, but the hills separating them were steep and high and rose to the main mountain spine of the South Island inland. The superb timber of the slopes was cut and burnt unmercifully and wastefully, only to reveal a soil which was not fertile enough to support rich pastureland such as was found further south in Canterbury and Otago. Soon the mountain

slopes reverted to a dull and uninspiring bush of gorse and manuka. The province was cut off from the rest of New Zealand by the mountains to the south and by Cook Strait to the north. It was even cut up into parts itself by the steep parallel ranges of hills and much of the transport from one part to another was easier by sea than by land.

True, gold was found in the 1860s, but not in such quantities as in Otago to the south or in Auckland in North Island. By the time of Rutherford's birth the population of Nelson province had risen to nearly 15,000, and there it virtually stayed – there was an increase of only 3,000 in the next twenty years. A third of these people lived within the Nelson city boundaries. Nelson, in fact, with its sunny, mild climate, troubled only by the earthquakes of New Zealand's fault zone, was settling into its present reputation as "a quiet and contented backwater" due to the "unambitious outlook of its own people" – these quotations come from the New Zealand government's own survey of the country's geological and agricultural resources.

Neither the depression nor Nelson's somnolence had begun in 1871, though both were threatening. The Maori wars had just ended, and in any case only one per cent of Nelson's people were Maori. The first railway in the colony had been started there, pushing south-west from Nelson up the Wairoa valley. Under the Vogel administration, with its programme of public works, the railway was pushed further, with a view to connecting the province to the richer country of the south – a project which has never reached fulfilment. It was this railway development that formed the backcloth to Rutherford's earliest years – and has caused some problems to his biographers.

He was born in Spring Grove, which was a scattered community along the Wairoa river valley containing a church, a schoolhouse and a post office. As the railway advanced, two stations were built about a mile apart, the one further from Nelson being called Spring Grove. The original Rutherford wheelwright workshop and the churchyard containing the graves of his grandparents and several aunts and uncles, which were once in Spring Grove are now in Brightwater, the name of the other railway station.

The house in which Ernest Rutherford was born has now disappeared, though a photograph of it survives. It was a small and simple, though not crude, single-storey wooden dwelling with a roof of wooden shingles and a verandah outside. The photograph brings to mind a deserted Hollywood "Western" set, and then makes one pause to think how small it was for the rearing of twelve children.

It is not certain whether this was the only house the Rutherfords lived in during Ernest's first five years, but it certainly cannot have been the only house he knew, for there were a number of Rutherford and Thompson relatives living in the same area. There is some reason for believing that for a few weeks he may have attended the Spring Grove school where his mother and grandmother had been teachers, but for all practical purposes he began his education at Foxhill school a few miles further up the valley. As the railway advanced his family moved to Foxhill, to a house which still exists and which seems to be simply a slightly larger version of the house in which he was born – single-storey, woodbuilt, standing alone and surrounded by a simple verandah.

The reason for the move surely lay with the railway, for Rutherford's father made most of his income at this time with a government contract to provide railway sleepers, cut and shaped from brown or black beech. And it was at Foxhill school that Rutherford first came under an important influence outside the family. The schoolmaster was a Mr Henry Ladley, and under him the boy stayed for six years, working his way up to Standard IV and obviously getting a solid grounding.

Nevertheless the home influence must still have predominated and the picture provided by the brothers and sisters in their old age is one of an earnest, God-fearing, but happy and laughing family, grouped round the pioneer hearth. Mrs Rutherford had her Broadwood piano, her most prized possession. Father played his violin. Everyone read or listened to others reading aloud. Sunday meant, of course, church services, though not of the three-times-a-day routine. There were spelling bees and sing-songs and church hymns at home. Mrs Rutherford pinned up maps on the wall to illustrate current affairs. Some memorialists have even asserted that this life taught Ernest to have a deep love of music, though this is plainly pushing admiration too far, for a less musically-minded man can scarcely have existed. What it did impart to him were hymn tunes which he continued to reproduce in a mixture of grunting and humming throughout his life. What this life definitely taught him was his habit of voracious and continual reading. It is recorded that Rutherford found Pickwick particularly amusing and his relatives remember that his easy, booming and infectious laugh was already developing. But likewise he was already picking up his delight in what were then called "yellow-backs" – thrillers, shockers and crime stories, that he continued to consume at an enormous rate throughout his life.

The temptation to see the first signs of later genius in the young boy must be avoided. But there can be no doubt that at the age of

ten Ernest Rutherford did possess a copy of Balfour Stewart's *Primer of Physics* because it has been preserved and shown in public exhibitions with his name inscribed and the date of July 31st, 1882.

This book was one of a series published in Britain, a venture which was in itself part of the educational reform movement of the times. The aim of the books was to impart the basic principles of the various sciences by encouraging the readers to perform simple experiments for themselves. Balfour Stewart's work asked the reader to provide only the simplest materials of weighing pans, wires, small coins, and the like. It is impossible to measure its influence on the boy of the 1880s. Sir Ernest Marsden, Rutherford's pupil and life-long friend, who eventually became the leading scientific official of his time in New Zealand and who devoted much effort to collecting information about Rutherford's childhood, points out that Balfour Stewart recommended and praised exactly the sort of methods that were to bring Rutherford the great results and insights of his adult life: "Simple direct experiments were outstandingly the feature of his methods of work as opposed to abstruse theoretical speculations removed from a directly visualised conception."

Balfour Stewart, it should also be noted, was the man who introduced experiments into the undergraduate physics course at Manchester, and was the most influential of the teachers of J. J. Thomson, who was in turn Rutherford's teacher.

All this makes Rutherford sound like a backwoods bookworm. It is quite certain that he was no such thing. All the children in the large family had their tasks to do around the house. To the very end of his life among the well-manicured fields and gardens of Southern England, Ernest chopped wood, cut down trees and hacked at overgrown bushes as a sort of hobby and as almost the only vigorous exercise he took; and it is known that this occupation began in his Foxhill days. He was fond in later life of recalling the rural tasks of his childhood. He told of the occasion when he was sent out to gather firewood and, with typical enthusiasm, gathered more than he could comfortably carry. His answer was to tie the bundle to the tail of the family cow and drive her home before him, which proved satisfactory until the cow came to a gap in the boundary-fence which was big enough for her but not big enough for the bundle of wood. In the ensuing struggle the cow lost the end of her tail but the firewood was brought safely home. When asked what he had done with the damning evidence of the remainder of the tail he replied that he had buried it, "because I had been taught that new things would grow from cuttings" which may not have

been very funny but was typical of the way he would amuse children and which was also characteristic of his rather earthy sense of humour.

There is no doubt, too, because there were many alive in the days of his greatness who had been the companions of his youth, that he got out and about into the forests and streams of that beautiful and only half-tamed country. He caught fish, he nearly drowned in a river and had to be rescued by his brother when he got out of his depth; he shot birds with a rather primitive gun, and it is claimed he once shot sixteen of the elusive tree-pigeons in a single day by working out a technique of firing just at the moment when they spread their wings to land on the high branches. Similarly there is a story that, when his mother asked him to help with the education of his younger sisters by giving them a lesson, he willingly agreed as long as his mother would "muster" them. When this mustering was done the boy solved the problem of keeping the little girls still and in place by the simple expedient of tying their pigtails together. Another well-remembered occasion was when he had propelled a missile right over the roof of their small house and caused considerable hurt, though little injury, to a younger brother on the other side. Ernest himself recalled that he stifled the complaints of the younger child by "sitting on his head" until comfort, or submission, was secured.

Whether these stories are "true" in an academic or historical sense matters little. They show simply that Rutherford was brought up in a rough, homespun, if not rowdy manner, which made him a breezy and extrovert character all his life. In later life, at English universities he was, not unnaturally, found a little ungraceful by men who had been brought up in the comfort of the middle-class homes of English clergymen or professors. At the same time this upbringing presumably toughened him physically and endowed him with the endurance to work extremely hard when he found that desirable.

More seriously, he undoubtedly learned in his youth to be adept with his hands and inventive in a society where "toyshops" were not available. He took an early interest in photography – indeed it is recorded that hardly a square foot of the country round his home was left unphotographed when this enthusiasm swept him along. And there is no doubt that his mother kept him and his brothers and sisters "up to the collar" (the local phrase) with their school work.

Throughout this growing-up period there came a number of changes in the family circumstances. The railway up the Wairoa valley never broke through to the rich South Island sheep-pastures over the mountains. His father moved his interests to flax-milling

at a place called Pukaka over the mountains to the east, where the native wild flax grew abundantly in a large swamp where the Pelorus River debouches into the large sea-inlet called Pelorus Sound. James Rutherford spent more and more time away from the Foxhill home, and was reduced to writing weekly letters to his wife – the road across from Nelson is still fairly precipitous. Eventually, in 1883 he moved his whole family and all his stock and possessions to his new base. The move was made by sea, the Rutherfords leaving Nelson on May 26th, on the paddle-steamer *Lady Barkly*, which was normally used on the service between Tasman Bay and Collingwood, but which had evidently been hired for this special run.

James Rutherford prospered at first. The family home was set up in Havelock. There was plenty of flax and he obtained more contracts for railway sleepers – 40,000 of them at two shillings and eightpence each. These sleepers were for the rapidly expanding railways around Christchurch, and were shipped from a jetty built by James Rutherford himself.

The New Zealand flax, *phormiuim tenax*, produces leaves about five feet long and five inches wide directly from the ground in the swampy area where it grows. The Maoris showed the early settlers how to cut the leaves and strip away the green matter to leave the strong fibres. The Maoris used these fibres for matting, clothing, making fishing lines and baskets. The Europeans used it basically for making ropes and other utilitarian purposes, rather as a substitute for jute – but the fibres were too coarse for processing into linen and textiles in the European fashion. And, of course, the Europeans invented various primitive machines to assist in the several processes needed to prepare the material. James Rutherford had his flax-mill near his jetty and exported most of his produce by sea in scows.

The eldest son of the family, George, had won a scholarship to Nelson College in 1881, shortly before the family moved to Havelock, so he was away for most of the time. And the period at Havelock was dreadfully marred by the tragic drowning of two of the younger brothers, Herbert and Charles, in a boating accident with another local boy out on the Pelorus Sound. Martha Rutherford was worst affected by the catastrophe; it seems almost to have broken her for some considerable time – the surviving children remembered that their mother stopped playing her piano for good and that all the light and laughter seemed to go out of the house. Ernest helped his father and remaining brothers in a fruitless search which lasted for months along the shores of the Sound in an attempt to find the bodies.

The stay at Havelock was not completely forlorn however. In particular, summer holidays were enjoyed and there were several trips back to the old Rutherford and Thompson country around Foxhill. They even stayed once in their old home, now deserted, when Ernest and the other boys were particularly attentive to their mother and strove to provide her with some amenities that they "cobbled up" from whatever materials they could find. The boys also earned pocket money on some of these trips by hop-picking in the fields around Nelson. And it is from one of these visits, when he was taken to his grandmother's home, that we hear of Ernest and the potato-masher. Apparently he noticed the old lady's masher was disintegrating so he promptly made her a new one of his own, improved design. This potato-masher is still preserved by the Royal Society in London, but there was another long-lasting relic of these summer holidays which was of slightly more value to Ernest himself.

It has been recorded locally that the three Rutherford brothers earned £13 for six weeks' work in the hop-fields one summer. Whether it was precisely after this season or on some other occasion, young Ernest certainly banked some of his hard-earned wages, for only a couple of years before his death Lord Rutherford of Nelson had to write to his sister, Mrs Strief, in New Zealand telling her that he had just been informed that he had a "windfall". In a letter dated May 24th, 1935 he says: "I have recently found that I have a Savings Bank Account in Nelson, New Zealand, and when I was nine years old, deposited £1.5s.0d. in it. This has been untouched and has now mounted up to £6.4s.6d. I have an idea that I must have earned this prodigious sum of money [at that time] by helping my Uncle Thompson on the farm." Without giving way unduly to the false wisdom of hindsight, it is worth remarking that, though he had to be very careful of the pennies in his young days, Rutherford's disregard of personal money-making remained one of his most pleasant characteristics throughout his life.

At this stage Ernest Rutherford came for the first time under the influence of an above-average teacher, Jacob H. Reynolds, the master and sole teacher at the Havelock school. Reynolds would give his brightest pupils an hour's extra lesson in Latin before the start of normal school hours. Ernest quickly showed that he was worthy of such extra tuition, and began to shine as a really clever boy. More accurately, we can now see, it was not so much that he was clever as that at this stage of his life there began to appear that power of concentration and that ability to master the subject in hand that was to distinguish him afterwards. It was always the power of his mind and personality that impressed acute observers

rather than any cleverness. The evidence of a Miss Buckeridge, collected in the 1920s by Ernest Marsden, illuminates this emergence of intellectual power; she was employed by Martha Rutherford as a sort of governess and help with the younger children and she remembered: "Ernest never needed to study; having read a school book once he knew it." She added a very different sort of tribute, however: "He was a lively boy and I loved to see him and the other children at their mother's knee at prayers." The younger brother, James, recorded an interview when he was eighty years old and he probably meant much the same thing, the power of concentration, when he remembered an occasion when the children were watching a thunderstorm on the mountains but "Ern" was found to be "dreaming" – thinking about something to the exclusion of what was going on around him.

Havelock was in a different province from Nelson, and the local centre was the small town of Blenheim. Marlborough is one of the smallest of the New Zealand provinces, certainly in terms of population, and the opportunity for further education came almost solely through the offer of scholarships, few in number, to Nelson College. In a society that valued education so highly there was real competition between the small country schools for their pupils to win one of these scholarships, but local experience showed that candidates from the rural areas were disturbed and "put off their stroke" by having to travel to Blenheim and spend several days in strange surroundings, so that they rarely did themselves justice. In any case, Sir Ernest Marsden has pointed out, local research has shown that at the age of around fifteen, country boys tend to be about a year behind their urban contemporaries, especially in reading. The Havelock authorities had therefore campaigned to have the scholarship examinations held in their own local school for their local candidates. The point had been won and an inspector was appointed to travel to the school for this great occasion when Ernest Rutherford came to take his turn in 1886. He was then around fifteen, rather older than many of the other candidates, certainly no child prodigy.

Nearly fifty years later when Sir Ernest Rutherford, Professor of Physics at Cambridge, Nobel Prize winner and one of the world's best-known scientists, made a triumphal tour of his homeland in 1925, the occasion of the scholarship exam was still remembered. The retired local inspector of schools, a Mr Lambert, related how on that hot summer's day of 1886 various interested local residents came quietly to the door of the two-roomed school at Havelock to enquire anxiously and in whispers how the local pride was doing. The supervisor, who apparently collected each page as it was

completed by the candidate, passed out the news including one comment on the arithmetic paper: "He is doing fine but has made a bloomer in question X." Gloom, it was reported, spread through the hamlet, but Ernest was a quick worker and had time in hand to check his answers at the end and put his errors right.

He won his scholarship with the previously unattained total of 580 marks out of a possible 600, including a maximum of 200 marks out of 200 in the arithmetic paper. The other subjects were geography, history and English.

The scholarships to Nelson College carried free tuition and a £40 grant for residential board. Ernest was therefore able to enter the school in February 1887, having been taken by his father across the mountain ranges on horseback.

Nelson College epitomised the high aims of the earliest New Zealand colonists in education. It was founded in 1856, just fifteen years after they had arrived in the new country, yet it was planned to be an imitation of Eton College both institutionally and architecturally. Though its first buildings were of wood, five of its first seven headmasters were graduates of Oxford or Cambridge and several of them had teaching experience at English public schools.

From the very start it had been forced to include a boarding element in its structure, drawing pupils from such a scattered pioneering community. The basic fees were £6 per annum, according to the first announcement of its existence in the local *Examiner* on April 7th, 1856, but the same announcement said there would be accommodation for boarders and day boarders and it promised that the college would be based on unsectarian principles.

Not only was the college one of New Zealand's earliest steps into secondary education, it was also one of the most successful (and remains so to the present). There was a steady increase in numbers throughout its early years. In the 1870s there came a setback when Mr McKay, described as "the strong disciplinary force in the school", moved off to become head of the new Wellington College on the other side of the Cook Straits in the North Island. He took with him fifteen of the senior pupils, some of the teachers and even some of the domestic staff. Nelson was left to "rebuild the boarding and teaching traditions".

There had been a long-running battle between the governors of the college and their successive headmasters over the relationship between the headmaster and the boarders at the school – it boiled down to whether the head should live in the same house as the boarders to exercise supervision like an English "housemaster" or whether the head could live in his own house, but this seems to

have been resolved by the time Rutherford first went to Nelson. Nevertheless the college was changing rapidly during the time when he was a pupil. In 1885 the governors decided to discontinue keeping a vegetable garden and cows. The year before his arrival, 1886, the first telephone had been installed in the college. More important than these small physical signs of the times was the fact that in 1886 the "not very satisfactory" system allowing students to stay on at the college as undergraduates while taking degrees from the University of New Zealand, had been stopped. From then onwards university studies had to be carried out at one of the university colleges proper. Instead there came the system by which senior pupils could matriculate for the university entrance at the end of their careers at the secondary school, a system which was introduced in 1888, towards the end of Rutherford's stay at the college.

In physical terms, too, the college was changing, notably in the fact that there was a serious falling off in number of students as New Zealand battled with its long depression. Numbers had been up to 160 in the early 1880s, despite the secession to Wellington College, but there were only about eighty boys at college in Rutherford's time. Various additions had been made to the school buildings during the prosperity period. A reading room and library had been built in the early 1880s, and the college history records: "As early as 1881, Mr J. W. Morton had fitted up the old bathroom and boothouse as a Chemistry Laboratory . . . and had ordered a stock of chemicals." Some thirty pupils joined his first chemistry classes, and even further strides were taken in science teaching when W. S. Littlejohn came on to the staff in 1882. The college history describes the progress: "Apparatus for work in other branches of science was added . . . Complaints about the inadequacy of the damp, draughty, old shanty known as the Chemistry Room, plus a growing awareness in New Zealand of the importance of practical science . . ." led the governors to appoint Littlejohn into the official position of science master and to build a proper laboratory in 1890.

When Rutherford first arrived at the college he would undoubtedly have been classed as a "small potato" in the schoolboy jargon of that place and time. And this despite the fact that he was a rather large and healthy boy, a little older than the average new boy, and that he started up the school higher than was usual – in Standard V – presumably because of his outstanding scholarship results. It is characteristic of the man he was to become that he called important people "big pots" for many years – throughout his life his admirers noted a "boyish enthusiasm" – while the few who

found his company uncomfortable were irritated precisely by his lack of adult phraseology and seriousness in his outward behaviour.

That Rutherford was treated from the start as a "clever" boy is demonstrated by his mother's memory (recorded many years later by Marsden) of the first interview between the Rutherford parents and the headmaster of Nelson College. The old lady described the conversation:

> After a short talk concerning Ernest and his abilities he said to us both, "I have a personal favour to ask of you and will tell you the reason why. Bishop X's son is learning Greek as well as Latin but where there is no competition there is no emulation, so I would esteem it a favour if you would allow your son to learn Greek as he has shown his knowledge of Latin in his exam papers." After thinking it over we consented and at the end of the year he won the Stafford and Senior Classical scholarships, so all was well.

A big, strong boy from a country background does not fall easily into the unpopular character of "a swot", and it is fairly clear that Rutherford had the physical size and the emotional fire to avoid what is probably the most unpopular of all schoolboy roles, while still retaining his power to work. A contemporary (C. E. Broad) recalled that "he had such powers of concentration that he would continue to read in the uproar of an unsupervised common-room, but when a missile landed on his head he would roar into activity with good-humoured rage". Eventually, in his last year at Nelson, he got into the rugger team as an efficient, if undistinguished, forward, but in New Zealand of all places, competence at the national sport (some say religion) of rugby football is a guarantee of popularity and high regard.

The headmaster who persuaded Rutherford's parents to let him learn Greek was W. J. Ford, a Cambridge M.A. who had taught for nine years at Marlborough, one of the better known, and more athletic of English public schools, and there he had become a housemaster. Ford was appointed to Nelson in 1886, just before Rutherford arrived, and he left early in 1889, while Rutherford was still a pupil. The official history of the college says that "a combination of circumstances led to his resignation", while a local history says he left "for financial reasons". He is described as "a very tall man with a black beard, a mighty hitter at cricket, capable of singing a lively song either solo or in a quartet with other members of the staff". All sources agree that he was a very good teacher, particularly of classics, and when Rutherford revisited the college in 1925 he spoke of Ford's "profound influence on me particularly in a literary direction".

But the man who really influenced Rutherford was the second master, William Still Littlejohn, an M.A. of the University of Aberdeen. He was in charge of the teaching of maths and science and in every respect was the opposite of Ford – small, wiry, bespectacled with jutting and unruly red hair, but with a personality that outshone any physical deficiency, so that Rutherford nearly fifty years later described him as "a fine figure of a man with his leonine head and ruddy hair and beard".

Throughout his life Rutherford's writing style was cool and lucid. This makes his books and papers exceptionally easy to read and understand. It makes his letters businesslike and impersonal. But when he came to write about himself he became unutterably boring. In the whole of his vast collection of papers there is only one in which fire and emotion breathe through. It is a description of a contest between Ford and Littlejohn which Rutherford wrote in 1934 in answer to a fairly routine request from a New Zealand writer, Alec Einar Pratt, for reminiscences of Littlejohn for biographical purposes.

The battle took place on the cricket field one weekend when Ford was entertaining a visitor from England who was also fancied as a cricketer. These two men apparently took on a team of Nelson College boys strengthened by Littlejohn. Rutherford wrote, "I was not a player but watched the game from the terrace overlooking the cricket field," and he describes how the match soon became a friendly competition between Ford and his guest to see who could make most runs – and in the course of this competition plainly forgot all obligations of sportsmanship towards their opponents. The two men hit everything the boys could bowl at them all over the field, wrote Rutherford, and he described how Littlejohn, playing wicket-keeper and quite without any chance of stumping the two great men, eventually took the ball "from the now weary boys". Although "not much of a bowler", he tried for over an hour using both overarm and underarm bowling; he never gave in and "attacked with the light of battle in his eyes". The interesting feature of this childhood reminiscence is that it did not end with victory for the boy's obvious hero – it ended with defeat – "in this case virtue was not rewarded. The team had been martyred to make a Roman holiday for the visitor." And Rutherford's final conclusion was that this had left him "with an enduring impression of high courage and resource under difficulties, and, though technically defeated, I thought Littlejohn was the true hero of the occasion".

Littlejohn was certainly the man who directed Rutherford towards science, although it was by no means clear at the beginning

that this was the course he would take. The master was in essence a mathematician and Rutherford was honest enough to recognise this, however much he admired the man: "I thoroughly enjoyed the teaching in maths, but the science teaching did not attract me so much, for I imagine Littlejohn had not the same width of knowledge in the subject as in mathematics." Also the teaching of physics, chemistry and practical chemistry in a converted boot-room may be thought a rather tall order for a man who was basically a mathematical specialist.

Rutherford paid Littlejohn a compliment which probably sounds more valid in our egalitarian age than it did in his own time – he wrote: "He was a fine teacher of mathematics. The boys varied in ability but he grounded them all thoroughly in algebra, Euclid and mechanics." The teacher, however, was perfectly willing to devote his own time to the more able, and he gave Rutherford private coaching at his own home in maths and science subjects. Littlejohn's children have remembered being sent off to the back quarters with strict instructions to be quiet in their play when Rutherford came to their father for special tuition. And it is well remembered in the Nelson neighbourhood that Littlejohn and Rutherford went for long walks both in the hills and along the coastline at weekends and Littlejohn would often halt to draw diagrams with his stick in the sand or the earth to illustrate the points he wanted to make in their discussions. There are also tributes from the pupil to the master's good standing as both humorist and disciplinarian, including the memory of the occasion in a science class when a boy, who was not attending properly, casually, almost abstractedly, picked up a bottle of chemical reagent from a shelf; Littlejohn saw this out of the corner of a good schoolmaster's eye and sharply but quietly told him to "drop it": the boy obeyed him implicitly and the bottle smashed to the floor. Littlejohn also brought his enormous enthusiasm to the running of the college Officer Training Corps in which Rutherford came to shine as a sergeant – his first and last experience of any military drill or discipline.

Both Nelson College and Rutherford himself remembered with pride the exceptionally smart display of drill provided by the Corps when Lord Onslow paid an official visit to the school following his appointment to the post of Governor of New Zealand. This occurred only a few months before Rutherford came to the end of his career there, and he was "Dux" of the school. It fell to him, therefore, to deliver the address of welcome, which had been written by the headmaster, Joynt. For some reason he was shy, and this was remembered many years later when F. J. Mules wrote to

him in 1937: "I sometimes recall your reluctance to discharge your responsibilities as head boy and resign the duty of reading Joynt's address of welcome to the Governor."

Joynt remained as headmaster of the college until 1898, when he became registrar of the University of New Zealand, and was immediately succeeded by Littlejohn as headmaster of Nelson College.

Rutherford's academic achievements at Nelson were impressive, though it must be remembered this was a provincial colonial college with only eighty pupils. He won prizes in every one of his three years there, prizes in English, French, history and Latin as well as in his strongest subject, maths, the most valuable being the Stafford and Simmons scholarships, each worth £100, which made a considerable difference at a time when the family fortunes over the hill at Havelock were undergoing considerable strain. In his last year he was top of the top class in all subjects. His report for June 1888 has been preserved and is of some interest: in classics "an occasional careless blunder" is his only fault; in English "has a retentive memory and a great power of reproduction"; in modern languages "a very careful scholar". No hint of genius or brilliance or imagination; that sort of note only comes in the report on maths: "Very quick, a very promising mathematician". The cricketing W. J. Ford recorded of him "Top in every class and his conduct irreproachable", but the succeeding headmaster, J. W. Joynt said, "Rutherford displayed some capacity for maths and physics but not to an abnormal degree and he was a keen footballer and popular boy."

Rutherford's earlier biographers have tended to leave his school career at that, implying that he carried all before him. But the records of Nelson College show that this was not so. At the time of Rutherford's schooling the question of examining the boys was a subject of controversy and change because the college had just been disaffiliated from the New Zealand University. Thus a visiting examiner in 1887, a Mr W. J. Kelly, a graduate of Dublin University, although recommending Rutherford for the classical scholarship, pointed out that another boy (C. E. Broad) was "slightly superior" in Greek. The mathematical scholarship, however, he awarded to Frederick Neve: "In Trigonometry and Arithmetic he was somewhat surpassed by Rutherford but this was more than counterbalanced by the other subjects." The same C. E. Broad also outclassed Rutherford the following year when the headmaster himself did the examining and gave Broad the first classical scholarship while Rutherford won the mathematical scholarship. And again F. Neve appeared in the honours list as

well. These reports show that Rutherford did not study chemistry, but chose the alternative subject of French.

It is therefore worth examining some of Rutherford's contemporaries at Nelson, for plainly they were not completely outclassed by him, as we have been led to believe. They were mostly honourable men, distinguished in their own small arena, but none approaching Rutherford's international status and fame. Broad had become headmaster of the same Nelson College by the time Rutherford revisited the school in 1925. Neve also became a schoolmaster. Ten Rutherfords are recorded in the College roll, including Ernest's two brothers. Some of them were not close relatives: none of them achieved more than local distinction and some of them hardly even that. The other five boys who won Education Board Scholarships to the college at the same time as Rutherford, were C. J. McEachen, who became a stationmaster, the same eminence as achieved by J. P. Petrie. J. A. Cowles became a teacher and inspector of schools, while J. H. C. Bond became superintendent of the New Zealand Shipping Company. C. A. Craig sounds the most imaginative of the group; he became a Catholic priest in Dublin and later returned to teach at Nelson.

Rutherford was, then, the best scholar but by no means outstanding in a small collection of worthy, but not particularly distinguished boys in a small, worthy college on the outermost periphery of European culture. He had at this stage shown no particular interest in science, but had received a sound and very broad education. Clearly even the most perceptive and sympathetic of his teachers regarded him as a good worker rather than a genius; Littlejohn's final report says, "*Nunquam non paratus*. Should give a good account of himself".

The young man took the next step in his career by winning his university scholarship to Canterbury College at Christchurch.

It was as well that he won the scholarship, for certainly at this stage his family could not afford him any help. Catastrophe had struck his father's enterprises at Havelock. The Atkinson government stopped the further building of railways and cancelled the order for sleepers. Floods on the Pelorus River drowned and killed the flax in the swamps, and James Rutherford himself was seriously injured, breaking several ribs, when he slipped and fell during loading operations on his jetty.

So, in what was still pioneering country and society, James Rutherford decided on another wholesale uprooting of his family. Through a relative on his wife's side he learned that there was flax available near New Plymouth in Taranaki province, where New

Zealand's most famous landmark, the beautiful cone of Mount Egmont, descends into the sea. He was able to buy land for £3 an acre at Pungarehu, thirty miles south of New Plymouth, and later he was able to cut flax from other nearby swamps under "royalty". After he had reconnoitred the place he chartered the sailing ship *Murray* with her captain, Captain Vickerman, and put his entire family, his horses, his flax-milling machinery, some spare timber, all his furniture and three extra "hands" on board and sailed for the North Island. Three days later they landed at New Plymouth and then the whole cargo had to be moved by wagon and horse along the still rough roads to their new home. In the course of his stay at Pungarehu James Rutherford invented and developed several new devices for treating his flax. His younger daughters married in the North Island, and the majority of Rutherford relatives are today to be found in that Island rather than in the South.

It is worth noting that James Rutherford was also a pioneer in attempting to plant flax, rather than relying solely on the natural growth and propagation of the plant, and that he went to considerable effort to find and experiment with specially selected varieties of the plant that the Maoris cultivated. But it was no way to make an easy living – a five-horse team could only draw three tons of flax on the two-day journey to the port of New Plymouth and the final product fetched only £13 a ton when it was sold in Melbourne.

So Ernest's family could hardly give him much financial support during his student days at Christchurch, and he could only go home during the long summer holidays – at other times he had to stay with his grandmother or other relatives still living near Nelson.

On at least one occasion when he did go home he landed at Wellington only to find that it was one of the days when no coach ran round the coast to Pungarehu. Without hesitation he walked the thirty-one miles.

He was still expected to take his share of the chores when he went home. Family memories assert that he repainted the house on one of his vacations and he also lent a strong hand in the various operations of treating and preparing the flax. But essentially, as with any other young undergraduate, this was the period when Ernest Rutherford cut loose from his family, and the break, in his case, must have been accentuated by the distance between home and university and the difficulty of the journey, including the sea crossing over a strait famed for its windiness.

Canterbury College was still in the first stage of its development. It was taking in just over 150 students a year, judging by the numbers matriculating, but there were only about 300 students actively working at any one time. The majority of the seven

professors then in residence were those who had been appointed when the college was opened in the early 1870s and were, therefore, born and educated in Britain. The college's total income was less than £10,000 a year and only about £400 of this came from students' fees – the largest part came from the 300,000 acres of land with which the college had been endowed by the early government of the province.

From the fact that Ernest Rutherford is listed as Number 338 in the catalogue of graduates from the college (prepared in 1927), and from the discrepancy between the annual numbers matriculating and the numbers attending, we may deduce that there was a high proportion of "drop-outs", but doubtless many of these would be youngsters whose families moved in that highly mobile society, and others would be country boys for whom the financial strain of a college education in those depression-times had proved too much. Rutherford himself lived largely on scholarships – these awards appear now on his list of academic distinctions, but there can be no doubt but that at the time they represented his main financial resource.

His academic record at Canterbury College is certainly impressive. He arrived with a Junior University Scholarship in 1889 and his date of matriculation is given as March 23rd, 1891. He won maths exhibitions in 1890 and 1891. The following year he won exhibitions in experimental science and maths. In 1893 he was awarded his B.A. degree and won a senior scholarship in maths. In 1894 he achieved his M.A. with the rare distinction of a "double first" – First Class Honours in Physical Sciences and Mathematics.

There is some slight problem about the dates in this academic list, in that they do not correspond to the dates given in, for instance, the official testimonials drawn up for Rutherford by the university authorities when he applied for the "1851 Exhibition Scholarship" in 1895. Most of the dates given in these testimonials are one year earlier than in the Canterbury College history, but this can be easily explained by the fact that he would have taken his exams for, say, the M.A. and passed them at the end of the academic year 1893, yet he would only have been officially "gazetted" with the result in 1894. There is more difficulty over the question of whether he was officially awarded a BSc degree by Canterbury. The first, and major, biography by A. S. Eve, records him as having obtained this degree. But the official history of the college does not record it. His testimonial in 1895, provided by Arthur Dandy, Chairman of the Professorial Council, says simply that he passed "the University examination for BSc" in 1894, but does not say whether he was actually awarded, or took, the degree.

The academic record as it stands seems to present a clear and simple picture of a brilliant student sweeping all before him and taking all the necessary early steps on his way to becoming the great scientist of the future. A closer look at the details reveals something rather different. When passing the first section of the exam for B.A. in 1891, Rutherford took not only maths and mechanics, but also Latin and English. A letter from his headmaster in his final year at Nelson, J. W. Joynt, dated July 11th, 1890, that is after Rutherford had left college and before he went to Christchurch, expresses doubt "if it will be possible to procure Bradley's *Aids to Latin Prose* in New Zealand". But the headmaster will try to get it and will have it sent if it can be found and adds, "You are right to try and do some work waiting for term to open."

When passing the final section of the B.A. exam in 1892, Rutherford took French and physical sciences, and also won the Senior University Scholarship in maths. When obtaining his "double first" in the M.A. exams he took optics and astronomy in the mathematics part of the course and we hear of "electricity and magnetism", which was to be his eventual choice for research, for the first time only in the physical sciences part of the course. Yet in the following year, 1894, when taking the BSc exam, Rutherford took papers in maths and applied maths, in Latin, English, chemistry, physical science and geology. We know, further, from the earliest of his notebooks to be preserved, that in 1893 he was taking courses in botany and biology.

There is a tendency among those distinguished scientists who have given Rutherford Memorial Lectures to praise all this as an example of a "truly broad education", and the avoidance of early specialisation. It can equally well be interpreted as not knowing exactly where he was going – a young man who undoubtedly had the power to work hard so that he could pass any exam in any subject he cared to take, but who showed no particular flair for anything and who certainly showed no sign of youthful genius in the subject in which he was to dominate all his contemporaries.

This was obviously the opinion of the soundest of his teachers, C. H. H. Cook, the Professor of Mathematics who wrote in his testimonial, "He is possessed of considerable mathematical abilities, and is endowed with great power of work so that he has been a highly successful student," which is hardly what even the "soundest" of professors would write if he felt he had a "high flyer" to write about.

Charles Henry Herbert Cook, first Professor of Mathematics and Natural Philosophy at Canterbury College, was undoubtedly

one of the major influences on Rutherford's intellectual development. He has been described as "solid, serious, dignified, greatly esteemed, a very corner stone of strength and stability", yet despite his large beard he could look smiling and cherubic. He loved choral and church music, yet he was a keen supporter of cricket and athletics at the university. He was a major proponent of university reform and played an important part in the national discussions about the shape of the University of New Zealand. But, above all, he was an excellent teacher and Rutherford acknowledged this throughout his life. And, most important for Rutherford at this crucial stage of development, Cook was completely sound and orthodox both in his teaching methods and in his own published works.

Cook had been born in London in 1844, and was therefore not yet fifty when Rutherford came under his influence. He had been taken to Australia when very young and graduated at Melbourne University. He returned to England, went to Cambridge and emerged as Sixth Wrangler in the mathematical finals of 1872. He then decided on a career as a lawyer and started reading for the Bar, but within less than a year he accepted the offer of the Professorship of Mathematics at Canterbury and emigrated finally to New Zealand.

It has often been said of Rutherford that even at the height of his power he was "no mathematician". In the sense that this phrase might be used by his great contemporaries among the European theoretical physicists this was true – he was never a man for Hamiltonians or quaternions. But it is only a half-truth. In all his greatest discoveries Rutherford was strictly quantitative. Measurement and mathematics were always present. This point will have to be emphasised again and again in examining Rutherford's scientific work – but though the mathematics he used as a scientist was simple to the mathematician, at all times the results observed in experimental situations were strictly compared with the results to be expected if such-and-such a law described the situation being examined – often it was a comparison with some simple law of scattering. The physical meaning – the model or vision of the Universe – was therefore either being confirmed or refuted.

Whitehead wrote of seventeenth-century science, "Mathematics supplied the background of imaginative thought with which the men of science approached the observation of nature" – and this is what Rutherford's maths was for him. And this is what he owed to Cook.

But it is also interesting that there is an eye-witness account of Cook discussing a problem in optics with a clever pupil, M. C.

Keane, a man some years junior to Rutherford, who despite his brilliance in mathematics at university subsequently became one of New Zealand's most respected journalists. The discussion took place at a point where the coach took over from the train on the journey to the West Coast. The story tells of Cook drawing diagrams on the dusty surface of the country road while discussing some problem that had been set in the exams. Keane, who was without coat, collar or tie, and in ragged trousers, was also without shoes, and he drew his diagrams with his bare big toe, holding up the coach while the argument went on and the professor happily missed his lunch. The episode is described as one "that could only have occurred in New Zealand" – but it is remarkably similar not only to the stories of Rutherford and Littlejohn on their Saturday walks in the Nelson area, but also the legends of Archimedes scrawling on the dusty floors of his villa in Syracuse. Plainly the New Zealanders (certainly of that time) liked to visualise themselves as simple, "pure", and poor classical scientists, and it will become clear that this is how Rutherford saw himself, too.

Cook, however, also had another role in Rutherford's development. He was counterweight and antidote to the other chief influence, Alexander William Bickerton, the first of all Canterbury's professors, the Professor of Chemistry. Bickerton was both Rutherford's inspiration and a perpetual "awful warning". He was heterodox, speculative, willing to dabble in almost any field. It was Bickerton who started Rutherford on research and appreciated and supported his first independent work. Yet forty years later Bickerton was still there in Rutherford's life, causing a struggle in the conscience of the President of the Royal Society, a struggle between Rutherford's famous loyalty and love on the one hand, and his scientific integrity on the other, as he despairingly tried to save the old man's "face" and finances whilst admitting that he had become an elderly scientific crank.

Bickerton was born in 1842 in Hampshire, trained as an engineer, and worked first in railway surveying. Soon he invented a new wood-working process and set up a factory in the Cotswolds, but also started teaching in a technical school in Birmingham. Thence by scholarship he progressed to the Royal School of Mines in London, and his experimental methods of teaching science led to his appointment to develop the science work at the Hartley Institute in Southampton and to an appointment at Winchester College as well as a job as county analyst. He was offered five professorships by the time he was thirty-two, and the one he accepted was Canterbury.

Bickerton came to Christchurch in 1874 as Professor of Chemistry – to which subject physics was later added. He had been selected by Lord Lyttelton who had been asked to find someone "young and with promise of future excellence", and his English thesis on the correlation between heat and electricity had been influential in obtaining his selection. He was offered a salary of £600 a year and he arrived in time to begin work in the first term in which Canterbury College officially began teaching. He was, therefore, the first professor of the university.

"He had a gift for public demonstration that was invaluable in those early days and an almost divine enthusiasm for science that at times carried him to excess," according to one author, Jenkinson, who is not prone to criticise. Another writes:

> Bickerton was nothing of a mathematician, otherwise, perhaps his physical ideas could not have been so heterodox, but also his originality was enhanced by his completely direct approach to the problems in which he was interested . . . There was, it seems, a strange mixture of the true scientist and the completely uninformed amateur in this remarkable individual, but as far as his influence on Rutherford is concerned two things at least may be said to his credit. He had boundless enthusiasm for research – and, in his more solid achievements he showed, by his very neglect of mathematical analysis, that the experimenter does well who keeps mathematics, not as a mistress, but as handmaid – and even then dispenses with her services at times.

This latter description was written by Norman Feather, one of Rutherford's own pupils who later became Professor of Physics at Edinburgh. It is therefore the more interesting that the less critical author also tells this story of Bickerton:

> . . . He was a poor mathematician with little faculty for exact arithmetic. His mistakes in the simplest problems of addition or subtraction were the standing joke of the back row in his classes. The professor, however, had an extraordinary faculty for a mental graphic arithmetic of his own. After looking at a long collection of complicated figures on the board, Bickerton would close his eyes for a few seconds and then dreamily announce that the final answer was about 430,000. No one in the class could tell offhand whether the answer would be closer to 0 or 40,000,000 but excited calculators would soon whisper some such figure as 437,618 round the amazed audience.

Rutherford obviously picked up Bickerton's public attitude to both mathematics and calculation, even though his serious commitment to both subjects was much greater than his master's.

Bickerton's many papers and publications varied from "On

Chlorine as a Cure for Consumption" to "On Molecular Attraction", from "On the Equilibrium of Gaseous Cosmic Spheres" to "On Hail". But his great work was his astrophysical "Theory of Partial Impact", an explanation of the origin of many astronomical phenomena such as double-stars, variable stars, novae and so on. This theory was put forward in a series of eight papers delivered to the Philosophical Institute of Canterbury between 1878 and 1880 – papers that even his kindest critics have been compelled to call "rambling, discursive and self-repeating". Some argue that Bickerton's work in this field has been wrongly neglected; it is only important here to wonder whether the concept of one body with great energy crashing into an isolated system of other bodies in space may have left any impression on the mind of the young Rutherford, so that when his turn came to consider the problem of energetic particles crashing into systems or bodies such as atoms he was freer to use his imagination than any of his contemporaries.

The principal forum for this remarkable if unreliable professor was the Philosophical Institute of Canterbury, the local branch of the eminently respectable New Zealand Institute, which has now become the Royal Society of New Zealand, and is the country's major learned society. It was, at the time when Rutherford was first elected a member on July 6th, 1892, rather typical of such institutions in a pioneering society – it was trying to build itself a tradition. In just the same way Canterbury College insisted on maintaining a regulation of 1878 that undergraduates must wear academical dress of gown and mortar-board at all times when on the college premises. Rutherford's first major research, published on November 7th, 1894 in a paper he read himself, was the first major research to be announced to the Institute, though Bickerton had read, typically, dozens of speculative papers to the same body over the years.

Yet it was undoubtedly Bickerton, and not Cook, the stern mathematician, who encouraged Rutherford to start research, although the young man was, at first sight, a mathematician. And it was Bickerton who appreciated, more than anyone, the importance of Rutherford's first researches. In his testimonials for the 1851 Scholarship it was Bickerton who wrote:

> From the first he exhibited an unusual aptitude for experimental science and in research work showed originality and capacity of a high order . . . Mr Rutherford conducted a long and important investigation in the time effects of electric and magnetic phenomena in rapidly alternating fields, and by means of an ingenious apparatus of his own design, was enabled to measure and observe phenomena occupying less than 1/100,000th of a second.

Bickerton also added, in his typically enthusiastic way, a comment that was completely inappropriate to a scholarship recommendation, yet is of great importance to the understanding of the young man he was recommending.

"Personally," he wrote, "Mr Rutherford is of so kindly a disposition and so willing to help other students over their difficulties, that he has endeared himself to all who have been brought into contact with him." The heterodox professor has a lesson for the modern biographer – under the blaze and weight of Rutherford's scientific discoveries and behind the supreme scientific politician he was to become, it will inevitably be hidden and forgotten that he was a man of exceptional personal kindness. Everyone who remembers Rutherford remembers this – that he was personally kind to them far and away beyond the normal behaviour of a pleasant human being. It is recorded by many memorialists that "Rutherford never made an enemy or lost a friend". But the man who was one of Marie Curie's great supports in her troubles is still remembered by elderly widows in England for his kindness to them when they were little girls or young wives at formal social occasions.

Rutherford threw himself into the life of the uncertain but enthusiastic young University College in Christchurch, in no way confining himself to science. He played rugby and became secretary of the young Science Society, a livelier congregation than the Philosophical Institute. The programme card for the 1894 session of this society, when Rutherford was only a committee member, shows him lecturing on "Electrical Waves and Oscillations" – he had begun his own research into this subject by this date. But his talk, on May 12th, is sandwiched between "Standards of Conduct: a Survey of Ethical Systems" and "The Subterranean Crustacea of New Zealand". The programme card states that the Science Society normally met in the Chemical Lecture Theatre, but on one occasion, when Rutherford himself was secretary he noted, "It being cold in the normal lecture room, the society adjourned to Mr Page's room." In some earlier biographies it has been said that Rutherford was only reluctantly persuaded to become secretary because the Science Society had come in for considerable criticism after a programme of talks on Evolution, including a lecture by Rutherford himself on "The Evolution of the Elements". There is no documented evidence of such a talk nor even of the society coming under public criticism, though this subject was a favourite Rutherford title some twenty years later. The subject seems inherently unlikely in 1895 although it became a reasonable subject for speculation after the great unravelling of the

mystery of radioactivity during Rutherford's spell in Canada in the first decade of the twentieth century.

If he did, as a young man, come to any form of public attention it is far more likely to have been on account of his activities in the Dialectic Society – the general debating society of Canterbury College – for throughout his life he loved a good argument for its own sake. When the subject of the Dialectic Society for the evening was "Is sculpture or architecture the greater art", Rutherford introduced a new note by arguing that the architectural beauty of the new College Hall (a late Victorian Gothic structure) was spoilt by the intrusion of an ugly telegraph post laden with wires. He asserted that the day was not far distant when the wires and therefore the post as well, would be unnecessary since science was on the threshold of discoveries that would lead to other methods of communication. He was referring obviously to his own early work in the field of "wireless communication", and his intervention must certainly have produced an interesting variation on a rather worn set of arguments, though we do not know whether he voted in favour of architecture or sculpture.

The list of his academic achievements in terms of scholarships and exhibitions is, indeed, impressive, though it is rendered rather less formidable by the realisation that the scholarship system in New Zealand was more highly developed and more officially supported than in Britain, for it was an accepted mechanism to enable the young in this scattered and pioneering community to achieve the generally desired high standard of education. More important, it has to be realised that Rutherford did not sweep all before him. He was not the most brilliant of his contemporaries, though he was in the first rank.

Rutherford had not entered Canterbury College at the head of the Scholarship list, and though he invariably headed the table in mathematics, he had several rivals who seemed to outrank him. In particular there was W. S. Marris, later Sir William Marris, who eventually became Governor of the United Provinces as the climax to a fine career in the Indian Civil Service. Marris won just as many mathematics exhibitions and scholarships as Rutherford and added to these many in Latin, though he was two years younger. Marris recorded, when A. S. Eve was gathering material for his biography, how he often triumphed over Rutherford in maths exams, because the papers set by Cook demanded a detailed knowledge of the "bookwork" at which he excelled while Rutherford was essentially a "problem solver". This evaluation by a fellow student seems to have been particularly acute, for in some unsigned notes which are a mark list for the Honours maths and

physical sciences paper, Rutherford is placed top in optics, geometry and algebra with the remark, "The work on the practical paper is greatly superior to anything I remember to have received in previous years". Marris also remembered that Rutherford was nervous in the examination hall.

But there were several others who entered Canterbury College at the same time as Marris and Rutherford who seemed, on their academic records, to be at least in the same class – Edgar S. Buchanan in modern languages, J. A. Erskine, another scientist specialising in physics, and James Hight, who made his name in the English department and became New Zealand's first Ll.D.

Indeed, when Rutherford finally left Canterbury at the end of the 1894 academic year his view of the future was by no means clear. He had, a year earlier, seriously considered going into medicine. This is proved by the existence of a letter from John Stevenson, a contemporary at the university (his date of matriculation is officially recorded as ten days after Rutherford's), who wrote from Edinburgh in September 1893. The letter is clearly in answer to one from Rutherford asking for advice about the possibilities of his joining Stevenson in medical training at Edinburgh and Stevenson advises the study of zoology before any move to Scotland. The description of student life in the Scottish capital, while revealing, is not encouraging – there is an Australian Club but it is "little less than a smoking, boozing, gambling den"; some lectures are attended by 300 students "all male and a rowdy lot they are" and "there are some of the most selfish, uncouth, brutal fellows attending some of the classes I ever saw".

It seems likely, from the censorious tone of this letter, that Rutherford had moved into, or been drawn into, a rather stern and puritanical social grouping. He is known to have taken lodgings quite early in his university career – possibly at the end of his first year – in the house of a widow, Mrs Arthur de Renzy Newton in North Belt, Christchurch. And it seems certain that this household, while not of the pious type, was strict and earnest. It was certainly anti-smoking and very strongly teetotal and even a centre of campaigning against drink. One of Rutherford's earliest friends, J. A. Erskine, who followed him, also with an 1851 Scholarship, to Europe, writes in his youthful letters most apologetically about his own passion for opera and excuses himself for his visits to the opera houses of Europe in the tones of one who is well aware that this will be regarded as frivolity and time-wasting.

Forty years later, one of Rutherford's oldest friends and protégés, Dr Clinton Coleridge Farr, apologises in a letter to Lady Rutherford that in a "primitive" pamphlet published at Havelock

he has stated that Rutherford was not a "potted angel" and adds, jovially or jokingly – it is impossible to tell which – that he has "armed himself with irrefutable evidence of the fact". In another letter the same Dr Farr, who was Professor of Physics at Christchurch, describes the vigorous activities of Mrs Newton in a local by-election.

This Mrs Newton, the widowed landlady, had four children, and Ernest Rutherford fell in love with the eldest of them, Mary. In the manner of those days, this attachment was at first an "unofficial" engagement, known only to the two families. Later the engagement was made official, but the marriage could not take place until he could afford to support a wife, which only came about when he obtained his first professorship. The courtship therefore lasted some six years. And that, for all practical purposes, is the end of the story of Rutherford's romantic sex life. There is no trace in the records or in the memory of those who knew him of any other attraction or attachment to a woman throughout the rest of his life. To the morals and psychology of the 1980s this may seem evidence of the sexual diffidence found in him by C. P. Snow. To his own generation it was evidence of an ideally happy marriage, as all the biographers and memorialists who wrote immediately after his death record it.

It was certainly one of the very few firm guiding lines of his life as he ended his university career. Otherwise the future must have seemed very clouded. Two descriptions of him by his contemporaries emphasise the point: "Very modest, friendly but rather shy and rather vague – a man who had not yet found himself and was not then conscious of his extraordinary powers," according to Sir William Marris; "A boyish, frank, simple and likeable youth with no precocious genius; but when once he saw his goal he went straight for the central point," Sir Henry Dale recorded.

It is only with hindsight that we can see that the physical research he had started in primitive conditions in a college basement was to open for him the doors to a wider world, was to provide him with the life and lifestyle he relished, and was already forming the mental processes and methodology by which he would change man's view of the world in which we all live.